Department of Marketing

# Green innovation games

## Value creation, managerial roles and managerial capabilities in resource intensive businesses

Tommi Lampikoski

Aalto University

DOCTORAL DISSERTATIONS

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# Abstract

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**Abstract**

Along with increasing environmental concerns and customers' growing knowledge of environmental and societal issues, corporate sustainability has gained increasing interest among management scholars and business practitioners alike. Mounting public interest in environmental questions, triggered by numerous ecological crises and stricter environmental regulations, is forcing companies to view corporate sustainability as a strategic issue.

Previous literature on corporate sustainability offer taxonomies for general environmental strategies, and offer general ideas for developing and managing corporate sustainability programs. However, previous research has not paid sufficient attention to the specific characteristics of different types of green innovations. Also, existing research fails to specifically address the specific managerial roles within the different innovation approaches. To fill in these gaps in the current knowledge, this doctoral research investigates the management of value creation for green innovations in resource intensive businesses from the perspectives of radical innovation management and corporate sustainability. In so doing, this study adopts an explorative multiple case study approach, including a primary case and a number of supporting cases, based on interviews with 49 senior managers in the United States.

Through a qualitative empirical inquiry, the present study identifies and organizes green innovation into four different value creation strategies-referred to "green innovation games", and recognizes key managerial capabilities required in mastering these games. In addition, the research uncovers and elaborates three managerial roles in managing for green innovations, specifically associated with managing for radical green innovations in resource intensive businesses. Finally, the findings show that establishing and nurturing the identified managerial capabilities, roles and the ways to master the diverse innovation games can support the longevity and survival of strategic green programs in organizations.

The study makes several contributions to the research on corporate sustainability. Overall, by analyzing the innovation activity through which organizations have pursued corporate sustainability, the study structures the management issues of green innovation to assist in maintaining a systemic flow of incremental as well as radical green innovations. For managers, the results contribute to advancing the activities that aim to grow businesses to conform to increased environmental concerns. Moreover, by improving the understanding of value-creation strategies that foster corporate sustainability, the findings help capitalize on the opportunities offered by green innovations.

**Keywords** corporate sustainability, green innovation, resource-intensive business, value creation, Interface Inc., innovation management, radical innovation

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"All is possible". Laird Hamilton, 2012

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In Helsinki, Finland

15.5.201

## LIST OF THE ORIGINAL PAPERS

Paper I: Tommi Lampikoski. (2012). Green, Innovative, and Profitable: A Case Study of Managerial Capabilities at Interface Inc. *Technology Innovation Management Review,* 2(11): 4-12.

Paper II: Tommi Lampikoski and Kristian Möller. (2013). Collaborative networks in green innovation: strategic games, value creation logics and managerial capabilities. XXIV ISPIM conference, Conference proceedings, Innovating in Global Markets; challenges for global growth, Helsinki, Finland, June 16th-19th.

Paper III: Tommi Lampikoski , Risto Rajala and Mika Westerlund. (2014). Corporate sustainability in industrial manufacturing: Revisiting the change in Interface's business model. Submitted to an international research journal in August 2014. Unpublished.

Paper IV: Tommi Lampikoski, Mika Westerlund, Risto Rajala and Kristian Möller. (2014). Green Innovation Games: Value-Creation Strategies and Corporate Sustainability. California Management Review**,** 57 (1): 88-116.

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# LIST OF FIGURES AND TABLES

# PART I: OVERVIEW OF THE DISSERTATION

The first part of the dissertation presents the research theme and provides an overview of the implementation of the study. Chapter 2 presents the theoretical positioning, objectives, existing literature review and delimitations of the study. Chapter 3 reviews the methodology of the study. Chapter 4 explores the key results from the four papers included in the dissertation and connects the outcomes of these papers to the overall theme of the study. Finally, Chapter 5 concludes Part I by summarizing the key findings and discusses its relevant theoretical and managerial contributions.

## *1. INTRODUCTION TO THE RESEARCH THEME*

In the following, the growing importance of corporate sustainability and green innovations are illustrated, followed by discussion on the concept of a sustainable enterprise. Further, a brief analysis of the most relevant research approaches to green innovation[1] is presented, including the institutional, micro, organizational and corporate/industry levels of research.

### 1.1 The growing importance of corporate sustainability and green innovation

The importance of advancing an environmental agenda for various industries and companies has been rising in recent years. In the words of Nidumolu et al. (2009:2)

[1] Note: This dissertation and its essays use the term green innovation instead of the other similar terms such as environmental, eco, ecological or sustainable innovation. Basically, all of these terms refer to similar issues as related to an innovation's scope, nature and targeted outcome.

"There is no alternative to sustainable development". On the one hand, this is driven by increased consumer awareness on the environmental impact of their consumption choices and their willingness to reduce their ecological footprint (Harrison et al., 2005**).** On the other hand, within a company's market and social domains, corporate sustainability is motivated by an array of influences including considerations relating to business performance. A review of the literature on corporate sustainability reveals that considerable scholarly effort has been devoted to identifying the *drivers* of corporate ecological responsiveness and in debating whether an organization's environmental competitiveness can be encouraged by a regulatory regime that supports a dynamic and innovative approach to environmental issues (Porter and van der Linde, 1995). Consequently, Hart (1995) claimed that environmentally sustained competitive advantage may be be rooted in developing environmentally orientated resources and capabilities that can also improve a company's economic performance.

Some suggest that companies operating in resource-intensive businesses act as the engines of change in pursuing and solving various climate change challenges (Hawken et al., 1999). This, in turn, places demands to collaborate on the actors who contribute to existing systems. It also questions the capabilities and competences needed to effect change toward environmental sustainability and how these can be developed. Related to this idea is Van Kleefe and Roome's (2007) statement that business is an engine of change through its capacity for technological development and innovation. Reducing the environmental burden of complex business systems will involve companies stimulating and redirecting the focus of innovation. Yet there is lack of empirical evidence on how green innovations are conceived, realized and managed in companies (De Marchi, 2012). This research gap is addressed by this dissertation.

Prior research illustrates that the global environmental harms caused by companies'

business operations include the annual overuse of natural resources and increased greenhouse gas emissions (Hart and Millstein, 2003: Elkington, 1994; Hawken et al., 1999). The suggested solutions for companies to solve climate change related issues and to reduce their environmental burden include relying on companies' capacity for green technological development and innovation and in redirecting their focus of innovation activities. Azzone et al. (1997) claimed that companies may choose either a passive lobbying-based green strategy or an innovation-based green strategy. The passive strategy views the environmental aspect as the most important competitive priority and aims to introduce new technologies that radically improve the environmental performance of current technologies, and to create new market opportunities as a consequence of environmentally friendlier product innovations**.**

Figge and Hahn (2012) point out that suitable strategies for sustainable businesses exploit win-win situations that reconcile environmental protection and financial success. Accordingly, it has been argued that environmental measures and activities, such as environmental impact assessment (Bruhn-Tysk and Eklund, 2002; Lawrence, 1997), design for environment (Fiksel, 1996), pollution prevention and cleaner production (Bullinger et al., 1999), and environmental management systems (González-Benito 2008; Vastag et al., 1996) are positively associated with gaining competitive advantages and improved financial performance (Elkington, 1994; Salzmann et al., 2005). By adopting this logic, environmental investments and proactive environmental strategies are drivers of economic value creation as they contribute to achieving abnormal risk-adjusted returns on capital.

Companies can achieve such win-win situations through cost reductions due to less resource and energy use, higher revenues through new products and services, or lower

capital intensity through lean production (Epstein and Young, 1998; Florida, 1996; Hart and Milstein, 2003; King and Lenox, 2001; Orsato, 2006; Schaltegger and Figge, 2000). Overall, the "green" business case is concerned with defining environmental strategies that pay off financially in order to bring environmental management in line with shareholder value creation (Reinhardt, 2000: Hart and Millstein, 2003). Therefore, the aim of the "green" business case is to arrive at a more efficient use of economic capital. Consequently, with the increasing salience of environmental issues such as climate change, businesses and the private sector are facing ever increasing demands to play an active role in reducing environmental burdens effectively and in helping to achieve environmental sustainability (Bansal, 2002; Hoffman, 2005; Kolk and Pinkse, 2005; Levy, 1997; Reilly, 1999).

In sum, the growing body of academic and business literature on corporate sustainability and green innovation highlights that in order to successfully advance the principles of sustainable development, companies need a better understanding of how to develop and manage (radical) green innovations and new business models (see e.g. Etsy and Winston, 2006: MIT 2012). Yet there is a notable lack of empirical evidence on how companies are realizing their green innovation management activities. This dissertation improves the understanding of the concept of green innovation among researchers and practitioners.

## 1.2 Research objectives

The core objective of this study is to investigate how to manage value creation through green innovation in resource-intensive businesses. First, the key research objectives are pursued by reviewing the existing literature on corporate level sustainability, innovation management and green innovation literature, and in explaining the key differences between the concepts of traditional innovation and green innovation. Second, the aim of the empirical analyses is to enrich the understanding how to manage the value creation for radical green innovations within the primary case company of this dissertation. In doing so, this study analyzes the critical managerial roles and capabilities required to manage different green innovations (in particular the *radical* green innovations) and assesses the critical organizational and managerial barriers blocking entry to experiment with other green innovations. It further describes the critical catalysts that enable the creation of different green innovations in the context of green business pioneers in resource intensive businesses.

The overall purpose of the dissertation is separated into more specific research objectives that address different perspectives to the issue and which will be addressed in four essays forming the entire study. Consequently,

- Essay 1 studies "the managerial capabilities for managing radical green innovations in the context of a traditional manufacturing industry".
- Essay 2 investigates "the characteristics of green innovation networks and the value-creation logic of different types of innovation networks?"
- Essay 3 examines " how to manage the greening process of a company's

business model in a traditional manufacturing industry".

- Essay 4 examines "how a business can become a revolutionary green innovator and what strategies and managerial roles are required to enable the change".

Specifically, Essay 1 aims to identify distinct managerial capabilities for managing radical green innovations by analyzing a green business pioneer from a resource-intensive business context. This article aims to illustrate how a green business company in the carpet industry succeeded in creating a systematic flow of radical green innovation between 1996-2010. The article further describes how the case company organized and managed the green innovation process and which core managerial capabilities were developed.

The second article (Essay II) investigates the role and value creation logic of collaborative networks in green innovation. There is scant academic research on the types and role of green innovation networks. The study addresses this research gap by examining the value creation logic and managerial capabilities required in managing green innovation networks. It evaluates differing value creation logic of three green networks in the corporate context. This study concludes by identifying four distinctive green innovation types.

The third article (Essay III) discusses how a sustainability leader firm among established businesses manages its green business model transformation. The article identifies and characterizes the phases of the managerial business model greening process and illustrates them through a single case study in the carpet manufacturing industry.

Finally, the fourth article (Essay IV) further examines the key differences within the identified value framework for managing radical green innovation. This article aims to illustrate how leaders of resource-intensive businesses can identify the barriers to profound green innovations, eliminate the organizational and mental barriers and establish and nurture three distinct managerial roles for both evolutionary and revolutionary green innovations.

In sum, the study conceptually and empirically investigates and contributes to the critical issues in the management of green innovations through constructing a research framework by identifying four distinct yet interconnected green innovation types (or so called green innovation games). The research recognizes distinct managerial skills, roles and capabilities to reinvent business through green innovations and through playing the identified four green innovation games. It further pinpoints the critical mental and organizational barriers blocking the playing of the green innovation games and highlights the strategies to overcome the barriers. The research also investigates the critical elements of greening a company's business model which, in turn, may result as a catalyst for gaining differentiation and competitive advantage. These issues are investigated through analyses of selected cases, i.e. sustainability leader firms among the established businesses which are analyzed in the four separate essays included in this dissertation.

The limitations of this dissertation are discussed in Chapter 3.

## 1.3 Research process and outline of the study

This study pays particular attention to the radical, disruptive nature of green innovations. The study adopts an abductive approach to theory advancement and builds on the research of the radical innovation management, corporate sustainability and green innovation. Through these theoretical lenses, the basis for the dissertation is laid by studies that describe the core sustainability and green innovation concepts, and it illustrates the key business drivers and benefits for corporate sustainability. It further identifies the key differences between traditional and green innovations and provides a synthesis of the prior literature on green innovations.

The dissertation is exploratory by nature and it adopts a multiple case study approach, including a primary case and a number of supporting cases. The research is based on interviews with 49 senior sustainability managers in the United States. It was conducted over a 5-year period from 2009 to 2013, during which time the primary empirical data was collected from 33 sustainability leader firms among established businesses, including a few start-up firms.

### 1.3.1 Background and motivation for the research

Between 2009-2010, the research process started with an initial literature review and preliminary interviews with managers of several sustainability leader firms among established businesses. The early stages of the process strove for an understanding of the key content areas and concepts; relevant theories underlying firm green innovation understanding, as well as on the context, the resource intensive business and their

relationship with the principles of corporate sustainability. The initial idea was to explore firms' business models and partners' open innovation relationships within business networks. However, both the preliminary literature reviews of green innovation and the initial interviews with managers of identified case companies altered the direction of research and concluded that the study should be directed towards investigating the management issues and challenges in relation to management for different green innovations. The second phase consisted of additional managerial interviews, which were conducted between 2011-2012. These interviews focused on identifying the specific managerial capabilities and roles required in managing various types of green innovations, in particular when managing for *radical green innovations*.

Whereas the theoretical comprehension was created by reading peer-reviewed journal articles, green innovation and corporate sustainability related industry knowledge was deepened through a wide body of growing literature on practitioner-oriented books, industry reports, journals and magazines. Moreover, participation in a five-year research project on green business firms' business models and networks in between 2009-2013 at the Helsinki School of Economics and Aalto University – in collaboration with Finnish National Agency for Technology (Tekes) and the research cluster Fimecc – provided further insight into the radical innovation and green innovation research domain.

These projects involved a five-year on site research to the UC Berkeley Haas School of Business, which enabled access to numerous sustainability leader firms among established businesses in Silicon Valley and the East Bay area, two regions on the cutting edge of corporate sustainability in the United States. The long term visit provided the opportunity to interview senior sustainability managers working in publicly recognized leader firms.

The researcher conducted two case studies in 2009-early 2011, which are not included in the present study, but both of which assisted in formulating and directing the research approach during the later stages of the process. The first descriptive case consisted of a business case study of Nintendo Wii, conducted jointly with Professor Henry Chesbrough at the UC Berkeley Haas School of Business. The case illustrated the management model of creating a radical innovation within a gaming industry. The study highlighted the openness aspect of collaborating and creating open innovations with company external game-developers and extended the researcher's knowledge on the area of developing and managing radical innovations. Yet, at the time, the case analysis ignored the environmental aspects of the commercialized innovation.

In order to gain further knowledge on the green aspect of innovations, the second desktop case study focused on Interface Inc., the recognized sustainability leader firm among established businesses in the US. This study analyzed Interface's long term journey from an environmental polluter into a green innovator firm and it eventually instigated the key research topic for this study, since it became (surprisingly) clear that the management of radical green innovation was a rather neglected area of research in prior studies. Therefore, this study focuses on this research gap and it selected Interface Inc. as the primary case subject.

This research is represented as an essay dissertation and each of the essays investigates specific aspects of the primary case company's experiences with managing the value creation of radical as well incremental green innovations. The insights gained from an extensive literature review on the subjected case company, along with accessed company management interviews, are highlighted in all of the essays which were written in the secondary phase of the research process, as illustrated in Figure 1.

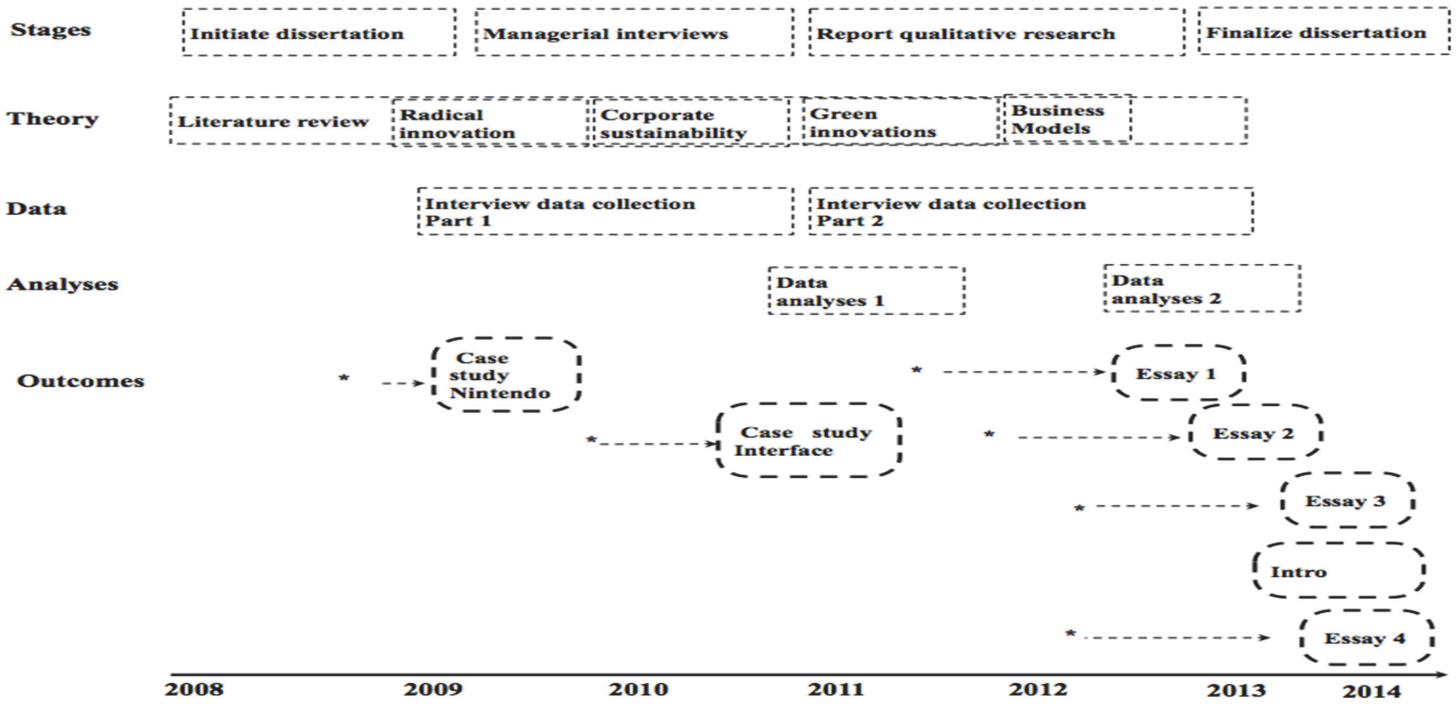


*Figure 1. Research process-main stages and activities*

### *1.4 Structure of the dissertation*

The dissertation contains two parts. Part I of the study is composed of five chapters. After the brief introduction and motivation of the study in the first chapter, Chapter 2 introduces the theoretical lenses and the essential concepts of the study. In addition to the theory content and concepts, the research context of the resource-intensive business is presented, and the phases and essays of the study are briefly illustrated. This positioning chapter is relatively extensive as it was noticed that the field is still lacking a comprehensive discussion on the forms, drivers and requisites of green corporate innovation. Chapter 3 presents the methodological considerations and the validity and reliability issues. Chapter 4 reviews the results of the original essays. Finally, Chapter 5 concludes Part I by summarizing the key findings and discusses its relevant theoretical and managerial contributions. The second part of the study consists of the original papers. The specific structure of essays and their links to core themes of this dissertation are presented in chapter 2.7.

## *2. Positioning the study*

In order to examine corporate green innovations, it is important to position the study in its field of academic research. The theory content supporting the empirical research, as well as the key concepts of interest and the research context are identified below.

### 2. 1 Conceptual background of the thesis

The aim of this literature review is to provide an analysis of the topic area and as such to serve as an introduction to the essays. The study explores the characteristics of value creation in green innovation from the perspective of sustainability directors and green entrepreneurs, focusing on the corporate and managerial level of analysis. A fairly extensive conceptual literature review of green innovation is included, providing an overview of the main ways in which the green innovation concept has been constructed in the prior research. This review establishes a context and positioning for the present research.

#### 2.1.1 Foundations for an extensive literature review

To begin with, this study adopts the principles of literature review underlined by Hart (1993), who stipulates that a literature review should consist of: (1) the provision of a conceptual and theoretical context in which the topic under investigation can be situated; (2) the presentation of a brief up-to date discussion of literature on the issues relevant to the topic and to the reader; (3) the illustration of reasons why the topic is of sufficient importance to be researched; and (4) the discussion of relevant research carried out on the same or similar topics of research.

There is no dominant nor consistent definition of a green innovation in the prior

literature. However, green innovation and corporate sustainability have gained increased attention from scholars as well practitioners. In order to better understand the non-established concept of green innovation and to gain overview of its evolutionary path, an extensive literature review was performed. This review covered the period of the origin of the term environmental innovation, from 1990 through December 2012. It was based on academic publications in the electronic EBSCO Business Source Complete database. The articles were sought using the search terms "green innovation", "environmental innovation", "eco-innovation" and "sustainable innovation". A total of 4875 academic articles matching these criteria were located. An additional search covered other databases and search engines, such as Proquest, Ebsco, Jstor and Sciencedirect, and the articles were sought with similar terms such as corporate sustainability and green innovation.

After the initial search, the researcher narrowed down the sample by focusing on high-impact academic journals such as *Academy of Management Science, California Management Review, Academy of Management Journal, Journal of Cleaner Production, and Business Strategy and the Environment.* The target articles in these journals were chosen on the basis of their titles, abstracts and keywords. Moreover, the core selection criteria specified that the articles had to have the term "green innovation", "eco innovation" or "sustainable innovation" in the title or abstract and that the full text of the article was available. The articles embodied either conceptual or empirical investigation of some aspect of the green innovation in business organizations, focusing on articles regarding the resource-intensive businesses. In addition, the final selection process focused on selecting articles which were both highly cited and had a high impact. The researcher utilized Schiederig et al.'s (2012) recent literature review analysis of the leading researchers and publication sources of the green innovation

phenomenon. The final selected articles were read in their entirety, and their key definitions and arguments concerning the management of green innovation were analyzed (See the References section which lists the key references used in this study).

## 2.2 Literature review

The underpinnings of a sustainable, "green" company are reviewed, followed with a literature review of the green innovation concept and contributing to the theoretical discussion on environmental, eco and green innovation. Throughout the literature analysis, the prior research's key arguments and research gaps which are relevant to this study are pointed out. Figure 2 illustrates the key research lenses of this dissertation.

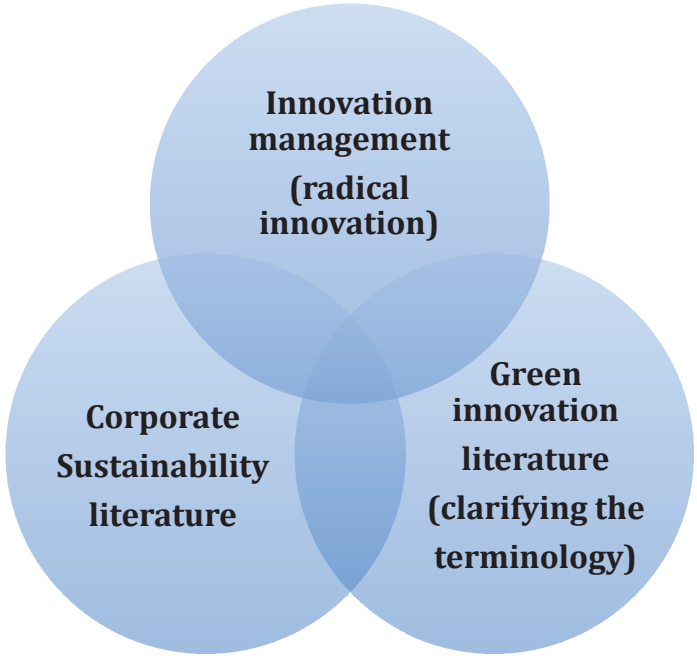


Figure 2. Key research theories of the dissertation

### 2.2.1 Definition of a sustainable enterprise

The idea of a sustainable link between business and environment centered around the notion that the goals of environmental conservation and the goals of business need not be disparate and conflicting (Barbier, 1987; Hawken et al., 1999: Holliday et al., 2002). According to Elkington (1994), a sustainable business contributes to sustainable development by delivering simultaneous economic, social, and environmental benefits-which Elkington (ibid) named as the concept of the triple bottom line—including the

components of people, planet and profit. Although criticized by some scholars (Dyllick and Hockerts, 2002: Prfiem, 2004), Gray (2006) claimed that the triple bottom line concept is increasingly accepted among business executives. Similar definitions to sustainable enterprise include *corporate sustainability, enterprise sustainability* and *green business.* Hart and Milstein (2003) pointed out that "a sustainable enterprise is a company that contributes to sustainable development by delivering simultaneously economic, social and environmental benefits". Their definition is based on Gladwin and Krause's (1995) notion of referring to sustainable development as a process of achieving human development in a connected, prudent and secure manner.

Holliday et al. (2002) suggested that only a few firms have begun to conceive sustainability as a business opportunity, offering avenues for lowering cost and risk, or even growing revenues and market share through innovation. Along the same lines, Savitz and Weber (2006) stated that a sustainable enterprise creates profit for its shareholders while protecting the environment and improving the lives of those with whom it interacts. Lash and Wellington (2007), in their study of US based large-sized companies, argued that firms in diverse industries will be at a competitive disadvantage if they do not pay attention to climate change and sustainability issues. In their opinion, companies that manage and mitigate their exposure to climate-change risks while seeking new opportunities for profit will generate a competitive advantage over rivals in a carbon-constrained future.

Recently, some practitioners and academics of corporate sustainability have launched the term of green business to describe sustainable businesses (Etsy and Winston, 2006; Winston, 2010: Werbach, 2010: Friend, 2009: Willard, 2009). In their view, a green business emphasizes the enduring commitment to advance environmental ideologies

and principles in one's business strategy and operations, and to decrease and eliminate the environmental and/or social harm caused by the production and consumption of their goods or services and focus on developing innovative products, services and processes that contribute to the sustainable development. Other researchers and practitioners (e.g. Wagner, 2009: Esty and Winston, 2006) stressed the importance of connecting green innovation with the core corporate innovation strategy. Their argument was based on the notion that environmentally conscious and ecologically friendly strategies could lead to competitive advantages and superior financial performance (Engardio, 2007; Esty and Winston, 2006; Hart, 2005).

To summarize, Zlonai (2001) highlighted a specific set of steps which a firm needs to follow in order to incorporate environmental goals into its business operations:

- cultivating and communicating its green vision
- taking a long term view of strategic planning
- developing green scenarios for the company
- formulating the company's environmental policy
- stating the value and procedures to follow
- developing and setting specific objectives and delegating responsibility for different areas of activity
- allocating resources such as finance, staff and technology with appropriate skills, and
- motivating, managing and coordinating the company's response to the environmental challenges

### 2.2.2 Reasons for managerial adoption of corporate sustainability

It has been broadly accepted that businesses are responsible for many of the global environmental problems, such as global warming and resource scarcity, which were identified in older studies such as Porter and van der Linde (1995) and more recently in an OECD report (2009) and by Lovins et al. (2009). As suggested by some scholars, this in turn has created a demand from the society, government, interest groups and all other stakeholders to ask firms to shift from traditional practices to more innovative green practices (Azzone and Noci, 1998; Bansal and Roth, 2000; Conceicao et al., 2006). For companies, these green practices include changes and revisions in strategies, manufacturing practices, product designing methods and resource consumption and all of which aim to minimize the stress on the natural environment and its resources. Furthermore, the media and consumers are increasingly more aware of the environmental impacts of human activities and may be more willing to make behavioral changes for environmental reasons.

Almost two decades ago, Hutchinson (1996) viewed a company's manager' motivation towards "greening" as a logical extension of a company's vision and values, or as an integral part of a firm's ideology, He pointed out that greening one's business typically initiated when a company faced a crisis situation such as when the cost structure of the business required a fundamental change, or immediately after being exposed by an environmental group or an activist organization, or when dealing with a potentially disastrous ethical or environmental accident or scandal. Hutchinson (1996) asserted that a sustainable society could improve the quality of life without destroying the earth's carrying capacity. Hutchinson's (1996) research indicated four responsibilities for business: social, i.e. respecting the community values; economic

performance in monetary terms; responsible resource use of energy and material; and ecology. Similarly, Hart and Millstein (2003) pointed out that there remains disagreement among managers regarding the specific meaning of and motivation for corporate level sustainability. Some managers view it is a moral mandate; while others view it as a legal requirement. For still others, sustainability is perceived as a cost of doing business—a necessary task to maintain legitimacy and the right to operate. Accordingly, Porter and Reinhardt (2007, 3) suggested that "while many companies may still think of global warming as a corporate social responsibility issue, business leaders need to approach it in the same hardheaded manner as any other strategic threat or opportunity".

While firms consider greening their businesses, they experience differing organizational and mental mindset-related barriers to change. These organizational and cognitive aspects are explored in the following.

## 2.3 The business barriers, drivers and benefits of corporate sustainability

### 2.3.1 Barriers to corporate sustainability and green innovation

The prior literature has identified several organizational and mental barriers to corporate sustainability. In 2003, Doppelt (2003: 2) argued that only a few executives in businesses grasp the fundamental paradigm shift that the sustainable development requires. According to Doppelt (ibid), managers are "blinded by long-held mental models", failing to fundamentally change the ways in which their organizations produce goods and services. Instead, these managers believe that sustainability involves better

controls, marginal improvements, or other "efficiencies" within their existing linear business model. Doppelt (ibid) claimed that these managers cling to the misbelief that traditional hierarchical organizations could manage so called cradle-to-cradle systems, instead of the traditionalized cradle-to-grave model, in which goods are produced and then discarded, instead of reused or recycled. Similarly, adopting an executive viewpoint, Nidumolu et al. (2009), Winston (2009) and Werbach (2009) pointed out that many companies become convinced that the more environmental-friendly they become, the more the effort will erode their competitiveness, as it might add costs and cannot deliver immediate financial benefits.

Doppelt (ibid) identified several barriers when companies seek to improve the management of environmental and social issues. These barriers included a lack of information, assigning environmental responsibility to a single unit, and lack of a clear vision. Table 1. highlights potential solutions for overcoming the identified barriers. Essay 4 of this dissertation identifies organizational and mental barriers blocking the entry to experiment with incremental and radical green innovations.

Table 1. Barriers to corporate sustainability (adopted and modified from Doppelt, 2003)

| Barrier | Solution |
|---|---|
| Patriarchal Thinking that leads to a false sense of security. | Change the Dominant Mindset Through the imperative of achieving sustainability |
| A "Silo" Approach to environmental and socio-economic issues | Rearrange the Parts by Organizing Sustainability Transition Teams |
| No Clear Vision of sustainability | Change the Goals by Crafting an Ideal Vision and Guiding Sustainability Principles |
| Confusion over Cause and effect | Restructure the Rules of Engagement by Adopting New Strategies |
| Lack of Information: | Shift Information Flows by Tirelessly Communicating the need, vision and strategies for achieving sustainability |
| Insufficient Mechanisms for learning | Correct Feedback Loops by Encouraging and Rewarding Learning and Innovation |
| Failure to Institutionalize sustainability | Adjust the Parameters by Aligning Systems and Structures with Sustainability |

In the following, the key drivers and benefits to corporate sustainability are described.

### 2.3.2 The business drivers and benefits of corporate sustainability

Many prior and recent studies have analyzed the critical business drivers for corporate sustainability. In general, these key drivers include:

- external stimulus and pressure from e.g., government regulation or social activism (Porter and Van der Linde, 1995)
- emerging business opportunities from technological advancements
- increased customer demand for environmentally friendly products and services
- transition of business mission and orientation toward corporate social responsibility and environmentalism
- increased need for collaborative action to address environmental challenges (Collins et al. , 2007; Horbach, 2008; ; De Marchi, 2010; Posch, 2010),
- transforming one's business to comply within the borders of four systemic conditions (Lovins et al, 1999), and
- recognizing corporate sustainability as the key driver for innovation (Nidumolu et al., 2009). Sharma et al. (2010) claimed that companies have advanced environmental sustainability e.g., in production and operations planning (Florida, 1996: Florida and Davidson, 2001: Dobos, 1999), recycling and reuse in manufacturing (Sarkis, 2001; Roy and Wheelan, 1992; Biddle, 1993), in green product design and remanufacturing (e.g., Guide and Van Wassenhove, 2001) and in pollution prevention (Bhat, 1992; Royston, 1980).

The importance of the environmental agenda for industry has been rising at the international level in recent years. Starting in the 1970s, the economic and social effects

of environmental degradation, caused by the unsustainable use of natural resources and increased industrial activity, combined with an ecological crisis initiated by companies, started to exert pressure on different industries to improve their performance. Also the combined influence and pressure from public and community opinion, environmental activist and pressure organizations, and the media started to target policy makers and initiated a regulatory regime which demanded high levels of compliance from the large industrial organizations and firms. On the one hand, the recent increase in consumers' awareness on the environmental impact of their consumption choices and their willingness to reduce their ecological footprint (Harrison et al., 2005) creates new market opportunities for companies.

On the other hand, increasingly restrictive policies punishing environmentally harmful behaviors and the actions of NGOs which raise attention on firms' polluting activities (Porter and van der Linde, 1995; Spar and Mure, 2003), encourages firms to control the effects of their activities on the environment to reduce reputation risks and avoid additional costs. Global societies have noted recently that environmental issues are increasing steadily due to the massive amounts of environmental pollution that are produced by industrial manufacturing (Chen, 2008) and the increased amount of greenhouse gas emission from globalized societies and the increased global population growth estimated to reach nine billion people by 2050[2] . This attention has driven many companies to accept environmental responsibility (Chen et al., 2006). Further, some researchers argue that the business continuity and sustainability depends on companies addressing environmental problems (Baker and Sinkula, 2005).

[2] See http://www.un.org/esa/population/publications/popnews/Newsltr_87.pdf

Shirivastava (1995) and Lovins et al. (1999) identified firms which hold the key role in advancing the economic development as they possess the financial resources, technological knowledge, and institutional capacity to implement ecological solutions (Schmidheiny, 1992; Welford and Gouldson, 1993). Adopting this view, several researchers and practitioners suggested that firms' pursuance of sustainability and increasingly embraced green values in consumption are key drivers of competitive advantage, and viewed that "going green" can be a holistic business solution that adds value to the companies and their stakeholders and that it should be a basic part of the system (Polonsky, 1995; Porter and Van der Linde, 1995). According to DeMarchi (2009), through green innovations companies integrate environmental concerns into their strategy while consolidating their competitive advantage.

Equally, Nidumolu, Prahalad and Rangaswami (2009) put forward the notion that there is no alternative to sustainable development and they viewed corporate sustainability as the key driver for innovation. In the empirical study of 30 large companies in the United States, including Hewlett Packard, Wal-Mart, FedEx, IBM, Waste Management, GE Cisco and P&G, Nidumolu et al. (2009) illustrated that these companies had increasingly advanced corporate sustainability in their business environment. Their study stressed the importance of placing sustainability into the core of firms' innovation activities. As a result, Nidumolu et al. (2009: 3) argued that "the increasing quest for sustainability is starting to transform the competitive landscape will force companies to change the way they think about products, technologies, processes and business models".

To summarize, as the challenges associated with sustainable development are multifaceted, involving economic, social, and environmental concerns, they have multiple implications for companies, including an increasing drive to collaborate with

external partners in order to reduce one's environmental impact.

#### *2.3.2.1 Collaboration for the development of green innovations*

It has been suggested that in most cases, the complex and systemic nature of environmental innovation has made green innovation a multi-party task requiring the participation of more than an individual firm. Evidence has been found in recent research of the growing role of cooperative arrangements in advancing environmental innovations (Collins et al., 2007; Horbach, 2008; Vachon and Klassen, 2008; Mazzanti and Zoboli, 2009; De Marchi, 2010; Posch, 2010).

Firms may have various reasons for forming environmental partnerships. For some firms, partnerships are one way of obtaining legitimacy from stakeholders and complying with environmental laws and regulations (Bansal and Roth, 2000). These firms are motivated by concerns about their public image, avoidance of penalties, or seeking approval of their products from their business partners (Fiedler and Deegan, 2007). For other firms, a partnership is an opportunity to join the evolving market for green innovations. Their motivations to enter into cooperative arrangements are access to new knowledge, sharing risk and pooling resources, each of which is essential to the gaining of competitive advantage (Hartman and Stafford, 1997; Biondi et al., 2002; Eckhard, 2008; Carrillo-Hermosilla et al., 2010). Moreover, a firm's direct influence on greenhouse gas emissions stemming from its operations are often limited, therefore a firm needs to collaborate with its customers – who are using the products – and with other stakeholders, such as suppliers.

Despite the broad research in the general field of innovation regarding the underlying

drivers of partnerships (Jorde and Teece, 1990; Tether, 2002; Fariaa et al., 2010; Zeng et al., 2010), there is little focus on green innovation. **Furthermore,** prior green innovation and environmental management literature lacks clarity in identifying influential partners. Evidence is scarce for explaining the extent to which different partners contribute to the environmental innovations of a firm (Yarahmadi and Higgins, 2012). The collaborative viewpoint of co-creating radical green innovations is inspected in Essay 2 of this dissertation.

#### *2.3.2.2 The benefits of corporate sustainability*

Prior research has pointed out the potential benefits of corporate sustainability. According to Fraj-Andre's et al. (2008), Miles and Covin (2000), Miles and Munilla (1993), Pujari et al. (2003), Shrivastava (1995), Hutchinson (1992) and York (2009), there are multiple benefits that corporations can potentially gain when integrating sustainability into their business. These include:

- efficient use of resources
- return on investment
- entering new markets
- increasing sales and revenues
- enhancing the corporate image
- attracting and retaining talent

- product differentiation and enhanced competitive advantages operations to be eco-efficient in order to gain competitive advantage over their competitors.

For many firms, the pursuit of corporate sustainability remains difficult to reconcile with the objective of increasing shareholder value. Indeed, some have even asserted that creating a more sustainable world will require firms to sacrifice profits and shareholder value in favor of the public good (see e.g, Friedman, 1970). However, by focusing on the legal or moral arguments for firm actions managers in this camp inevitably underestimate the strategic business opportunities associated with the corporate sustainability issue. To avoid this problem, managers need to directly link corporate sustainability and social issues to the creation of shareholder value (Banerjee, 2002; Hart and Millstein, 2003). In their view (ibid), examining global challenges associated with sustainability from a business perspective, can help identify strategies and practices that contribute to a more sustainable world and, simultaneously, drive shareholder value.

## 2.4 Key research approaches into green innovation

This study aims to provide a brief yet holistic picture of the key prior research approaches to green innovation. The focus of this review is on representing organizational, industry, and individual firm research approaches. However, the so-called institutional and macro-level approach, as well as the micro level approach are also briefly discussed, in order to provide a comprehensive overview of the green innovation discussion.

The corporate green movement has been studied through the lenses of numerous

theoretical disciplines and on various levels. For the purposes of this dissertation, the most relevant research approaches include (in descending order of relevance):

- *Institutional level research* presenting the concept of sustainable development (e.g. Brundtland, 1987) and the activities needed to form sustainable societies through active participation and guidance from governmental and other institutional entities (e.g. Kolk, 2005). Moreover, institutional research investigates the effects of different environmental policy instruments and legislative measures from single to a multi-country context (e.g. Porter, 1991; Elkington, 1994; Porter and Van Der Linde, 1995).
- *Micro level research* examining the behavioral patterns of environmentally conscious consumers, consumer groups or communities, often from the marketing perspective (see e.g. Antil, 1984; Ellen, Wiener, and Cobb-Walgren, 1991; Kinnear, Taylor and Amed, 1974). It further analyzes the emergence of markets for green products and services (Tolliver, 2009) and the impacts of green consumerism on the society. It also studies the "green washing" phenomenon, when corporations misleadingly claim to have developed environmentally friendly products to consumers (e.g. Delmas and Burbano, 2011).
- *Organizational level research* investigating the role of organizations in the adoption and implemention of environmental management strategies, programs and innovations. This area of research can be classified into two differing views, one of organizational and management theorists (Barnard, 1938; March and Simon, 1958; Thompson, 1967) and the other cof ecological theorists (e.g. Shirivastava, 1991, 1995; Daly and Cobb, 1994; Williams, Medhurst, and Drew, 1993). Their approaches differ on the role of organizations in adopting and implementing environmental programs and innovations.

- *Industry and firm level research* studying the required environmental investments, strategies and capabilities of environmentally focused firms. The initial research formed around two schools of thought. The first approach consisted of environmental economists and management theorists, who based their argument on the "win win" idea, meaning that the environmental investment made economic sense and benefited both the firm and the natural environment (for proponents of this views, refer to e.g. Hart, 1993; Saunders and McGovern, 1993; Elkington, 1994; Porter and Van der Linde, 1995; Giulio M. Gallarotti, 1995; Lovins et al., 1999; McDonough and Braungart, 2002; Esty and Winston, 2006; Werbach, 2009). Other research approaches embraced the "shareholder value" thinking and opposed the view that environmental investment automatically made economic sense to companies. Their argument was based on the fact that the basic function of the firm was to serve its shareholders (e.g. Palmer et al., 1995; Walley and Whitehead, 1996; Morsing, 2003).

In the following, a brief summary of these theoretical approaches are presented, starting with the macro and micro approaches. Next, the key organizational and industry and firm level of studies are presented. For the purposes of this dissertation, the key emphasis is placed on the industry and the firm level of studies. These choices are explained in further detail in Chapter 3. Methodology.

The organizational and firm/industry research approaches provide the conceptual underpinning necessary to understand the fundamentals of a sustainable business, highlight the key business drivers and illustrate the critical need to successfully create and manage green innovations. By doing so, the analysis, particularly at the corporate

level, complements the main theoretical and empirical framework and arguments established in the four essays of this dissertation. The institutional and micro research approaches are only briefly illustrated in order to provide additional insight into the multifaceted nature of the green innovation phenomenon.

### 2.4.1 The institutional and macro-level research on sustainable development

There is an ongoing debate on whether sustainable development can be defined operationally. Some agree (see e.g. Rennings and Wiggering, 1997), while others doubt or deny that it can (Norgaard, 1994; Cary, 1998; Minsch 1997). Those who doubt or deny understand sustainability more as a heuristic idea, similar to ideas of liberty and justice, guiding and orienting one's search rather than predicting its outcome.

At the institutional level, the trend towards more sustainable forms of development was initially identified at the UNCED conference in Rio in 1992, which presented the concept of *sustainable development*. This concept involves the integration of environmental thinking into every aspect of social, political and economic activity in a society. The classic definition of sustainable development was popularized through the work of the Brundtland Report, commissioned by the UN. The Report (WCED, 1987: 43) stated that "sustainability is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Therefore, the concept of sustainable development does imply limits – not absolute limits but limitations imposed by the current state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. By the mid 1990s, Elkington (1994) argued that a few progressive countries such as Holland, the UK, Japan and those in the European Commission were

in the process of adopting the concept to create a sustainable global society.

Elkington (ibid) further pointed out that most industries and businesses such as chemicals, coal, automobiles, pulp and paper, tourism and shipping would be affected by the emergent climate change issues and urged them to take proactive action. In 2005, according to Kolk and Pinske (2005), in a period of less than a decade, the policy and strategic debate on climate change had changed substantially. In their view, up until the late 1990s, most companies focused more on political, non-market strategies, usually opposing upcoming regulatory regimes relating to climate change issues.

Shirivastava's (1995) view also supported the opinion that governments must establish ecologically sustainable economic policies (see also Zimmerman, 1990). Upon adopting this policy view, governments often support firms' environmentally and socially responsible behavior through various policy instruments and subsidies with the intention of increasing international competitiveness and simultaneously supporting sustainable development (Porter, 1991; Porter and Van Der Linde, 1995). In recent years, the governments of, for example, the United States, Spain and Germany have provided tax or other benefits to the private purchasers of solar power.

In sum up, the primary focus of the international debate on sustainability has been on the importance of respecting community values and safeguarding the natural environment, thus prioritizing the social and ecological dimensions of sustainable development. As a result, the issue of sustainable development has been dealt with from an ethical, radical and macroeconomic perspective, while financial, managerial and competitive implications have been rather neglected (see e.g. Solow 1992; Pearce et al., 1989; Patton, 2005). This bias is particularly noteworthy since the pursuit of sustainable

development requires that firms allocate significant financial resources and face up to relevant managerial changes. If not rewarded by the market, such behavior may negatively affect a company's competitiveness (Chiesa et al., 1999) and its profitability.

### 2.4.2 Micro level research – green consumer behavior

The consumer and capital markets for green products, services, and firms have been expanding rapidly in the last decade. According to Tolliver (2009), the consumer market for green products and services was estimated at $230 billion in 2009 and predicted to grow to $845 billion by 2015. Sharma et al. (2010) state that researchers in several business disciplines have convincingly argued that environmentally responsible strategies can contribute to competitive advantage and superior financial performance. While debates on ecological conservation and environmental practices in the marketing field have raged for over three decades, much of the focus has been on understanding, identifying and targeting the environmentally-conscious consumers through marketing (Antil, 1984; Ellen, Wiener and Cobb-Walgren, 1991; Kinnear et al., 1974).

Prior studies indicated that incorporating consumer and managerial concerns on the natural and physical environment lead not only to superior business performance, especially in terms of competitive advantage, but also to enhanced corporate reputation (Menon and Menon, 1997; Shrivastava, 1995; Sisodia,Wolfe and Sheth, 2007).

Thus, the prior micro level studies have focused on identifying the individual and local level choices of consumption (e.g. Amran and Kulatilaka, 2009). Other studies analyze the drivers of greenwashing that can mislead consumers about the environmental

performance of companies' products (Delmas and Burbano 2011). According to Amran and Kulatilaka (2009) new green innovations are underway at many levels, building momentum forthe shift to a non-carbon future. Already suggested over two decades ago, the challenge within the micro level of sustainability is to drive capital to investments built around a "clean infrastructure"– one where the key driver for these investments are supported by individual consumers who make behavior and consumption choices based on products that emit less greenhouse gases and thus are less of a burden on the natural environment and its limited resources (see e.g. Shirivastava, 1995).

### 2.4.3 Organizational level studies on the ecologically sustainable organizations

Ecologists maintain that two opposing worldviews underpin the different approaches to organizations in ecosystems: at one end is "frontier economics", and at the other end so called "deep ecology" (Colby, 1990; Lovelock, 1979; Passmore, 1974; Ruether, 1992). According to the expansionist view of frontier economics, organizations act in a global economic system that is independent of the ecological system, searching out limitless markets to exploit and exhaust. In contrast, according to the ecological view, organizations act in an economic system that is inextricably intertwined with and dependent on the ecological system, all actions having deeper, ecological consequences. As Daly and Cobb (1994) observed "ecosystems support economies, not vice versa". The key differences between these divergent approaches are shortly discussed in the following.

### *2.4.3.1 Organizational theorists approach*

Previously, the traditional organization theorists (e.g., Barnard, 1938; March and Simon, 1958; Thompson, 1967) seemed to view difficulty of creating ecologically sustainable organizations as simply a subclass of the larger problem of effectiveness; referring to creating effective and efficient firms that can survive in changing niches and markets. Organization theorists attempted to transport principles of ecology directly into different theoretical subdomains such as leadership (Egri and Frost, 1994), organizational learning (Mylonadis, 1993), and organizational design (Ostlund and Larsson, 1991). Some researchers consider how to replace the expansionist notions underlying their theories with ecological concepts such as sustainability and stewardship (see e.g., Post and Altman, 1992; Shrivastava, 1992, 1994).

According to Zandbergen (1995) this school of thought emphasizes the method of achieving sustainability through the process of adaptation. In their view, adaptation can range from very specific responses to switches in general strategy. The first methods theorized about and applied have been direct responses to environmental pressure for positive ecological change. Each program has specific steps for integrating sustainability into companies' activities**.** The standardized approaches include specific practices and strategies such as the total quality environmental management, pollution prevention programs, lifecycle analysis, environmental impact assessments, environmental audits, and environmental labeling.

"Greening" organization theorists have modified prior models of organizational strategy to include environmental pressures and organizational responses, with the aim of making firms more proactive. Schmidheiny (1992) has examined eco-efficiency within a strategic framework for the organization. Theorists have also begun to consider

"ecological sustainability" in terms that go beyond strategic adaptation of individual firms (Fischer and Schot, 1993). For example, Hunt and Auster's (1990) five-stage continuum model for corporate cultures builds on some notions of strategy as well as culture, but it does not really tap into the deeper culture underlying both the firm and its environment. Shrivastava (1992, 1994) and Throop, Starik, and Rands (1993) advocated the comprehensive integration of organizational and ecological principles. The core culture of firms and systems of learning must be based on ecological assumptions concerning nature and reality and the role of humankind. Egri and Pinfield (1995) also argued for a change in "deep culture" or in paradigms as a precursor to systems-level action by organizations.

#### *2.4.3.2 Ecological theorists approach*

According to Zandbergen (1995), similarly to the organizational theorists perspective, ecological researchers define sustainability through the lenses of the Brundtland definition**.** The "reformist" paradigms (Egri and Pinfield, 1995) have some typical principles about the role of organizations. First, ecologists believe that organizations as a whole must act within the model of sustainability to help achieve some balance between the ecological and the social system (Daly and Cobb, 1994). Further, ecologists tend to believe in the leading role of grassroots innovation; that is, individuals first, then particular organizations and sectors, are in the leading role of pioneering ecological innovations (see e.g., Bramwell, 1989).

Ecologists also tend to believe in so called bioregional action for organizations. If individuals, firms, and sectors are the source of action, then it follows that the location of that action is going to be around the communities in which these actors are

embedded. Whatever innovations regarding sustainability are made by these actors will be tied directly to these local environments. Finally, ecologists also tend to believe in accountability for all actors, but especially organizations (Zandbergen, 1995). Table 2 summarizes the thinking about the role of organizations in sustainability and compares the differing views of organizational and ecological theorists.

| Schools of thought | Definitions of sustainability | Role of organizations |
|---|---|---|
| **Organization theory** | • Organization-specific, including effect-tiveness<br>• Brundtland definition of sustainability | • Technical innovations<br>• Specific practices<br>• Strategies<br>• Organizational culture |
| **Ecological theory** | • Brundtland definition<br>• Simple feedback model of sustainability<br>• Complex, dynamic models | • Diversity<br>• Grassroots innovation<br>• Regional networks<br>• Accountability/feedback |

**Table 2.** Comparison of organizational and ecological views of sustainability, adopted from Zandbergen, 1995.

### 2.4.4 Industry and firm level approaches

From a business perspective, prior research (Hart and Millstein, 2005; Porter and Rheinhard, 200x: Nidumolo et al., 2009) has illustrated that the challenges of sustainability offer significant potential for new business opportunities and innovations. These opportunities can be instigated through new regulations and laws in regards to social and environmental issues (Hockers, 2008, Preuss, 2007) and through offering new sources of ideas, inspiration and vision leading to novel business opportunities (Hart and Millstein, 2005; Day, 1998; Hart, 1995; Azzone and Bertele, 1997). However, some studies indicated that only a minority of businesses consider sustainability as a source of innovation (Hockers and Morsing, 2008). The reluctance for green innovation might stem from the high risks associated in this kind of innovation (Hall, 2002; Doppelts, 2007).

During the early 1990s, two primary schools of opposing ideology emerged in relation to corporate sustainability research. These schools were exemplified by (i) the “win win” hypothesis and (ii) the “shareholder value” approach. Adopting a corporate perspective, the early debate and research centered around the issue of whether “it pays to be green” (Porter, 1991; Porter and Van der Linde, 1995; Walley and Whitehead, 1994). The first school of thought, consisting of environmental economists and management theorists, adopted the view of so called "win-win hypothesis”. This meant that the environmental investments can benefit both the environment and the firm (see e.g., Elkington, 1994) The other school of thought, consisting of academics and a group of executives, emphasized that companies exist to serve their shareholders. For this reason they expressed substantial skepticism and uncertainty over the “win-win” argument (see e.g., Morsing, 2003; Palmer et al., 1995; Walley and Whitehead, 1994). These differing notions are discussed in further detail below.

#### *2.4.4.1 The proponents of the "win win"- hypothesis*

The scholars and practitioners of the "win win" hypothesis (see e.g, Gallarotti, 1995; Hart, 1996; Makeower, 1993; Saunders and McGovern, 1993) emphasized that environmentally focused activities and investments can simultaneously benefit the company, its customers and the environment. According to these scholars, there are extensive opportunities for businesses to profit from environmental investments and innovations. By way of illustration, Porter and Van der Linde (1995) asserted that companies should promote resource productivity in the form of materials savings, increases in process yields, and better utilization of by-products; because waste consists, fundamentally, of an inefficient use of resources. Reinhardt (1998, 43) underlined that "firms can increase profits if they set ambitious environmental targets, lobby for tighter not looser government regulation, and make the environment the central organizing principle of their businesses". He (ibid) further pointed out that "it is clear that the environmental problems society confronts are significant and that firms can and should profit from contributing to their solutions".

Moreover, these scholars highlighted that companies must locate hidden opportunities to profit from environmental investments and eventually transform such investments into new sources of competitive advantage. The "win-win" situation underlying the Porter hypothesis (Porter, 1995) suggested that regulations can force firms to invest in environmental research and development in order to cut down the costs of complying with environmental regulation standards. Companies undertaking green innovations will be able to reduce their production costs and/or enter into expanding markets. Between 1995-2008, the "Porter" hypothesis has been empirically tested multiple times in different contexts and with different datasets as the interest to control emissions and environmental pollution heavily mounts on industries and governments (e.g.

Brunnermeier and Cohen, 2003; Horbach, 2008; Mazzanti and Zoboli, 2006; Popp, 2006).

Lovins et al. (1999) adopted a technical point of view on the resource productivity issues, and suggested that by using eco-design and eco-efficiency measures, the potential of a new set of business practices to enhance resource productivity is so considerable that a new economic system may emerge from its application. Lovins et al. (ibid) substantiated their argument by presenting examples of large corporations that are increasing the productivity of natural resources, shifting to biologically inspired production models, moving to a solutions and service-based business model, and reinvesting in natural capital. Therefore, in their view, such practices would promote so called "Natural Capitalism," where regulatory and market mechanisms eventually succeed in making organizations internalize environmental costs (Lovins et al., 1999: 146-148). In effect, through the reconfiguration of industrial systems, such strategies and practices could be transformed beyond the physical borders of firms. From the perspective of industrial ecology, individual manufacturing processes are viewed as parts of broader industrial systems, which should be optimized according to the ecological principles of efficiency (den Hond, 2000).

Furthermore, during the early 2000s, the scholars of the “win-win” approach argued that the waste, by-products, and energy from one firm could serve and feed processes in another system, forming so called "closed-loop systems" or the “cradle to cradle” solution suggested by McDonough and Braungart (2002). In their view, “cradle to cradle” is a product design principle which suggests that every part of the product should be safe and designed for re-use and designed in a way that minimizes the use of natural resources. A case in point, in their view, is the application of industrial ecology

which requires not just an interdependent flow of materials, processes, and energy inside an industrial cluster, but also entails new forms of collaboration between participating firms. Orsato (2006:133) proclaimed that eco-efficiency practices can generate some level of savings for the majority of firms by stating: "eco-efficiency strategies have greater potential to generate competitive advantage in firms that supply industrial markets, face relatively high levels of processing costs, and generate wastes and/or by-products".

#### *2.4.4.2 The proponents of the shareholder value approach*

The proponents of the shareholder value group – represented by academics and a group of executives – argued that companies exist solely to serve their shareholders. In their opinion, managers who lose their focus by chasing environmental objectives cannot compete effectively with those who keep their eyes on the goal of shareholder value. Further, if pursued beyond the compliance with government regulations, environmentalism in companies is likely to divert management attention and capital from the real problems of the business.

For these reasons they expressed substantial skepticism and doubt over the "win-win" argument (see e.g. Morsing, 2003; Palmer et al., 1995; Walley and Whitehead, 1994). In their view, the "win-win" arguments were non-realistic. They further argued that corporate sustainability strategy is a complex issue for managers and hardly the right choice for all companies in all situations, such as companies operating in the oil and chemical industries. In fact, they pointed out that sustainability strategies can often result in increased costs and decreased profits due to substantial increases in the required environmental investments, especially in industries with overcapacity, heavy

competition and declining margins.

To summarize the prior debate, the question of how far companies have a social responsibility to improve their environmental performance, and the relative costs and benefits to the organization of doing so, has engaged academics and practitioners for more than 40 years (Friedman, 1970; Holliday et al., 2002; Walley and Whitehead, 1994; Werbach, 2009; McDonough and Braungart, 2002). A key strand in this debate has been the idea that complementarity can exist between a company's economic and environmental goals, a proposition which has found support in political, business and academic circles and which is exemplified by concepts such as "eco-efficiency", "ecological modernization" and "win-win" (De Simone and Popoff, 1999; Mol and Sonnenfeld, 2000).

In essence the argument is that companies that voluntarily embrace environmental good practice can simultaneously improve their business performance, thereby helping to create what has been called the "double dividend" of environmentally responsible behavior. Under this view the environment is seen as a critical business concern and an area of managerial activity that can yield significant benefits to the organization, whether via the adaptation of business behavior to a changing external context or through the accumulation of resources that promote distinctive organizational competencies (Azzone and Bertele, 1994; Gallorotti, 1995; Hart, 1995).

Reinhardt (1998, 44) expressed criticism by suggesting that the prior debate "has been framed on wrong terms" and in his view the debate should move away from the topic of "whether or not" corporations can offset the costs of environmental investments to the question of "when it is possible to do so". In his (ibib) opinion, "environmental

policy, like other aspects of corporate strategy, needs to be based in the economic fundamentals of the business: the structure of the industry in which the business operates, its position within that structure, and its organizational capabilities."

Prior scholarly work suggested that the way companies integrate environmental concerns into their strategies while consolidating their competitive advantage is through green innovations (Azzone and Bertele, 1997; Porter and van der Linde, 1995; Esty and Winston, 2006; Nidumolu et al., 2009; Werbach, 2010; Anderson, 2009). This emerging, yet not conceptually established term of environmental or green innovation is reviewed next.

## 2.5 Introduction to the concepts of traditional innovation and green innovation

Prior to discussing the concept of green innovation, the well-established traditional innovation literature discussion is briefly presented with its prevailing core definitions and typifications. This is a necessary point of enabling the discussion on the specific aspects of green innovation and in linking these insights with the key research objectives of this dissertation.

### 2.5.1. The concept of traditional innovation

Schumpeter's (1934) classic definition of innovation is to put innovative ideas into practice, describing innovation as an activity which possibly involves the development of a new product, the introduction of a new service or the use of a new process and/or the establishment of a new venture. Other researchers view innovation as new useful,

commercialized initiatives and they typically classify innovation into the following categories: administrative versus technical in their *focus* (Damanpour and Evan, 1984; OECD 2005), product versus process in their *orientation* (Utterback and Abernathy, 1975; Ettlie and Reza. 1992), radical versus incremental in their *nature* (Dewar and Dutton, 1986), and architectural versus component in their *scope* (Christensen, 1992a, b). Next, each of these differing points are illustrated.

*Administrative* innovations involve new organizational structures and administrative processes such as recruiting personnel, allocating resources, distributing rewards, and structuring tasks or units. *Technical* innovations can be product or process innovations, further discussed below, depending upon their application, but are generally more observable, more testable and are perceived to be more advantageous than administrative innovations (Damanpour and Evan, 1984). Along these lines, Gopalakrishnan et al. (2010) underline that the distinction between these types of innovations is important as each follow distinctly different paths, and each are facilitated by different kinds of organizational structures. As technical innovations often originate among scientists and engineers of an organization and follow a bottom-up implementation process, the administrative innovations originate among the top management personnel and often follow a top-down implementation process (Daft, 1978).

*Product* innovations refer to new products/services introduced to meet a market need, while *process* innovations are new elements introduced into an organization's production or service operations (Utterback and Abernathy, 1975; Ettlie and Reza, 1992). In some cases, a product innovation generated by one firm may become a process innovation for another. The key distinction between these two types of innovations is the notion that their adoption may demand differing organizational skills.

Thus, product innovations require that firms assimilate customer need patterns with design and manufacturing during development while process innovations enable improved efficiency and effectiveness of product development (Ettlie et al., 1984). Consequently, Utterback, (1978) illustrates that the frequency of occurrence of product and process innovations varies significantly over the stages of the industry or technology life-cycle with process innovation following product innovation.

*Radical* innovations, in turn, can be new to the firm, industry and/or the world; can be competence destroying or destructive in nature to reflect the impact they have on markets, firms, and industries (Schilling, 2008). In contrast to radical innovations, *incremental* innovations reflect the minor improvements to existing products or processes. Typically, radical innovations require more time for development and involve greater risks for market adoption, yet they possess the potential for great positive impact on firm profitability as well as for change in the dynamics of an industry and its underlying economic assumptions.

Furthermore, an innovation can be a part of a system. An innovation is a component in nature if it does not change the overall system configuration of the product (Schilling, 2008). An innovation is architectural in nature if it requires changing the configuration of a system (Henderson and Clark, 1990). Yet, not all innovations are equal in their impact. In particular, radical innovations can have a significant impact on the emergence of new industries and the success of new technologies through the establishment of dominant designs in technology intensive industries such as the PC and software businesses (Benner and Tushman, 2003). While incremental innovations can provide real, tangible benefits to firms and consumers within the borders of existing industries, the impact of incremental innovations is frequently overshadowed by the game-changing magnitude of radical innovations.

Similarly to Benner and Tushman, other researchers, such as Kim and Mauborgne (1999), agree on the notion that radical innovations can alter, redefine or rejuvenate existing industries by de-maturing obsolete technologies or cause the creation of a new industry (Anderson and Tushman, 1990). However, radical innovations are often not initiated by the industry incumbents. It has been argued that large incumbent firms tend to favor exploiting existing technology through incremental innovations (Kusunoki, 1997). In contrast, Bower and Keogh (1996) point out that industry outsiders or newcomers are more likely to develop radical technologies that can redefine industry or transform industries.

Companies can choose to focus on a few innovations that have a tremendous impact or many innovations of limited impact (Kimberly and Evanisko, 1981; Damanpour and Evan, 1984). Organizations that are willing to adopt many innovations or undertake a so called high innovation magnitude strategy are consistently willing to face uncertainty and take on risks (ibid). A high magnitude type of strategy works in industries where many incremental innovations are needed to make an impact on the market (Gopalakrishnan and Damanpour, 2000). Other industries favor a "low magnitude innovation strategy" (Gopalakrishnan, 2000) where one or two radical innovations alter the industry and generate profit streams.

Technological innovation refers to technical advancement in either product or process (Akgu¨n et al., 2009; Mavondo et al., 2005; Rennings and Rammer, 2009; Tushman and Nadler, 1986; Utterback and Abernathy, 1975). While product innovation suggests, by name and nature, positive changes in a product or service a firm provides, process innovation refers to positive changes in the way a product is manufactured or a service is provided (Tushman and Nadler, 1986). The ultimate aim of product innovation is to improve product performance in return for new customers and new markets, while the

aim of process innovation is to enhance productivity, cost efficiency and flexibility (Adner and Levinthal, 2001; Rennings and Rammer, 2009).
With the availability of extensive research on traditional innovation, one may ask what is the need for studies and theorizing on green innovation.

### 2.5.2. Origin of the terminology for green innovation

The terms environmental, eco, or green innovation have their roots in the concept of sustainable development. Van Dieren et al. (1995: 332) date its formulation back to the 1972 UN Stockholm Conference on Human Environment. According to Dresner (2008: 30), sustainable development originated in 1980 by the International Union for the Conversation of Nature and Natural Resources in the World Conservation Strategy Report, which advocated "*t*he integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and well-being of all of the people". Despite the early conceptual definition, the notion of sustainability still remains a fuzzy concept due to the fact that there are over 50 conceptual definitions of it (see e.g. Faber et al, 2005; Robinson, 2004). Some of these terms include e.g., sustainable development, human sustainability, social sustainability, ecological sustainability, environmental sustainability, and corporate sustainability as well as aligned concepts of corporate social responsibility and corporate citizenship.

Faber et al.'s (2005) review of the prior sustainability literature concludes that the ecologists, economists, sociologists and biologists each take on their own favorite perspectives. Frequently, most researchers ignore other perspectives in their studies. In the late 1980s, the Bruntland report, commissioned by UN, popularized the concept of

sustainable development and defined it as the capacity to guarantee a decent future for future generations. The report (WCED, 1987: 43) stated that development should meet "the needs of the present without compromising the ability of future generations to meet their own needs".

Typically in prior research, the concept of sustainable development is evoked to define the ultimate goal of green innovation. The most cited definition of sustainability comes from the World Commission on Environment and Development (WCED) report (1987), which touches on environmental, social, and economic aspects of sustainable development such as the notion of resource limits, including energy, materials, waste, and land; equitable access to constrained resources; intergenerational and intra-generational equity; and finally a progressive transformation of economy and society. To sum, there is lack of consensus on this definition and a variety of sustainability worldviews are presented in the literature (see e.g., Cotgrove, 1982; Gladwin et al., 1995; O'Riordan, 1991).

### 2.5.3. Prior definitions of eco, environmental and green innovation

During recent years, academic research on green product innovation has grown in interest (Chen, 2001; Chung and Tsai, 2007; Pujari et al., 2003, 2004; Pujari, 2006; Rehfeld et al., 2007; Tseng et al, 2011; Lin et al, 2012), yet there is a lack of a standardized definition of it (Pansera 2012 ; Schiederig et al (2012; Kesidou and Demirel 2012). The concept of green innovation is, however, a relative newcomer to academia (see e.g., Wong, 2012). The majority of the earlier studies have focused primarily on the definitional issues and the theoretical explanations for the emergence

of green innovation (see e.g. Chen, 2011; Foster and Green, 2000; Noci and Verganti, 1999), and illustrating links between green performance and financial performance (e.g. Huang and Wu, 2010). The direction of research has expanded beyond the business level and some researchers such as Beise and Rennings (2005) and Rennings and Rammer (2009) have explored the policy implications of environmental innovations, particularly in the fields of energy and resource-efficiency.

Within the last two decades there has been an increase of academic work suggesting different definitions of eco-innovation, green or environmental innovation (Schiederik et al., 2012). Yet, according to Andersen (2008: 3), "environmental innovation research is still in its early phase, and there are worldwide very few actual innovation researchers working with environmental issues". Similar to the concept of sustainable development, green innovation remains an ill-defined concept. Previous literature has used a variety of ways to define proper conceptual reference points for innovation. Some scholars have referred to environmental innovations (e.g. DeMarchi, 2012; Wagner, 2007; Porter and Van Linde, 1995), while others suggest terms of eco-innovations (Pansera, 2012; Kesidou and Demirel, 2012; Ekins, 2010; Kemp and Foxon, 2007; Smith, 2001; Rennings, 2000), or sustainable innovations (Smith et al., 2010; Carrillo-Hermosilla et al., 2009; Tello and Yoon, 2008), environmental innovations (Mourah and Ahmed 2012; OECD 1997), and green innovations (Schiederig et al., 2012; Wong 2012; Dangelico and Pujari, 2010; Chen 2011; Bernauer et al., 2006; Chen et al., 2006; Noci and Verganti, 2002).

The term green innovation has been popularized in some recent academic studies within management literature, in empirical case studies and in consultancy reports and among the media (e.g., MIT 2010; Etsy and Winston, 2006; Friend 2009) and is thus adopted

as the key term used in this dissertation. Table 3 presents some of the key definitions of these overlapping terms.

Table 3. The key definitions of environmental, eco and green innovation

| Authors | Definition |
|---|---|
| Porter 1991 | " is initiated to meet the green requirements of a regulatory body or the green concerns of the target customers". |
| Porter and Van der Linde (1995) | "...creates value by addressing the green concerns of the market, industry, firm and/or individual customers that a product or process is targeted to serve". |
| *Fussler et al (1996)* | "... is the process of developing new products, services which provide customer and business value but significantly decrease environmental impact". |
| OECD (1997b) | *"Environmental innovations* encompass all innovations that have a beneficial effect on the environment regardless of whether this effect was the main objective of the innovation. They include process, product, and organizational innovations". |
| Beise and Rennings (2005), Beise-Zee and Rennings (2005), Rennings and Zwick (2002) | "New or modified processes, techniques, practices, systems, and products to avoid or reduce environmental harms". |
| European Commission, Innova (2006) | "...is the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for all with a life-cycle minimal use of natural resources per unit output, and a minimal release of toxic substances". |
| Ottman et al., (2006) | "... as new environment-friendly products, services and processes which aim to protect the natural environment by conserving energy and other |

| | |
|---|---|
| | resources and by reducing pollution and waste". |
| Kemp (2007) | "...is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization and which results, through its life cycle- in a reduction of environmental risk, pollution and other negative impacts of resources use ". |
| Andersen (2008) | "... is innovation which is able to attract green rent on the market". |
| Wagner (2009) | "the *creation* of new, or significantly improved, products (goods and services), processes, marketing methods, organisational structures and institutional arrangements which - with or without intent - lead to environmental improvements compared to relevant alternatives". |
| Carrillo-Hermosilla et al., (2009); OECD (2009); Potts (2010) | "...as a means of boosting a firm's competitiveness while maintaining the environment and its valuable resources for the future generations". |
| Mourad and Ahmed (2012) | " Environmental innovations can have a typical business objective with the aim of reducing costs in the production process or the product characteristics, to raise the product quality and thus to improve the competitive situation, with a reduction of environmental impact at the same time". |

#### *2.5.3.1 The evolution of the conceptualization of environmental and green innovations*

One of the pioneering definitions of environmental innovation include Porter's (1991; Porter and Van Linde, 1995) definition which underlined it to be driven to meet regulatory requirements or to respond to growing customer demand for environment-friendlier products. In 1995, Porter and Van Linde (1**995**) further expanded the notion to create value by "addressing the green concerns of the market, industry, firm and/or individual customers that a product or process is targeted to serve". Building on Porter's work, Fussler and James (Bartlett and Trifilova, 2010:2) define environmental

innovation as "new products and processes which provide customer and business value but significantly decrease environmental impacts" (Bartlett and Trifilova, 2010). Further, in 1997, the Organisation for Economic Co-operation and Development (OECD 2008: 19) defined environmental innovation in rather broad terms: "Environmental innovations encompass all innovations that have a beneficial effect on the environment regardless of whether this effect was the main objective of the innovation. They include process, product, and organizational innovations". Similarly, other research (James, 2007) viewed environmental innovation as "relevant actors (such as firms, private households), which: (i) develop new ideas, behavior, products and processes, apply or introduce them, and (ii) contribute to a reduction of environmental burdens or to ecologically specified sustainability target" (Rennings, 2000: 322).

Reinhardt (1998: 46) stated that environmental product differentiation takes place when: "a business creates products that provide greater environmental benefits, or that impose smaller environmental costs, than similar products". This definition pointed out that green products are not only those products with a lower environmental impact, but also those providing higher environmental benefits compared to conventional products" (ibid).

Murphy and Gouldson (2000) claim that organizational innovations do not reduce environmental impacts directly, but facilitate the implementation of technical (process and product) environmental innovations in companies. In turn, process innovations are defined as improvements in the production process resulting in reduced environmental impacts, e.g. closed loops for solvents or material recycling. The principal environmental impact of many products stems from their use (e.g. $CO_2$ emissions of a product) and disposal rather than their production. Accordingly, product innovations

target reducing environmental impacts during a product's entire life cycle.

Rennings (2000) claimed that the double externality characteristic of environmental innovations could be used to delineate green innovations from other innovations. Rennings (ibid) further defined the double externality in a way that environmental innovations have, next to the positive externalities from spillovers which are common to all innovations, additionally the characteristic of leading to a reduction of external environmental cost as a negative externality. Besides identifying environmental innovations as a subset of all innovations in an economy, a distinction can also be made in accordance with the Oslo manual (OECD and Eurostat, 1997) into product innovations (i.e., environmentally-sound product design) and process innovations, such as process-integrated environmental technologies (see also Ziegler and Rennings, 2004; Rehfeld et al., 2007).

#### *2.5.3.2 OECD's definition of eco-innovation*

The OECD's (2009: 40) study continued to refine the conceptual definition of eco-innovation and contrasted these with so called non-environmental alternatives: "the creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organisational structures and institutional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives". The study further expanded the typification of eco-innovations and viewed green innovation in close relation to the traditional definition of innovations. The newness aspect of eco-innovation relates to the environmental improvements in contrast with competing, e.g. traditionally manufactured product choices. The report (ibid) further identified various innovation activities including: (i) the targets for innovations which are focuses on greening the products, processes,

marketing methods, organizations and institutions; (ii) mechanisms-referring to the ways in which changes are made in the specified targets such as in greening one's manufacturing operations; (iii) modification, or the redesign of alternative green products and the creation of entirely new eco innovations; and (iv) impacts, i.e. the effects of eco-innovation on the environment.

The prior OECD's definition is echoed in other studies as well. Wagner's (2000: 322) earlier study analyzed German manufacturing firms, defining eco-innovation as "measures of relevant actors such as firms, households which: (i) develop new ideas, behavior, products and processes, apply or introduce them, and; (ii) contribute to a reduction of environmental burdens or to ecologically specified sustainability targets." In a latter study, Wagner (2009: 124) further broadly classified eco-innovations as "the creation or implementation of new, or significantly improved, products, processes, marketing methods, organisational structures and institutional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives".

#### *2.5.3.3 Reducing a company's environmental impacts and conserving natural resources*

Rennings and Zwick (2002: 3) viewed green innovation "as means to avoid or reduce an organizations or a firm's environmental impacts, typically categorizing green innovation into a new or modified processes, techniques, practices, systems, and products, with the aim of avoiding or reducing environmental harms and impact from corporate or human activities. These typifications are supported by studies from other scholars (see e.g. Kemp et al., 2001; Beise and Rennings, 2005, Tseng et al., 2009a;

Yung et al., 2011; Chen et al., 2006.) These proposed definitions typically includes all the changes in the product portfolio and in the production processes that tackle sustainability targets and reduce greenhouse gas-emissions, and included both incremental and radical improvements.

Further, Ottman et al. (2006: 24) viewed green innovation as an innovation driven way to conserve the use of natural resources and the resulting environmental impacts by stating that "New environment-friendly products, services and processes which aim to protect the natural environment by conserving energy and other resources and by reducing pollution and waste". Kemp and Pearson (2007: 3) expanded the prior notion to also include the management and business methods that are new to the adopting organization or firm in question and viewed the environmental impact from the life cycle perspective of product, processes or services. They write that the "*production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization and which results, through its life cycle- in a reduction of environmental risk, pollution and other negative impacts of resources use* ".

In sum, Arundel and Kemp (2009: 34) noticed that eco-innovation is "a new concept of great importance to business and policy makers*"*. They (ibid) concluded that it is about innovations with lower environmental impact than relevant alternatives and that eco-innovations may be technological or non-technological, i.e. either organizational, institutional or marketing-based. In their view, eco-innovations may be inspired by economic or environmental considerations. The former includes objectives to reduce resources, pollution control, or waste management costs, or to sell into the global market as eco-products.

### *2.5.3.4 Creation of new markets*

Andersen (2008: 5), studied eco-innovation from the industrial dynamics perspective and illustrated that "Eco-innovation is innovation which is able to attract green rent on the market". Further, Andersen (ibid) referred to firms as polluters rather than eco-innovators. Likewise, Keeble et al. (2005: 3) connected eco-innovation with social issues, pointing out that "sustainability-driven innovation is the creation of new market space, product and services or processes driven by social, environmental or sustainability issues". On the one hand, while these scholars introduced the concept of social sustainability, they fell short of clearly defining the term, and instead used only broad terms. On the other hand, they explicitly stated that sustainable innovation requires the creation of new markets. Other scholars are satisfied with the general definition of advocating "green products, green technologies and green processes" (see e.g. Chen et al., 2006; Chen, 2011; Wong, 2012).

### *2.5.3.5 Green process innovations*

Chen et al. (2006: 534) referred to green innovation as "hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management". In a more recent study, Chen (2011) claimed that companies with the capability to develop process innovation, might be able to have less or even a negative impact on nature, social, and cultural aspects. Chen et al. (2006: 534) further pointed out that "Green process innovation is defined as the application of innovative ideas leading to the adoption of production processes and/or management practices that create less or no negative ecological, human health, social, cultural and economic impacts".

### *2.5.3.6 Connecting green innovation to a firm's business case*

In their literature review for corporate sustainability, Salzman et al. (2005) pointed out that the business case is not a generic argument that corporate sustainability strategies are the right choice for all companies in all situations, but rather something that must be carefully honed to the specific circumstances of individual companies operating in unique positions within distinct industries. Successes in whole industries and at other companies are useful examples, but the case still has to be applied to one company at a time (Reed, 2001: 4). Salzmann et al. (2005: 27) further illustrated that the business case for sustainability has been approached in many different ways to prove or disprove the sound economic rationale for corporate sustainability management that shall be defined as ''a strategic and profit-driven corporate response to environmental and social issues caused through the organization's primary and secondary activities.

***Connected to the concept of sustainable development***

Several recent studies (Porter and Reinhardt, 2007; Wong, 2012; Carrillo-Hermosilla et al., 2009; OECD 2009; Potts, 2010; Wong, 2012) continued to link environmental innovation to the concept of sustainable development and referred to it as a means of enhancing a firm's competitiveness while maintaining the environment and its valuable resources for the future generations. Similarly, Tello and Yoon (2008:164) viewed sustainable innovation as "the development of new products, processes, services and technologies that contribute to the development and well-being of human needs and institutions while respecting the worlds' natural resources and regenerative capacity".

### *2.5.3.7 The systemic and collaborative nature of green innovations*

Prior studies have pointed a number of distinct characteristics of green innovations which are briefly explored in the following.

***Systemic nature***

The prior research has underlined the importance of initiating and commercializing systemic green innovations. Studies spanning the innovation systems and evolutionary economic literature describe environmental innovations as systemic, requiring a higher cooperative effort and implying higher complementarities with the activities performed by network partners (Andersen, 1999, 2002; Foxon and Andersen, 2009). Eco-innovation often requires changes in the raw materials or components used, the logistical and technical integration with external partners and the re-design of products. Cooperation with suppliers is important to ensure the supply of inputs or components with eco-friendly features – which may not be readily available on the market – to verify that they fulfill the requirements or to modify the internal production process accordingly (Seuring and Müller, 2008; Geffen and Rothenberg, 2000; Meyer and Hohmann, 2000; Goldbach, 2003).

Seuring and Müller (2008) have shown that the technical and organizational interdependencies with suppliers and business clients are increasing as firms attempt to close their production cycles and enhance recyclability. Furthermore, to design and commercialize a product that reduces environmental impact is a rather complex task and often requires information and skills distant from the traditional knowledge base of the industry. In sum, the prior research frequently points out to the need to innovate across the full life-cycle aspect, i.e. to reduce the natural resource consumption and material flows through extensive environmental input and output analysis of a company's products and manufacturing and distribution processes. This also means that

manufacturers of products should take full responsibility of their products at the end of their lifecycle, instead simply discarding them.

***Collaborative nature***

The prior research on green product innovation literature is lacking in illustrating why and how companies integrate environmental sustainability into new product development (Dangelico and Pujari 2010) and into their innovation management activities. Companies that develop and market innovative green products seem to face several challenges but empirical studies that report on these challenges are scant (Berchicci and Bodewes, 2005; Hall and Vredenburg, 2003; Ottman et al., 2006). Rennings (2000) and Wong (2012) state that while innovation processes toward sustainable development have received increasing attention during the past years, theoretical and methodological approaches to analyze these processes are poorly developed. Some researchers point out the collaborative nature of green innovations. Similarly, general innovation management studies have underlined that to develop new products or processes, firms increasingly cooperate and conduct open innovation with lead users (Von Hippel, 1988, Von Hippel, 2005), with suppliers, universities and other companies (Chesbrough, 2003; Belderbos et al., 2004), rather than relying on internal resources and ideas alone.

To sum, scholars such as Rennings (2000), Andersen (2008), Kemp (2009), DeMarchi (2012), Kesidou and Demirel (2012), and Schiedrig et al. (2012) have argued that while innovation processes towards sustainable development and green innovations have received increasing attention from scholars, the theoretical and methodological approaches to analyze these processes have been poorly developed. Moreover, De

Marchi (2012) claimed that the systemic and complex character of green innovations suggests that, to develop them, cooperation may be even more important than when it comes to introduce other types of innovations. This call for collaboration in the creation of radical green innovation has not been thoroughly addressed in the prior literature. In particular, essay 2 of this dissertation investigates how collaborative radical green innovation can be managed in the context of three differing industries. It further identifies and suggests specific managerial capabilities required in managing for radical collaborative green innovation.

#### *2.5.3.8 Contrasting traditional and green innovation*

Consequently, one may ask how traditional innovations *differ* from environmental innovations. An innovative product or process is defined by its "newness". Garcia and Calantone (2002) acknowledged that this "newness" can be assessed from three dimensions: new to the industry, new to the firm initiating the innovation and new to customers. According to Linder et al. (2003) an innovation must create value. In their view (ibid), value creation through product or process innovation may mean the introduction of a new product or process which generates higher margins, greater revenue, enhanced stakeholder value, greater market share, better corporate image or improved performance in terms of "greenness". These arguments are echoed in the research by Paladino (2007), Baker and Sinkula (2005), Foster and Green (2000), and Song et al. (2000).

It has been suggested that while a conventional innovation is developed not particularly to address environmental challenges, a green innovation is initiated to meet the green

requirements of a regulatory body or the green concerns of the target customers (Porter, 1991; Porter and van der Linde, 1995). Conventional innovation, as defined by the Oslo Manual, is neutral and open to all kind of changes while green innovation "places emphasis on innovation toward sustainable development" (Rennings, 2000: 322), For this reason, environmental research (see e.g., Rennings, 2000; OECD-report 2009; Carrillo-Hermosilla et al., 2010) viewed green innovation as a subset of all innovations. Similarly, Wong (2012) reasoned that this subset notion of green innovation is breaking new ground by introducing radically new products and encroaching into the territory of conventional innovation by stealing market share from "non-green" alternatives or causing the complete phase-out of environmentally unfriendly products and processes. The speed of expansion, however, is slow as the processes involved in materializing a green innovation are complex and fraught with difficulties and uncertainties.

The prior environmental management and innovation literature stress both green innovation as a means of enhancing a firm's competitiveness while also maintaining the environment and its valuable resources for future generations (Cleff and Rennings, 1999; Rennings, 2000; Biondi et al. , 2002; Frondel et al., 2008; Carrillo-Hermosilla et al. , 2009; OECD, 2009; Potts, 2010). As stated previously, green innovation represents a separate sub-group of general innovation with a focus on reducing or avoiding harm to the environment (Rennings, 2000; OECD, 2009; Carrillo-Hermosilla et al., 2010).

Traditional innovation management literature has highlighted the role of demand-pull and technology-push factors as determinants of innovation. Several contributions support the idea that, given the low private incentives for firms to invest in green innovations, regulatory and institutional frameworks are to be considered as additional key determinants of their introduction (e.g., Porter and van der Linde,1995; Cleff and

Rennings, 1999; Kemp, 2000; Jaffe et al., 2002), especially for the development of the more radical changes of technological systems toward the greening of industries (Freeman, 1992; Rennings, 2000; Foxon and Andersen, 2009).

Prior research identified three distinct ways to catalyze green innovation. First, the responsive way can arise in response to environmental requirements (Johnstone et al., 2010; Popp, 2003; Porter, 1991; Porter and van der Linde, 1995) or rising consumer and corporate environmentalism (Chen, 2011; Martinsons et al., 1997). Second, the proactive way can be driven by goals of higher profitability, cost efficiency (Rennings and Rammer, 2009) or from the drive to lead the way in green development and green technology since developing environmental-friendly products, represents a shared goal and priority for all innovative activities (OECD, 2005). Third, traditional innovation creates value through the consequent efficiency, productivity or product market performance improvements, while green innovation creates value by addressing the green concerns of the market, industry, firm and/or individual customers that a product or process is targeted to serve (Linder et al., 2003; Porter and van der Linde, 1995).

Hellstrom (2007) stated that innovation towards a sustainable society may be conceived on three broad levels: technological, social and institutional. It is commonly held that technological eco-innovation must be supported by a corresponding evolution of social arrangements and institutional support structures (Freeman, 1996). So, eco-innovation must, in order to succeed, also build on relevant social structures, and in some cases the innovation should also be able to influence these structures. Hellstrom (ibid) concluded that by critically viewing the general innovation literature, it is clear that only a minority of all technological development is geared towards change of this type.

## 2.6 Synthesis of the literature review

Based on the extensive literature review, this study and its four essays make three principal contributions to the prior fragmented literature on the green innovation management. First, in Chapter 2, it organizes and pools together the extant interdisciplinary research approaches around the fundamentals of green innovations and corporate sustainability and pinpoints the key differences between traditional and green innovation. As underlined by prior scholars, the large quantity and wide diversity of research on corporate sustainability and green innovation has led to a lack of consensus and direction of research (see e.g. Faber et al, 2005).

Second, it typifies differing green innovations and identifies their distinct characteristics and connects these with the required novel managerial capabilities and roles (essays 1, 2, 4). The prior green innovation classifications have categorized green innovation broadly in managerial, process, product, technological innovation, and green system innovations (see e.g., Tseng et al. 2009; Ying et al., 2011; Kemp, 2009). Due to this broadness one may argue that this is an under researched and under developed area of research (Wong et al., 2011).

Third, this study suggests a new managerial framework for managing the value creation of differing green innovation, in particular for managing radical green innovation. Although the available frameworks succeed in providing general guidelines for developing and managing an overall corporate sustainability strategy, they do not address the conditions of different types of green innovations. Moreover, they lack in addressing the management of breakthrough green innovations per se. The extant research on green innovation does not differentiate between evolutionary and

revolutionary innovation activities, whereas in the traditional innovation literature these modes are not only distinguished (see e.g., Afuah, 2003; Gopalakrishnan et al. 2010) but seen as significantly different in terms of their managerial requirements (Tushmann and Reilly, 1993). To fill in this gap, this research focuses on building a specific framework for distinguishing between different types of green innovations, with a special emphasis laid on managing radically new types of green innovations better.

Furthermore, this study examines whether such a classification model is empirically valid at selected green pioneers of resource-intensive business. As the majority of prior research on green innovation has been devoted to analyzing drivers of corporate ecological responsiveness and to debating whether businesses can gain commercial advantage from environmental behavior (Worthington and Patton, 2005), less is known about how companies manage the value creation for differing green innovations. Thus, there is a lack of a specific managerial framework that addresses the management for both incremental and green innovations. Consequently, this study suggests a novel value creation model which should prove useful to both practitioners and researchers by increasing their understanding on how to manage diverse green innovations. Finally, the analysis of management for green innovations provides the basis for future research directions. These contributions are discussed in further detail in the following.

### 2.6.1 Green innovation- a conceptual clarification

During the last two decades there has been an increase in academic work suggesting different definitions of environmental, eco- or green innovation (Schiederik et al., 2012). Yet, the green innovation research is still in its early phase as there are very few

innovation researchers working with environmental challenges (see e.g. Andersen, 2008). Similarly to that of sustainable development, green innovation remains a fuzzy concept (Kesidou and Demirel, 2012; Schiederig et al., 2012). Further, scholars have stated that the study of green innovation could benefit significantly from empirical analyses which investigate the details of specific green innovation types and, particularly, their dimensions (Carrillo et al. 2010, 2009; Rio et al., 2011). Moreover, there is still scarce empirical evidence on the specificities of those innovations regarding how they are designed and realized, notwithstanding the importance for the development of firms' strategies (Tseng et al., 2011). The prior research (Nidumolou et al., 2009; Lovins et al., 1999) has discovered the external drivers and benefits of corporate greening, yet the internal factors to the firm – such as capabilities and firm characteristics – have been seldom reviewed in the existing literature even though they are viewed as important for business strategies and innovation performance (Rio et al., 2011).

### 2.6.2 Conceptual definition of radical green innovation

Despite the confusion over the terminology related to green innovation, prior research suggests that traditional innovation and green innovation differ significantly in their scope, nature, purpose, and targeted outcome *(as discussed in the section x.x.x).* Yet, the current literature remains silent on how to conceptualize radical green innovation and differentiate it from an incremental green innovation. *In effect, the essays 1 and 4 of this dissertation contribute to the detailed clarification of the concept of radical green innovation.*

For the purposes of empirical investigation of managing for green innovations within resource-intensive businesses, and to illustrate the focus of the current study, a definition of the concept of radical green green innovation is established. The prior ontological analysis of green innovation (Wagner, 2009; Beise and Rennings, 2005; Kemp et al., 2001) typically maps both incremental and radical innovation under a similar conceptual "umbrella" (see e.g. Kemp et al., 2001; Beise and Rennings, 2005). Yet a few prior environmental studies, such as Dangelico and Pujari (2010) and Azzuro et al. (1995), have pointed out major differences between radical and incremental green innovations. They have suggested that radical green product innovations include the use of new technologies, or the replacement of one critical component with a completely new one that significantly reduces the overall environmental impact of the product.

Within the traditional innovation management research, prior research has illustrated the major differences between incremental and radical innovations (Afuah, 2009; O'Connor and Ayers YEAR; McDermott and O'Connor, 2002; Schilling, 2008; Benner and Tushman, 2003; Kim and Mauborgne, 1999). These scholars agree on the notion that radical innovations can alter, redefine or rejuvenate existing industries by de-maturing obsolete technologies or cause the creation of a new industry (Anderson and Tushman, 1990). This study acknowledges the concepts suggested in the innovation management literature and agrees with scholars such as O'Connor and Ayers (2005, PP), who defined radical innovation as "the commercialization of products and technologies that have strong impact on the market, in terms of offering wholly new benefits, and the firm, in terms of its ability to create new businesses".

Similarly, this study builds on the view suggested by Azzone et al. (1997: 564) who referred to "an innovation-based green strategy", whereby the environmental variable is viewed as the most important competitive priority and innovation-based solutions are sought by involving the introduction of new technologies, the creation of new market needs as a consequence of environmentally friendly products or business models. Innovation based green strategy also requires innovative attitude from the leaders of a firm.

Previous literature on sustainability and green innovation literature lacks theoretical and empirical understanding on how to create and manage radical green innovations in resource-intensive businesses. To add clarity to the prior discussion, this dissertation defines radical green innovation *as:*

> "a consciously driven change in a firm's strategy, its business model, and managerial practices addressing its environmental impact. It may imply great changes to the business by disrupting the competitive structures, modes of operation and institutionalized assumptions in a given industry*"*.

Developing new businesses and product lines based on radical innovations, these can become essential for the renewal of a company's competitive position and they can require management practices that differ substantially from those required for incremental innovation (O'Connor and Ayers, 2005). Therefore, Essays 1 and 2 specifically address and investigate managerial capabilities for creating radical green innovations. Moreover, radical innovation is viewed as critical to the long term success of firms (McDermott and O'Connor, 2002). Essays 1, 2 and 4 study the aspect of continuous commercial success achieved via the systematic creation of radical green innovations which are explored by analyzing a traditional resource intensive business in the United States.

McDermott and O'Connor (2002) and O'Connor and Ayers (2005) pointed out that it is often hard to get managerial support for radical projects in large firms, where internal cultures and pressures often favor low risk, immediate reward type of development efforts. In this study, the specific mental mindset and organizational barriers to green innovation's management are addressed in Essay 4. One may argue that the radically different new products and business models involve the development or application of significantly new technologies; require considerable behavioral changes to existing markets; and require new skills, abilities, and systems throughout the organization. For instance, Horbach (2008) highlighted the importance of technological and organizational capabilities in stimulating green innovation in the context of manufacturing firms. In this sense, there is a need to further research how incremental and green innovation can be conceptually differentiated and the critical differences explained in more detail. Further, there is a need to increase managerial understanding of how to implement and manage radical green innovations and to pinpoint which managerial capabilities (Essays 1 and 2) and managerial roles (Essay 4) are relevant to sustainability managers and other practitioners.

Although there is a substantial body of literature which presents environmental practices at a societal level (Stubbs and Cocklin, 2008; Robinson, 2004), there is a lack of solid theoretical foundation and empirical observation on the management of green innovations in companies and in the implementation of sustainable business models in companies (Bansal, 2005). In particular, previous literature has not paid sufficient attention to investigating how companies operationalize their strategy renewal and how they connect corporate greening with the core components of their business models. To address this gap, Essay 3 of this dissertation analyzes the process of transforming a firm's current business model towards an environmentally sustainable model.

### 2.6.3 Strategic managerial paradox for leaders of green businesses

This study suggests that the corporate greening process and the proactive targeting of (radical) green innovations represent a challenging managerial strategic paradox for leaders. On the one hand, prior scholars have illustrated multiple benefits from greening their operations and highlighted why companies incorporate environmental goals into their strategy and operations (Sharma, 2002). The scholars favoring corporate sustainability underline multiple benefits that can stem from integrating environmental sustainability issues into product development and business operations (Fraj-Andres et al., 2008; Miles and Covin, 2000; Miles and Munilla, 1993; Pujari et al., 2003; Shrivastava, 1995; York, 2009). On the other hand, some scholars and practitioners argue that going green lacks a viable business proposition (Morsing, 2003; Walling and Whitehead, 1994; Clarke et al., 1994). In order to gain benefits from green innovations, managers need a better understanding of green innovation and its management and implementation.

Further, to carry out a product innovation that reduces environmental impacts is a complex task and often requires information and skills distant from the traditional knowledge base of the industry. Consequently, some scholars, such as Grayson (2008), underline the "need for a new mindset" for corporate sustainability to stimulate green innovation. Therefore, based on this view, green innovation represents an emerging technological and business frontier on which firms are still inexperienced and technological uncertainties increase as there are no widespread and accepted standards either in terms of specific technological solutions or measures to evaluate the environmental performance of products and processes.

Consequently, Starkey and Crane (2003) point out that modern organizations largely

operate within a system of assumptions, values, and beliefs that privilege profitability and economic growth and that marginalize ecological concerns (Shrivastava, 1994). According to Gladwin et al. (1995), management theorists and practitioners appear to be largely locked with existing mental models that constrain their ecological sense making. The strategic paradox of managerial mental models is investigated further in Essay 4 of this dissertation by investigating mental barriers to incremental and radical green innovations and by suggesting multiple coping strategies (such as unlearning) to overcome the identified barriers.

## 2.7 The essays of the dissertation

Figure 3 illustrates the essays of this dissertation and links the essays with the core objectives. In the first phase of the research, the emphasis was placed on identifying the capabilities for managing for radical green innovations, both at the firm-level and with external partners. In this respect, the methodology adopts a systemic combining theory development approach. In the second phase, the study focused on the development of one of the key conceptual propositions of the entire dissertation, the four innovation types or "games" framework and its empirical evaluation, through single and multicase study analyses. The selection of the primary case company and the subsequent sub-cases and a more detailed description of research methods applied in each study are described separately in the original papers.

The positioning and focus of each paper is highlighted in Figure 3. representing a rough sketch of this dissertation. The arrows in Figure 3 represent the logical interrelationships of the key themes, the purposes of the essays and objectives of the

papers, and they describe the routes of knowledge accumulated in the process and link these with the core objectives of the dissertation. This knowledge manifests theoretical, methodological, and cumulative empirical understanding, skills, and expertise across the two phases of the study. □

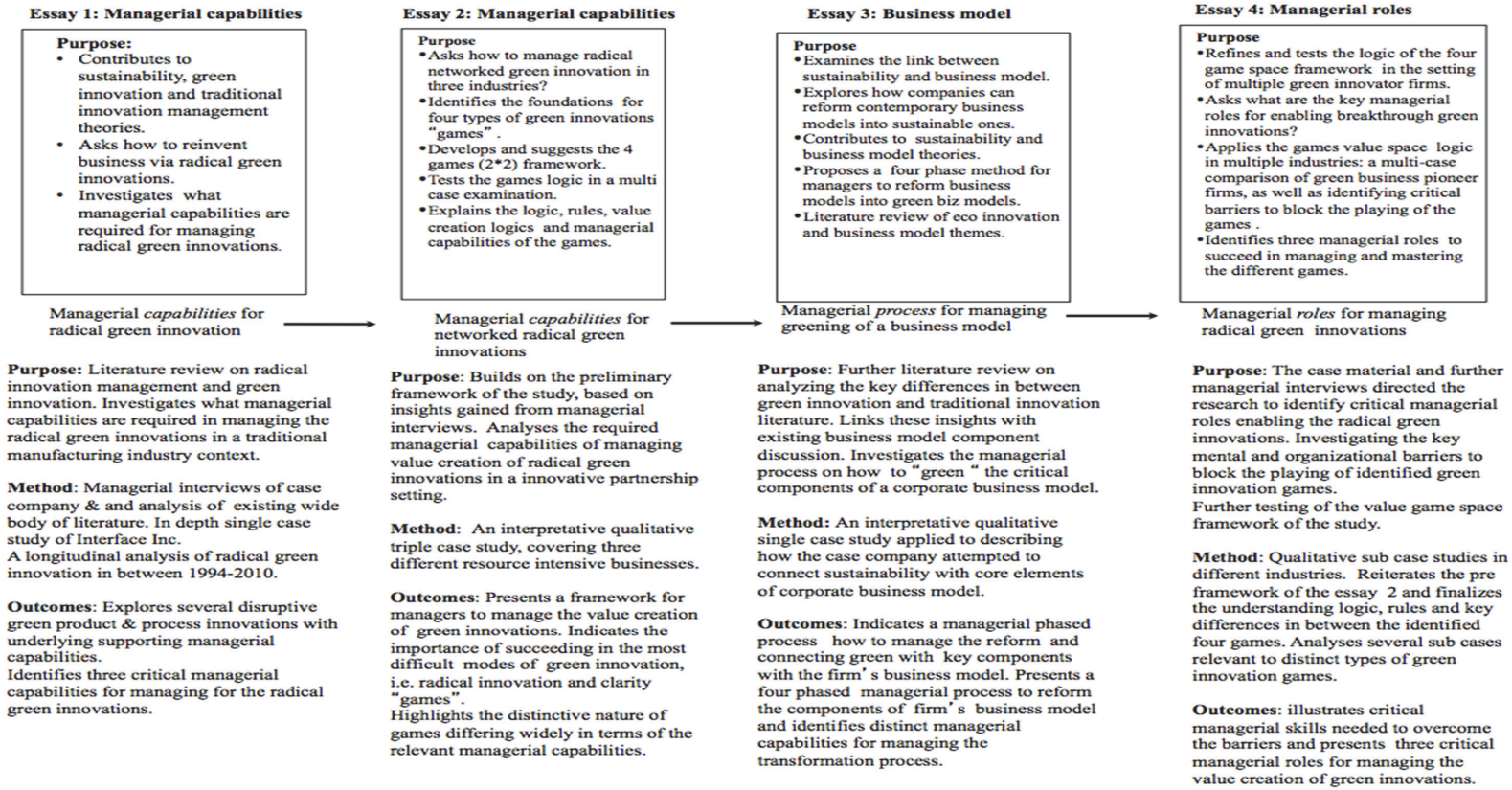


*Figure 3. Connections in between the four essays of this dissertation*

In short, Essay 1 investigates the managerial capabilities for managing radical green innovations in a resource industry context, while Essay 2 expands this notion by illustrating the managerial capabilities in the context of networked radical green innovations in three different resource intensive business contexts. Essay 3 examines and identifies a managerial process for greening a firm business model. Essay 4 in turn identifies critical managerial roles for managing incremental and radical green innovations. The essays' key objectives, research setting and key contributions are described in further detail in Chapter 4.

## *3. Methodology: research method and data analysis*

This dissertation consists of four essays, all of which have a qualitative research approach (see Part 2.). The empirical inquiry conducted in this dissertation is focused on sustainability leaders among established businesses in resource intensive industries. This introductory section provides an overview of the research approach, data collection and analysis methods of the research. The chapter concludes by discussing the reliability, validity and limitations of the study.

### *3.1 Research approach*

An explorative qualitative research approach was employed to achieve the research aims of gaining deep insights how companies manage green innovations. In particular, the case study approach used in the study provides a multitude of advantages which make it attractive in domains such as innovation management and corporate sustainability. On one hand, the subject topic can be highly complex while at the same time lacking a strong support by corresponding theories, as in the case of new service design or green innovation (Stuart et al., 2002). On the other hand, the research objective, which focuses on the question why the phenomenon emerges, is also well covered by the case study approach (Yin, 2009). Therefore, all of the articles of the dissertation adopt a qualitative research approach. Qualitative research has been used extensively in social sciences to gain deeper understanding of the studied phenomenon.

More specifically, prior research (e.g., Carrillo et al., 2010, 2009; Rio et al., 2011) have pointed out that the study of green innovation can benefit significantly from empirical analyses which grasp the details of specific green innovation types and their

dimensions. A case study approach is ideal for generating theoretical and pragmatic insights from empirical observations when little is known about a phenomenon and when there is disagreement within the literature (Eisenhardt and Graebner, 2007). Furthermore, case study is able to capture the specific details of green innovations, which can be unnoticed when relying on aggregate quantitative analyses. This study conducts an analysis of primary case study and several sub cases, since multiple cases can increase the external validity and, ultimately, the generalizability of research findings (Cook and Campbell, 1976; Patton, 1999; Maxwell, 2012).

### 3.2 The market and cultural choice

The researcher conducted a number of interviews with senior managers in recognized green pioneer firms such as Nike, Method, Intel, IBM and Interface in the Northern California's Silicon Valley and the San Francisco Bay areas. Silicon Valley has been recognized as the leading region for innovative green business and clean technology companies in the US. California's Green Business Program lists over 2,600 firms in 120 categories of business who have a green certification (California Green Business, 2012). Moreover, the city of San Francisco hosts about 500 green certified companies and Berkeley 200 green businesses in 2011[3]. In 2005 alone, venture capitalists invested about $1.13 billion to companies operating in the clean technology domain in California, and the state of California leads in clean energy production of electricity in the US.

[3] see e.g. http://www.sfgreenbusiness.org and http://www.sfgate.com/business/article/Silicon-Valley-companies-going-green-in-a-big-way-2501721.php#ixzz2NMnL4Prg.

The researcher's long term visit at UC Berkeley, Haas School of Business, provided the opportunity to access multiple leading green pioneer firms in the area. It allowed the researcher to visit cutting edge firms and conduct face to face interviews with senior managers of sustainability, including the primary case company of this dissertation. Silicon Valley and the San Francisco Bay area host hundreds of firms, both start-ups and more mature enterprises, focusing on green business, and the State of California recently pioneered progressive green legislation, introducing the US's first carbon emission based marketplace.

Therefore, the cultural context of this dissertation and its cases are primarily North American. The targeted companies were identified based on their progressive green business activities and on their public recognition as green leaders in their industries. The targeted green business companies included category leader firms such as Starbucks, IBM, Interface, Unilever, Intel and Nike. For example, IBM and Intel were listed as the greenest companies in the US in Newsweek's annual ranking of green businesses (Newsweek, 2012). In this vein, Climatecounts' annual ranking lists of sector leaders include,Nike in apparel, Starbucks in food services, Unilever in food products, and IBM in technology sector[4].

Within the traditional innovation management literature and in empirical studies, these companies are also often associated for advancing innovative products and services within their respective industries. The targeted green start-up firms represented publicly certified B-Corporations in the United States, including Method, Pact, Oneworld Futbol, Senda Athletics, and Back to the Roots. Certified B-corporations are legally

[4] See Climatecounts 2012, 2012-2013 Annual Company scorecard report, available at http://climatecounts.org/pdf/CC_2012_FinalScores.pdf

entitled in their mission statement to advance simultaneously for profit business objectives as well as solving environmental and/or social challenges. In this sense, the selected startups were founded on the principles of the triple bottom line concept (Elkington, 1994). All but one of the interviewed start-up managers were founders of their companies.

### 3.3 The justification of the selection of the primary case company

This study adopts the viewpoint of Azzone et al. (1997) and examines companies that emphasize an *innovative approach* towards corporate sustainability in their strategy. That is, those organizations have adopted a highly proactive approach to corporate greening by introducing new green products or processes which have required radical innovation in their management procedures and processes and resulted in superior performance. By following this logic, the number of potential case companies in the US is limited to a handful of sustainability leaders amongst established businesses that operate in the resource intensive business and that have adopted a long term environmental orientation and commitment as core to the strategy, business model, leadership, and culture. Consequently, this reasoning led to the selection of an early pioneer in corporate sustainability, the Interface Inc. Examination of the company is supported by literature (see e..g Doppelt, 2003; Elkington, 2001; Griffiths, 2000) as the environmental journey of Interface has been documented in the prior literature; yet little is known about their management for radical green innovations. In addition, the researcher gained an access to senior management of sustainability in the firm during the research process. The case company is presented next.

### 3.3.1. Interface Inc. – A green business pioneer in a resource intensive manufacturing business

The primary case company, Interface Inc., is a global market leader in the industrial carpet tile manufacturing business, and is a recognized pioneer in corporate sustainability that operates in a highly toxic and oil dependent industry. During its 18 year long corporate greening- journey, it has pioneered several first-to-the-world green innovations and embraced innovative green leadership since 1994 (see Appendix X. for further details of the firm's environmental goals.). The researcher gained access to conduct several interviews with senior sustainability managers of Interface during 2010-2012.

Previous empirical case studies of Interface consider it to be a leader in restructuring its business model around environmental sustainability (Doppelt, 2003; Elkington, 2001; Griffiths, 2000; Melhus, 2005; Vaccaro, 2008; Amodeo, 2005; Stubbs and Conclin, 2008). Yet, these studies are deficient when it comes to acknowledging the radical nature of Interface's green innovations and how they were managed. Previous empirical studies have mainly analyzed the transformational process of Interface from a polluter to a greener company, analyzed the experiences through the lenses of the company founder and CEO Ray Anderson (Anderson, 2009), or described the cultural transformation towards sustainability through narrative lenses and core changes in the organizational belief system during 1996-2005 (Amodeo, 2005). So far, the prior research on Interface has been silent about the management for radical green innovations, particularly on what managerial competencies, roles and strategies were used to support the creation of radical green ideas and business initiatives.

### 3.3.2 Selection of the supportive case companies and unit of analysis

This research has been conducted as a multiple case study (Eisenhardt and Graebner, 2007) that includes one primary case and supporting cases of which extensive qualitative materials were collected. The choice of cases was made following the theoretical sampling (Eisenhardt, 1989) and those cases were chosen that were most likely to offer a useful extension to current theory presented in the literature review chapter in this study. The companies were based on the appropriate mix of homogeneity and diversity they provide in relation to their corporate sustainability and green innovation management setting. The selected companies have many similarities, several of which are pioneers in combining corporate sustainability goals holistically with their corporate strategy, business goals, leadership, culture and values. Consequently, this dissertation focuses on three case studies from three industries and business domains; traditional manufacturing, housing design and construction, and an eco-city and knowledge-hub development. Moreover, the resulting framework of game space of the study is tested first in a three industry setting (Essay 3) and following that in a multi-industry context, reflecting the experiences of sustainability leaders among established businesses across diverse industries (Essay 4). Along all of the essays, the experiences of the primary case, Interface Inc. were echoed.

### 3.3.3. Unit of analysis within the primary case company

This study's primary case company, Interface Inc., is a recognized pioneer in corporate sustainability. Appendix 4. presents a detailed description of the primary case company. To begin with, the researcher gained access to the primary case company and

interviewed three sustainability directors of Interface, two of the managers were interviewed multiple times to further elaborate on new insights from the prior interviews and existing literature and in order to double check the facts written in various research papers (Essays 1, 3 and 4). Moreover, three of these managers had experienced the historical evolution of Interface's corporate sustainability program and one of these managers had a leading role in incorporating the external network's insight into the core of Interface's business, since 1994 (see Essay 2 of the study).

To avoid the subjective bias, additional insight to the Interface case were gained by interviewing an external expert of Interface, who studied the evolving cultural transformation towards corporate sustainability at Interface in 1996-2005 (see Amodeo, 2005), as well the extensive secondary literature and prior studies on Interface. Furthermore, the interviewed managers of the case company were actively involved in checking the facts of essays 1- 4 and suggesting new insight to further refine and develop this dissertations' framework of the four green innovation games, in particular regarding the essays 1 and 4. Furthermore, two of the senior level managers of Interface were interviewed a total of 3 times each to elaborate and build on the existing and emerging themes and the underlying key arguments. This continuous interaction and collaborative iteration work contributed to final iteration and formulation of the identified three managerial roles and the listing of critical core competencies required for mastering the radical green innovations.

Lastly, the supporting sub-cases of this dissertation included two additional examples of firms operating in resource intensive business. First, Architecture for Humanity operates in the operating in housing design and construction business. Second, Masdar-city in clean energy R&D and innovation in effort to build the greenest city in the world (Essay 3). Finally, the Essay 4 includes several supporting examples of companies

operating in different industries and the guiding model of the dissertation is applied across sectors.

In the following, a detailed description of the data collection and analysis is reviewed.

## 3.4 Qualitative data collection and analysis

Upon entering the green innovation and corporate sustainability research field, the researcher had already established a preliminary understanding of the phenomenon, and used that understanding to make sense of the events that were encountered during the interview process and the literature review. However, the observations the researcher made in the green innovation field brought forward topics and perspectives that required the researcher to reconstruct the theoretical frame of reference. This doctoral research is conducted as a multiple case study (Eisenhardt and Graebner, 2007) that includes one primary case and multiple supportive cases of which extensive materials were collected.

### 3.4.1 Data collection, 2009-2012

The study's empirical material were collected through qualitative methods, namely via 49 in-depth interviews with green entrepreneurs and sustainability managers of incumbents over a four-year period in the U.S amongst 33 firms. Due to the specific nature of the information being sought, key informants were selected based on their knowledge of the environmentally oriented business initiatives of their firms and the

underlying reasons for these initiatives. In particular, this study considered senior level managers as the primary informants. These companies are based primarily in the US and consist of recognized pioneers in the field of corporate sustainability representing start-ups and medium to large sized multinationals operating in diverse resource intensive industries such as ICT, industrial manufacturing, and consumer goods.

The selection of case companies was especially based on their commitment towards sustainability issues, which was considered evident through their long term commitment to corporate greening as well as environmental awards (in regards to green innovations) perceived leading positions in their industry in terms of green business related actions. The interviews followed the guidelines suggested by Yin (2003, 2012), regarding which type of questions asked in the interviews should be considered from the perspective of the research setting and objectives. The semi-structured interviews contained several open-ended questions, discussions, and considerations by management related to selected themes of the interview. In this respect, the present study focused on "what" questions as it tried to explore the empirical phenomena; i.e., the identified behavior related to green innovation management models in the resource intensive businesses. Thus, a majority of the questions asked in the management interviews focused on what had happened in real life concerning green innovation and its management within the case companies. In addition, the analysis focused on "how" and "why "questions, as the study identified and described the identifiable patterns of their green innovation management experiences through multiple empirical observations.

During the interviews, the following areas were discussed: issues relating to the management and the managerial competences required for green innovation, key differences between incremental and radical green innovations, new

service/management model and business models companies have developed, motivations to engage in corporate sustainability, green innovation creation and related challenges, new business opportunities and barriers/risks they have faced, managerial capabilities, and roles needed to manage green innovations. All these characteristics are arguments for using the qualitative case study approach in the domain of the corporate sustainability.

The interviews were exploratory in nature and sought to elicit managers' views on the corporate sustainability and green innovation management practices in their firms, with their own frames of reference and without imposing researcher's own preconceptions. In the qualitative field study, there were no models set out to test specific points, but rather to elicit and analyze the views of experienced professionals of corporate sustainability and green innovation. During the interviews, the researcher asked for further contacts either inside the same firm or within a leader's personal network related to corporate sustainability. The researcher also asked for interviewee's opinion on the most innovative pioneers of corporate sustainability in the US, to further point out the other leading companies, sustainability managers and thought leaders.

Open-ended interviews were conducted during the visits to companies, and clarifications were sought later through e-mails, phone calls and follow up meetings. All of the interviews were conducted in English. The majority of the interviews were recorded and transcribed for analysis. Regarding the seven interviews that were not recorded, it was due to the fact that the researcher was following the interviewees' request either not to tape the interview or due to the noisy background, with interviews taking place in a public location. However, these interviews were instantly coded and a memorandum was prepared right after the interviews and these unrecorded interviews

did not lead to a systematic selection bias because they were distributed randomly across the data sets. Four of the interviews of the primary case company included two researchers, with one researcher taking notes and the other asking questions. A list of the interviews is presented in the Appendix 1. and an outline of the themes of these interviews is summarized in the Appendix 2.

The interviews were conducted in two different phases, which are briefly described in the following. In the first phase of the field study taking place 2009 through 2010, the data collection included 20 interviews in 15 green businesses in the US. The interviews ranged from one hour to maximum of three hours. In the second phase of the study, taking place from 2011 through 2012, the interviews were conducted with additional 29 senior managers, green entrepreneurs, and thought leaders in the US. This phase focused on the barriers of corporate greening and the needed managerial competence requirements. In sum, four of the 49 interviews were conducted with two researchers, one taking notes and one asking the questions. Furthermore, three of the 49 interviews were conducted in Finland. In sum, the average length of an interview was approximately one hour and thirty minutes.

The roles of the interviewed managers in the companies varied slightly. The majority of the interviewed managers were experienced, senior level executives, working in a resource intensive business and possessing a minimum of 5-20 years of experience in corporate sustainability. These managers in larger corporations were typically responsible for green innovation activities and the corporate sustainability program, and had a title such as Sustainability Director. A smaller portion of interviewees were either the (co-) founders of green business startups (e.g. Method Home, Oneworld Futbol, and Pact – all of which are Certified B corporations) or were considered as leading

authorities in the green business theme in the United States including publicly recognized thought leaders of corporate sustainability[5]. During the analysis and reporting of results, the identification of individuals and responses were prevented and protected due to confidentiality reasons.

In addition to conducting an intensive field study to collect primary data, an extensive set of secondary data was collected on the case companies over a four year period. The data consisted of internal documents, brochures, bulletins and annual reports, presentation materials, reviews, and information published on internal and external Web and blog sites, and pages of independent forums and industry associations, as well as the documents and reports given by respondents to the researcher. This principle was adopted from Yin (2003, 2012), who emphasizes the importance of using multiple sources of evidence, creating a case study database, and, maintaining a chain of evidence as essential principles of data collection. For these reasons a comparable case study database was created on the primary case company and the supporting sub cases. As Kasanen et al. (1993) and Yin (2003) illustrate, the primary aim of case studies is to acquire a deep understanding of the nature, significance, and functioning of one or a few cases, and to report this understanding thoroughly, carefully, and credibly to the larger scientific audience. At the same time, they consider a common argument against case studies, which is that they provide little basis for scientific generalization. Eisenhardt (1989) discusses this concern by introducing a process for building more generalizable theories from case study research. Her theory-building process is based on the use of multiple cases and cross-case analysis, which allow the researcher to draw more generalizable theoretical conclusions.

[5] see http://www.sustainabilityprofessionals.org/issp-sustainability-hall-fame

### 3.4.2 Systematic combining

This dissertation adopted the approach of systematic combining which is described "as a nonlinear, path-dependent process of combining efforts with the ultimate objective of matching theory and reality" (Dubois and Gadde, 2002:556). The literature review revealed that the concepts of green innovation and corporate sustainability have not been well established in the prior literature. For that reason, the literature review reflects an apparent conceptual evolution, and a research process consisting of both inductive and deductive phases has been deemed suitable for the present study.

According to Dubois and Gadde (2002), this allows the researcher to explore the meaning of a construct without being constrained by strictly predefined theoretical frameworks. The research approach of the study is based on a constant movement between an empirical world and a model world, where researcher navigates ''*between asking questions, generating hypotheses, and making comparisons"* to make sense of both theory and empirical phenomena (Dubois and Gadde, 2002; Strauss and Corbin, 1990). More specifically, Dubois and Gadde (2002) illustrate that for the generation of theory, such as systematic combining, literature analysis plays quite a different role. The researcher's objective is to discover new things— i.e. other variables and other relationships. According to Dubois and Gadde (ibid), this allows the researcher to explore the meaning of a construct without strictly predefined theoretical frameworks. Therefore, an open-minded interpretation of the empirical findings; i.e., the highly heterogeneous instances of identified characteristics and types of green innovation and corporate sustainability within corporations are a guiding principle in this study. Even during the discovery process, the researcher must consider phenomena in the light of a theoretical framework. The researcher should not be unnecessarily constrained by

having to adhere to previously developed theory. There is no doubt that theory is important, but it is continuously developed over time.

The question of whether one should start with 'received theory', which has been debated by inductionists and deductionists, is not an issue with which systematic combining is concerned. According to Strauss and Corbin (1990), it is important to enter into the research situations with some background in what they refer to as 'technical literature'. They argue that there is no need to review all of the literature beforehand. In fact, such a review could hamper the desired process. In systematic combining, the researcher would not be able even to identify all the literature since the empirical fieldwork parallels the theoretical conceptualization. Hence, the need for theory is created in the process. Since 1993, the researcher has gained experience in the case study research, innovation management, radical innovation and green innovation management research through conducting various studies-and over 13 years- has executed these concepts in practice via introduction of several ideas to innovation development projects in the ICT industry.

There are a few major differences between the abductive and decuctive approaches. First, the abductive approach is to be seen as different from a mixture of deductive and inductive approaches. Second, *an abductive approach is fruitful if the researcher's objective is to discover new things*— other variables and other relationships. Third, similarly to the grounded theory, the main concern is related to the generation of new concepts and development of theoretical models, rather than confirmation of existing theory. Essentially, one stresses theory development, rather than the theory generation. Consequently, systematic combining builds more on refinement of existing theories than on inventing new ones. Fourth, one major difference is the role of the framework

when comparing both deductive and inductive studies.

In studies relying on abduction, as within this study, the original framework is successively modified, partly as a result of unanticipated empirical findings, but also through theoretical insights gained during the process. Consequently, *this approach creates fruitful cross-fertilization where new combinations are developed through a mixture of established theoretical models and new concepts derived from the confrontation with reality.* Under the four game- strategic value creation framework with its underlying concepts, the rules of the game and managerial roles were in a constant flux over the course of the research. The final version of the framework was arrived at once all the data had been processed. Three other researchers assisted in the analysis of data and the interpretation of findings.

## *3.5 Evaluation of the method selected*

### 3.5.1 Reliability and validity

Validity and reliability refer to the scientific qualities of the research. Traditionally, the validity and reliability in quantitative research have been the criteria against which the quality of a study is measured. The validity refers to whether the study measures what it was intended to measure and the reliability refers to whether the findings are repeatable in other contexts (Bryman & Bell, 2003; Yin, 2003). In this study, and for qualitative research in general, these criteria must be approached differently, because it is recognized that the aim of the research is not to measure an objective truth (Bryman

& Bell, 2003). Within qualitative research there is much discussion of the validity and reliability of research (Yin, 1994; Eisenhard, 1989; Silverman, 2000). According to Cook and Campbell (1979) validity is the best available approximation of the truth and to the generalizability of the results. Reliability evaluates the possibility of replicating the study and obtaining the same results, and, whether the research process is credible or not and whether the readers of qualitative research reports can relate to the findings (Eskola & Suoranta, 2003).

Eskola & Suoranta (ibid) point out that researchers need to describe the research process carefully in order to that it is both methodologically and theoretically transparent, to increase the quality of qualitative research and the ability of the readers to evaluate it. Along the same notion, Moisander and Valtonen (2006;27) highlight that the "data production process, analytical procedures and principles, how interpretations were developed, and conclusions drawn" as well as "the theoretical stance from which the interpretation takes place" need to be stated explicitly. Yet, there is a lack of generally accepted guidelines for the assessment of conceptual studies, and validity has different implications in both qualitative and quantitative research. However, there are some similarities, such as the fair and generated representation of the actual phenomenon, which Lincoln and Guba (2000) call as the authenticity of research. They (ibid) define authenticity as fairness, ontological and educative authenticity, and catalytic and tactical authenticity. The aim in their use of fairness is that research process and reports should equally implicate all views, claims, perspectives, concerns and voices. This is ensured also by enabling critical views to come out, even if they contradict the consensus view. In the theoretical part of this study, contradictory perspectives are presented, and empirical analyses are conducted in consideration of this principle.

In the essays, as well as in this introductory part of the dissertation, an effort has been made to underline the choices made in the research process as explicitly as possible to enable readers to evaluate the evolution of the preliminary and the second phase of the research process. The first two essays are based on an analysis of the primary case company's green innovation management and the managerial capabilities required. The analysis in Essays 3 and 4 focused on the themes that emerged from the qualitative interviews. The themes were partly pre-determined because of the thematic interview guides that were used to ensure a certain level of standardization between interviews, but some themes also emerged from outside the interview guide and these insights were further elaborated during the managerial interviews.

To increase the theoretical transparency of these studies, the data collection and analytical phases were based on previous research according to principles identified by Moisander and Valtonen (2006). This was particularly important for identifying and analyzing the prior theoretical and empirical studies on green innovations and corporate sustainability. Furthermore, the fact that the majority of the data was gathered by one interviewer through semi-structured interviews, increased the consistency of the research (Bryman and Bell, 2003). In Essay 4, which was a multiple case study, the use of semi-structured interviews also enhanced cross-case comparability (ibid.). In analyzing the data, the transcriptions of the interviews were read and re-read several times to ensure the validity of the categorization of themes (Dey, 1993). Furthermore, to make the analysis more explicit and evaluable (Eskola and Suoranta, 2003), the research process is clearly explained, and some of the interpretations made are supported by quotations from the interviews wherever feasible. These procedures make it possible for readers to evaluate both the research process and the researcher's interpretations, and thus, increase the reliability of the findings. Finally, to make the

studies replicable, this study lists the thematic interview guide that was used to guide the interview process carried out in the essays of this study (Appendix 2).

### 3.5.2 Triangulation

A dominant research line in social sciences consists of *research triangulation*. It means the application and combination of several research methodologies in the study of the same phenomenon (Yin, 1994: Yin, 2012). The rationale behind this thinking is that one can be more confident in a result if different methods lead to the same result. Thus, it is employed in studies of both quantitative (validation) and qualitative (inquiry) nature. Yin (1994) illustrates that the use of case study tactics requires multiple sources of evidence, as well as developing of sufficiently operational set of measures, internal validity, external validity, and reliability.

There are four types of triangulation: (1) data, (2) theory, (3) investigator, and (4) methodology (Denzin, 1978). All these types are required to meet the triangulation requirements, and they are discussed briefly in the following.

*Data triangulation* contains time, space, and people. In the present study, more than one senior manager in the primary case company firm was interviewed to avoid overly subjective opinions and views (see Appendix I for the list of interviews). Furthermore, data was collected from different types of firms according to the theory-based green innovation classification to avoid the bias due to the unintended firm similarity. The data comprise interviewees from 33 different companies that represent various industries of corporate sustainability.

*Theory triangulation* involves the use of more than one theoretical scheme in the interpretation of phenomena. The present study draws in all respects on several distinctive theoretical approaches including traditional innovation management theories, green innovation and corporate sustainability fields of research; all of them are widely recognized in the field of green innovation management research. These theoretical lenses were applied across the study. In this way, the principle of theoretical triangulation was addressed throughout the study. The analysis process was a continuous interaction between theory and empirical research in accordance with the principles presented by Dubois and Gadde (2002).

*Investigator triangulation* involves multiple researchers in an investigation. Such collective research activity was addressed in designing data collection and the central themes utilized, as well as in the gathering, analysis and reporting of data in all papers except for the first essay – one that is required to be the product of this dissertation's author solely. Even then, the thematic questionnaire format was refined and finalized in co-operation with a research fellow familiar with the topics of innovation management and corporate sustainability. Moreover, the resulting strategic green innovation framework of the study was constructed, reiterated, and finalized with the input from three other researchers who co-developed the strategic games, identified the key rules and characteristics of these games, pinpointed managerial capabilities and differences between various games, identified the value creation logic of the differing games, and explored the key barriers to accessing the differing green innovation games. Moreover, the three managerial roles constructed in the study were further developed and reiterated by a total of four researchers (see essay 4 of this dissertation) , while three researchers identified, and reiterated the phases of corporate business model greening in Essay 3.

*Methodological triangulation* necessitates the use of more than one method to gather data. In the present study, the thematic interviews were utilized in data gathering, and investigation was enriched via the use of secondary data. The secondary data included company-related articles in academic working papers and theses, newspapers and magazines, web-pages, annual reports and brochures. Secondary data proved helpful in gaining a more comprehensive view and understanding of the case companies, their environmental activities and development of green innovations. These choices are explained in detail in the following.

In accordance to Yin's (1994, 2012) opinion, multiple sources allowed the researcher to address a broader range of historical, attitudinal, and behavioral issues. Combining sources of evidence, while shifting between analysis and interpretation, usually denotes triangulation (Yin, 1994; Denzin, 1978). According to Yin (1994), the main advantage of triangulation is the development of converging lines of inquiry. Huberman and Miles (1994) express this notion as ''self-consciously setting out to collect and double check findings.'' As Dubois and Gadde (2002) suggest multiple sources of data may contribute to revealing aspects unknown to the researcher, i.e., to discover new dimensions of the research problem. Most data collecting activities are directed towards the search for specific data in line with the current framework. These activities need to be complemented by efforts aiming at discovery. This may result in redirection of the study.

Research process:

In this dissertation, interviews were combined with other sources of information by:

- Gaining direct access to representatives of the selected primary case company: Interviews were carried out with experienced senior sustainability managers of the

primary case company Interface Inc. which is the global market leader in the carpet tile manufacturing business. These managers' typical role was to manage, initiate and commercialize new green business initiatives and to incorporate corporate sustainability business activities into the heart of the strategy, business model, culture and leadership of the company in question.

- Performing further discussions and multiple interviews with Interface's two senior sustainability directors resulted in the reiteration of earlier findings and assisted in the redefinition of the preliminary framework of the study. The study's key propositions (cf. Essays 1, 2 and 4) were tested and the company-related facts were double checked with these further managerial interviews. In addition, two senior managers commented on any potentially misleading or incorrect facts in the essays, which were then corrected). That way, they assisted in the redefinition and clarification of the needed competencies and managerial roles in order to "master" the three identified critical managerial roles as suggested in the integrative analysis (Essay 4).

- Conducting additional managerial interviews with other industries' experienced sustainability managers and "green" entrepreneurs who possessed long experience in corporate sustainability and in managing for differing green innovations. This was conducted to increase the understanding of the management of green innovations and how companies approached the value creation through various types of green innovations. The interviews were carried out with corporate sustainability managers and founders of startups with built-in triple bottom line goals (i.e. people, planet and profit ambitions). These interviews directed the researcher to further analyze the critical skills required to overcome barriers to adopting green innovations, which in turn led to further reiteration of the framework

(particularly having an effect on the proposed results regarding the Essays 2, 3 and 4).

- Carrying out an extensive literature review on the extensive amount of academic and practical studies of the primary case company. The majority of the case material of Interface covered the time period from 1996 through 2010.

- Utilizing publicly available printed sources of information, web content, company reports, firm presentations, and materials such as Interface's Corporate Sustainability report and Annual Reports were utilized. Moreover, the researcher received corporate reports and material related to the commercialized green innovations. These supportive materials were given to the researcher by the interviewed managers of the case company. Furthermore, the validity of the case company's corporate information and facts were reviewed by three sustainability managers from Interface, regarding Essays 1, 2 and 4. Lastly, the facts presented in Essay 3 were reviewed and verified by one sustainability manager from Interface Inc.

In sum, the essays of in this dissertation outline qualitative techniques and methods. To ensure reliability of the study, and thus to enable another researcher to reach the same results, criteria for choosing primary case firms, sub cases and potential survey respondents, the main interview themes and the analysis methods are reported in detail. The context of this study is resource intensive business, operating primarily in the US. Lastly, the researcher regards the results to be reliable and believe that the replication of research process would produce similar results. Yet, a critical concern is if the results from the study can be generalized to a larger population. The limitations of the study are reviewed next.

## 3.6 Limitations

The study is limited to studying environmentally oriented companies operating in resource intensive businesses. In other words, the study focuses on sustainability leaders amongs established businesses which develop, and commercialize environmentally friendly products, services and whose business is built on the three pillars of sustainability, adopting the principles of people, planet and profits as suggested by Elkington (1994). The study adopts a corporate level of analysis and illustrates the green innovation management activities of a primary case company, Interface Inc., which operates in the carpet manufacturing industry. However, as companies in different industries face highly differing challenges and focus areas of corporate sustainability, their environmental strategy and focus areas differ widely from other companies. For example, some industries are less dependent on infrastructure limitations (such as in software business) or acquiring and utilizing resource intensive raw materials. Moreover, their innovation development cycles are typically faster and cheaper to implement than those of traditional manufacturing businesses.

As a consequence, some of this study's outcomes may be applicable in related industries or across industries, but many of the premises are different even in other resource intensive businesses that have varying impact on the environment from different parts of their operations. Therefore, one must be cautious about generalizing the findings to other industries. Future research should consider the extent to which the findings apply beyond the primary traditional manufacturing industry.

Further, the qualitative data of this study was collected entirely in the United States (except for three interviews that were conducted in Finland). This might be a concern,

if the focus of green innovation management activities varies widely by country. Thus, the reader should be careful about generalizing the results into other country contexts. Future research is required to investigate whether the results hold between different geographical and cultural areas. Another issue is the fact that this study relies on data gathered from senior sustainability managers' perspective and perceptions. The management of green innovation is a complex issue and it calls for informants with long term knowledge of the firm strategy, innovation management strategies and other specialized information. Typically, such knowledge and understanding is possessed by senior management, including for example the company founder(s), CEO, Innovation Manager, or Chief Sustainability Officer.

The present study focused solely on senior managers during the course of two phased qualitative data collection. However, in the case of green innovation management, the people who interact with firm's key stakeholders and partners- in regards to green innovation development on a daily basis- may not be senior managers but lower to middle-level employees. Thus, their daily activities with innovation development partners may turn out to be most influential concerning the implications concerning the development of a certain green innovation. Thus, the specific ways of managing and developing green innovation could be better captured by investigating the people at the middle to lower levels of a firm, regardless of their managerial status or organizational level. There are possibilities for cultural differences as well within the managing for green innovations, due to the fact that majority of the interviewed managers were from the United States.

## *4. REVIEW OF THE RESULTS*

This doctoral dissertation includes four research papers, three of which have been submitted to or published in peer-reviewed international research journals and one paper which was published in a conference proceeding. In this section, the results of the papers are reviewed from the perspective of their contributions to the objectives of the present study. The objectives are filtered into he main research question of "how to manage value creation through green innovation in resource-intensive businesses". The first paper addresses how radical green innovations are typified and managed amongst a green pioneer firm in a traditional manufacturing business. The paper further identifies critical managerial capabilities for advancing radical green innovations.

The second paper discusses how three companies in resource intensive businesses are managing networked, radical green innovations. The third paper investigates how managers can infuse green objectives into the core elements of its business model. Finally, the fourth paper examines the key managerial roles of managing and creating value through differing green innovation types in industries beyond the traditional manufacturing and tests the applicability of the key framework across multiple firms considered as pioneers in corporate greening.

Next, each paper is analyzed in terms of their key research objectives and methods, as well as their findings and the contributions they make to the whole study. Part 2 of the dissertation lists the original papers.

## 4.1 MANAGEMENT OF RADICAL GREEN INNOVATIONS: THE TYPOLOGY AND MANAGERIAL CAPABILITIES

Paper I: Tommi Lampikoski. (2013). Green, innovative and profitable*: a case study of managerial capabilities at Interface Inc*. *Technology Innovation Management Review,* 2(11): 4-12.

### 4.1.1 Research objectives and methods

This paper addresses the first research objective of the dissertation: what are the observable managerial capabilities for managing radical green innovations in the context of a traditional manufacturing industry? It examines a sustainability leader among established businesses which has pioneered green innovation management practices and strategies in the traditional manufacturing field. The paper aims to identify the critical management capabilities for managing radical green innovations. It differentiates the concepts of traditional innovation and green innovation and illustrates the shortcomings of traditional management thinking, which addressed solely the advancement of value creation through incremental green innovations. First, the paper establishes a guideline for managing radical green innovation through identifying three dynamic managerial capabilities. The guideline is constructed through a longitudinal analysis of the case company, i.e. analyzing the firms' green innovation development program during 1994-2012. Second, the paper discusses these guidelines through a qualitative empirical analysis of selected cases in the traditional manufacturing field. The primary data for the cases is gathered through senior managerial interviews conducted personally. Moreover, the study utilizes extensive secondary material available from the public sources.

### 4.1.2 Findings and contribution

This paper argues that green business firms need to increasingly invest in managerial capabilities required in creating a systematic flow of radical green innovations. The paper contributes to the dissertation by identifying and analyzing three interconnected managerial capabilities of radical green innovation in a resource intensive business context. Each identified capability reflects a unique purpose, task, set of skills and outcomes and they evolve as a combined set, instead of consecutively. This paper illustrates how the analyzed case company succeeded with the creation of continuous radical green innovations by investing in managerial capabilities that allowed it to research the emerging green business field, and recognize the emerging green business opportunities, and scale the emerging radical green innovation in an attempt to revolutionize its industry's traditional business practices. These interconnected capabilities enabled it to continuously challenge and disrupt the existing management recipes, established knowledge, and proven industrial practices, and they enabled it to create a sustainable competitive advantage through a continuous portfolio of radical green innovations, as illustrated in Table 4.

| | CAPABILITY FOR RADICAL GREEN INNOVATION | | |
|---|---|---|---|
| | 1. RESEARCH | 2. RECOGNIZE | 3. REVOLUTIONIZE |
| Purpose | Make sense of the emerging paradigm. | Recognize the missing pieces. | Connect and scale the emerging dots. |
| Tasks | •Facilitate investigative curiosity through experimental re-engineering and reframing of challenges.<br>•Borrow from nature's design principles.<br>•Observe and look inside and outside the company for sources of radical ideas.<br>•Search and discover new and unknown ways of doing things. | •Identify partners, suppliers, and stakeholders best equipped in filling the identified gaps with complementary skills, brands, and talent.<br>•Spot out senior leaders with respected track-records and power to prioritize the radical experiments.<br>•Discover emerging innovation opportunities and gaps across the emerging value system. | •Connect the strategy, entrepreneurial leadership and environmental vision with a continuous flow of radical green innovations.<br>•Seek answers to "what if" -questions and push the boundaries of what is possible.<br>•Eliminate old fashioned industrial recipes and practices. |
| Critical question | Are we able to make sense of the emerging green business paradigm? | Do we possess the capable talent to design, develop, and cultivate the next wave of radical green innovations? | Can we revolutionize the existing industrial system through radical green innovation? |
| Outcome | •Holistic understanding of how the environmental system works and how it is connected to strategy, leadership, and heart of innovation activities.<br>•Collection of novel principles, values, and frameworks to apply across business functions. | •Established foundation for a strategic breakthrough innovation program, supported by senior leaders.<br>•A talent and resource pool supported by an open network capable of making a difference. | •Culture of environmental leadership, experimentation, and innovation.<br>•Systematic flow of differing radical innovations.<br>•Competitive advantage through new profits, and access to new markets and differentiation. |

**Table 4. Three managerial capabilities for radical green innovations**

Moreover, the paper adds to the understanding of managing systematic value creation via radical green innovations and discusses its implications for the senior managers of corporate sustainability. This paper suggests that without being able to master all of the three capabilities, a firm can experience difficulties in its efforts to manage the creation of a continuous flow of radical green innovations and might be limited in creating incremental green innovations only.

## 4.2 STRATEGIC GAMES, VALUE CREATION LOGICS AND MANAGERIAL CAPABILITIES WITHIN NETWORKED RADICAL GREEN INNOVATIONS

Paper II: Tommi Lampikoski and Kristian Möller (2013). Collaborative networks in green innovation: strategic games, value creation logics and managerial capabilities. XXIV ISPIM conference, Conference proceedings, Innovating in Global Markets; challenges for global growth, Helsinki, Finland, June 16th-19th.

### 4.2.1 Research objectives and methods

This paper addresses the second research objective of the dissertation by examining: what are the characteristics of green innovation networks and what is the value-creation logic in different types of innovation networks? Focusing solely on radical green innovations, this paper investigates the *roles and value creation logic of collaborative networks*. In addition, this paper investigates which managerial capabilities are required from the pioneering companies initiating networked green innovations. The prior paper's (chapter 4.1) outcomes are investigated further by researching the *managerial capabilities in a collaborative innovation context*. The paper examines the pioneering green innovation management practices and strategies in the traditional manufacturing field from the perspectives of the primary case firm of this dissertation and two other firms operating in the resource-intensive business field. The primary data for the cases is gathered through managerial interviews and material available from the public sources.

### 4.2.2 Findings and contribution

The paper's evaluation of differing value creation logic of green networks resulted in the identification of four distinctive green innovation games. The current theoretical and empirical understanding of the green innovation networks is limited to the studies of co-innovation with suppliers (Simpson et al., 2007; Seuring et al., 2008; Zhu et al., 2008; Tate et al., 2011). This paper's outcomes expand this knowledge by analyzing the collaborative formation of radical green innovations and it generates a contribution to the understanding of the formation and management of green innovations. This paper's analysis provided the initial framework of this dissertation, as highlighted in Figure 4.

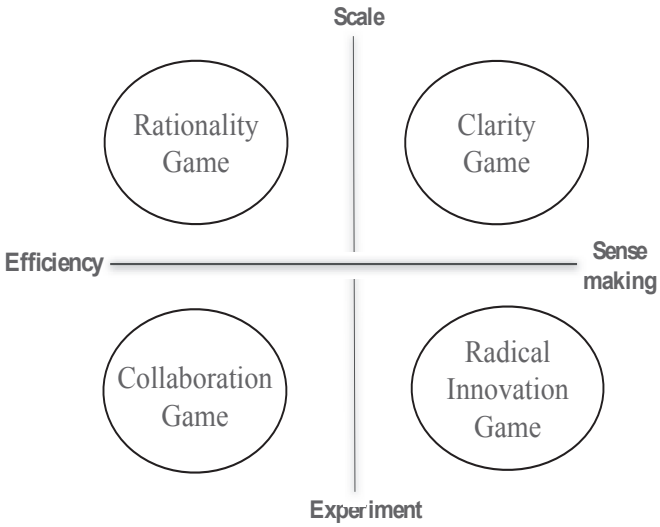


***Figure 4.*** *The four strategic games of green innovation*

Each identified green innovation game reflects a unique focus of innovation, network orchestration capabilities, and value creation logic. Moreover, this paper supplements the viewpoint that the systematic interaction among partners creates a capability for continuous green innovation that can lead to a sustained competitive advantage (Sharma and Vredenburg, 1998; Hart, 2005; Esty and Winston, 2006). This is the case when a company succeeds in playing all of the four green innovation games. This paper contributes to the green innovation literature by indicating support for the notion that partnerships can enable firms to move towards entirely new clean technologies or reformed business models where sustainable practices replace old and environmentally unfriendly ones (Moore and Manring, 2009).

The results imply that sustainability and innovation managers contemplating value creation through green innovation networks need to navigate and innovate across all of the innovation games. The four game-value framework can be used as a simple diagnostic tool. By assessing one's activities in each of the four quadrants, managers can assess the balance of their innovation portfolio. A lopsided portfolio suggests vulnerability, a lack of managerial capabilities and missed business opportunities. To conclude, this paper's outcomes help practitioners to: (i) make sense of the basic rules and fundamentals of the different green innovation games, (ii) provide guidelines on how to play the games, and (iii) assist in building and mastering new managerial capabilities.

## 4.3 MANAGERIAL PHASES AND CAPABILITIES FOR GREENING A MANUFACTURER'S BUSINESS MODEL

Paper III: Tommi Lampikoski, Risto Rajala and Mika Westerlund. (2014). Corporate sustainability in industrial manufacturing: Revisiting the change in Interface's business model. Submitted to an international research journal, February 2014. Unpublished.

### 4.3.1 Research objectives and methods

Although there is a substantial body of literature on sustainability at the societal level, prior research has paid little attention to exploring the process through which a firm can manage the transformation of its business model towards operationalized sustainability. Therefore, this paper investigates the managerial agency that triggers the process of greening a firm's business model in the manufacturing industry context. The investigation is conducted at the level of key business model elements, including *managerial cognition*, *value propositions*, *relationships*, *resources* and *revenue models*. This paper sheds light on the third research objective of the dissertation: how to manage the greening process of a company's business model in resource intensive manufacturing industry? The primary data for the single case study is gathered through qualitative, semi-structured interviews with senior managers of the case company in the United States. Moreover, the study utilizes extensive secondary material obtained from publicly available sources.

### 4.3.2 Findings and contribution

This paper provides theoretical implications that support further research of corporate sustainability and contributes to the whole dissertation by investigating the managerial

agency throughout the business model greening process from the institutional entrepreneurship perspective. By adopting the conceptualization from the well established institutional change literature, this paper analyzes the corporate greening process as a multi-layered and consciously driven change in a firm's strategy, its business model, and managerial practices addressing its environmental impact. It may imply great changes to the business by disrupting the competitive structures, modes of operation and institutionalized assumptions in a given industry. Further, this paper sheds light on the process of institutional change by elaborating on Lewin's (1951) three-stage theory of change, which suggests that institutional change typically includes the stages of "unfreezing", "moving" and "refreezing". To manage the process of institutional change of transforming a corporation's business model into an environmentally sustainable one, the study re-interprets the first stage as "recognizing the potential for environmental sustainability" and divides the second stage into two more specific phases of "reimagining the vision for environmentally sustainable business" and "reinventing the business model". The last stage was reframed as "responding to greening initiatives by implementing the new business model". Table 5. illustrates these interconnected phases. Each phase reflects a set of unique managerial activities, tasks and challenges.

| | Categories of activities | | | |
|---|---|---|---|---|
| **Levels of the process** | Recognizing the potential of business model greening | Establishing the desired vision of sustainability | Reinventing the business model to leverage the green vision | Reconfiguring the business ecosystem for sustainable business practices |
| ***Sense-making*** | *Acknowledging the consequences of sustainability* | *Differentiating the identity from key competitors*: | *Making sense of greening in economic terms* | *Allowing competition between greening initiatives* |
| ***Sense-giving*** | *Keeping things reachable by focusing on the most influential green initiative.* | *Imagining the green vision* | *Reshaping the critical components of the business model* | *Communicating the interconnected-ness of business model in the ecosystem* |
| ***Intrinsic influen-cing*** | *Gaining acceptance and support for green programs* | *Putting forward a sustainable mission* | *Supporting business model renewal* | *Supporting relevant activities* |
| ***Extrinsic influen-cing*** | *Building up collaboration with new partners* | *Reinforcing sustainability-favorable identity* | *Highlighting the long-haul effects of greening activities* | *Endorsing the benefits of sustainability in the ecosystem* |

**Table 5. A summary of the key process phases of greening one's business model**

Consequently, this paper improves the prevailing managerial and academic understanding of how companies can reform and operationalize their contemporary business models into environmentally sustainable ones.

## *4.4 THE VALUE CREATION STRATEGIES AND MANAGERIAL ROLES FOR MASTERING THE FOUR GREEN INNOVATION GAMES*

Paper IV: Tommi Lampikoski, Mika Westerlund, Risto Rajala and Kristian Möller (2014). Green Innovation Games: The Value-Creation Strategies and Corporate Sustainability. California Management Review**,** 57 (1): 88-116.

### 4.4.1 Research objectives and methods

The fourth paper builds on and explores the four green innovation games, initially characterized and identified in Essay 2. This paper tests the frameworks' applicability in diverse industries and with several sub-cases among the publicly recognized *green pioneer firms*. In essence, this paper contributes to the fourth research objective: how a business can become a revolutionary green innovator and what strategies and managerial roles are required for this change? In addition, the paper aims to identify and analyze critical organizational and mental barriers, and suggests strategies and three managerial roles that help managers to overcome these barriers. Finally, the paper aims to reiterate the four game framework for managing both evolutionary and revolutionary green innovations. The paper builds on the qualitative empirical analysis of pioneering green companies in diverse industries such as ICT, food, traditional manufacturing and clothing industries. The primary data for the cases is gathered through 49 senior manager interviews and extensive analysis of the secondary data available from the public sources.

### 4.4.2 Findings and contribution

This paper includes the following contributions to this dissertation. After reviewing the established frameworks for corporate sustainability, it was apparent that the prior frames lacked the connectivity of sustainability with the management for diverse green innovations. Although these frameworks succeed in providing general guidelines for developing and managing a corporate sustainability strategy, they failed to address the requirements of different types of green innovations. Nor did they consider the management of revolutionary green innovations per se. This paper contributes to this knowledge gap by proving a detailed characterization, emphasis, foci of change and barriers unique to the four innovation games. Moreover, the findings of the paper offer several guidelines for managers. First, the notion of green innovation is complex and risky. It does not offer a clear heuristics for effective management. By using the game metaphor and introducing the Rationality, Collaboration, Radicality, and Clarity games of innovation, this paper offers a road map for the emergent and interconnected strategies of green innovation. The second contribution relates to the notion that a profound understanding of the different green innovation games requires experience and knowledge as their underlying logic are different. By understanding the critical barriers unique to their companies and industries, senior managers are able to execute justified catalyzer strategies. Third, companies fail to enter or play these games due to the lack of establishing and nurturing of three critical managerial roles—Unlockers, Connectors, and Transformers, as indicated in Table 6.

**Table 6. A brief summary of the three managerial roles**

| | | Characteristics | |
|---|---|---|---|
| **Role** | **Critical importance** | **Focus of change** | **Examples of critical tasks** |
| ***Unlockers*** | • Rationality Game<br>• Radicality Game | • Cognitive models<br>• Institutional structures | • Allow innovative experimentation through trial and error. |
| ***Connectors*** | • Collaboration Game<br>• Radicality Game<br>• Rationality Game | • Corporate strategy | • Connect the green vision with corporate strategy, leadership, culture and stakeholders. |
| | | • Operations | • Connect corporate greening with the organization's operations through an ambitious, yet conceivable roadmap. |
| ***Transformers*** | • Clarity Game | • Organizational culture and values | Redefine the purpose of business. |
| | | • Financials and revenues | • Focus on balancing short-term financial pressure with the pursuit of long-term green vision. |

Consequently, the papers concludes that senior leaders need to align the three roles across the organization's management and recruiting systems, managerial duties and daily decision making routines, infusing these gradually into the corporate culture.

## 4.5 Summary of the findings

This dissertation makes four principal contributions concerning the management of green innovation in resource intensive businesses. First, the findings of this study point out that competitive advantage through corporate sustainability requires the capability and skills to create radical green innovations, which, in turn, provide differentiation advantages, enable access to new markets and speed up the process of reducing a company's greenhouse gas emissions. Further, this dissertation suggests that firms can generate the highest benefits of corporate sustainability by focusing on radical green innovations. In this sense, Essays 1 and 2 of this dissertation identify managerial capabilities for radical green innovation, both internally to a firm and externally in the case when creating networked green innovations. Based on the analysis of the key case company of this dissertation, the study identifies three critical managerial capabilities:

1. *Research capability* by referring to making sense of the emerging sustainability paradigm by helping the firm to gain a holistic understanding of corporate greening. It assists in seeking inspiration and understanding of how to adopt and apply radically different corporate sustainability frameworks and design principles into the innovation development.
2. *Recognize capability* through pinpointing opportunities by building on the insights gained in the research activity. It helps management to identify the missing pieces of the "puzzle" by recognizing new business opportunities, potential gaps and weaknesses within the existing industrial system, and contradicting them with the emergence of the green paradigm.
3. *Revolutionize capability* by enabling managers to connect all of the pieces of the emerging green business paradigm and set radical ideas as a corporate priority. With the help of this capability, radical green innovations are integrated deeply

into the core of a company's vision, strategy, culture, and entrepreneurial leadership.

These capabilities enabled the case company to continuously challenge and disrupt the existing management recipes, established knowledge and proven industrial practices; and create sustainable competitive advantage through a continuous portfolio of radical green innovations. Each capability reflects a unique purpose, task and skills, as well as outcomes. These managerial capabilities are principally not consecutive, separate capabilities; rather they evolve together as a combined set. Furthermore, managers must focus on the constant navigation between these capabilities, and a lack of experience in one capability domain can prohibit success in others.

The second contribution of this dissertation relates to the investigation of the role and value creation logic of collaborative networks in green innovation. There is scarce academic research on the types and role of green innovation networks. The study addresses this research gap by examining the value creation logic and managerial capabilities required in managing green innovation networks. It evaluates differing value creation logic of green networks in three corporate cases and concludes by identifying four distinctive green innovation games; the Rationality, Collaboration, Radical and Clarity Games. By understanding the basic rules and fundamentals of these games, managers responsible for green innovation can build and master new managerial capabilities required in networked innovation. However, as the paper concludes, this is challenging as the games differ widely in terms of the relevant managerial capabilities.

The third contribution relates to how the primary case company of this dissertation manages its green business model transformation. The article characterizes the phases of managerial business model greening process and illustrates them through a case

study in the manufacturing industry. The investigation takes place at the level of business model elements, namely *managerial cognition*, *value propositions*, *relationships*, *resources,* and *revenue models*. The findings propose that green business model transformation requires questioning the established business model elements and executing the required changes. The analysis illustrates four interconnected phases of the business model greening process: *recognizing* the opportunities and challenges in the current state of affairs*, reimagining* the future possibilities*, reinventing* business model elements*,* and *responding* to the needs of the essential stakeholders.

The paper contributes to the whole dissertation by identifying and analyzing the core elements of the business model of the primary case company of the dissertation and it expands our knowledge on managing the green transformation of one's business model. The findings further suggest that an understanding of these phases and the required managerial activities can assist companies to succeed in greening their business models. Furthermore, managers can benefit from the findings in diagnosing the strengths and weaknesses of their managerial actions in regard to the business model greening process. Consequently, this paper improves the scholarly and practical understanding of how companies can realize new green business models.

The fourth contribution of this dissertation relates to the identification of four different value creation strategies for evolutionary and radical green innovations which are referred to as Rationality, Collaboration, Radical Innovation, and Clarity games. These games were initially pinpointed in Essay 2 and further refined in Essay 4 of this dissertation. These games also form the key framework for the dissertation. Currently, most large companies are building green programs into their organization, focusing on creating incremental, step by step improvement, yet lack the skills to connect sustainability with radical innovation activities. The fourth paper contributes to this gap

in knowledge and illustrates how leaders of resource intensive businesses can identify the barriers to profound green innovations, eliminate the organizational and mental barriers and establish and nurture three novel managerial roles for revolutionary green innovations, i.e. unlocker, connector and transformer. The key argument of the fourth paper is that green business innovators should benefit from developing three specific managerial roles for managing radical green innovations. The paper contributes to the whole dissertation by identifying and analyzing three critical managerial roles for evolutionary and in particular revolutionary green innovations through an analysis of green pioneer firms.

## *5. DISCUSSION AND CONCLUSIONS*

This chapter presents the key theoretical and managerial contributions of this dissertation.

### 5.1 Theoretical and managerial contributions

This dissertation generates three principal contributions concerning the management of green innovations in resource intensive businesses. First, it identifies and organizes green innovation into four different innovation "games" and recognizes key managerial capabilities required in mastering these games. Second, the research uncovers and elaborates three managerial roles in managing green innovations, specifically while managing for radical green innovations in resource intensive businesses. Third, successful management of these capabilities, roles and games can nurture and support the long term longevity and survival of strategic green programs in business organizations, and these can assist in creating a systemic flow of incremental as well as radical green innovations. These contributions are briefly discussed in the following.

### 5.1.1 Theoretical contributions

The dissertation contributes to the existing theoretical and practical understanding in three ways. First, it provides an in-depth understanding of the value creation aspect of green innovation and especially in regards to managing radical green innovations (Essays 1-4). Unlike the focus in current research, which has highlighted generic benefits of eco-efficiency driven eco-programs or focused on debating whether "it pays to go green", this study identifies ways to classify green innovation into four different modes (Essays 2 & 4) with distinct characteristics, managerial skills, roles and

capabilities for managing these various types of green innovations (Essays 1- 4). To date, prior literature remains rather silent on these issues. Furthermore, previous studies lack comprehensive frameworks and models that would explain the relationship between these key concepts.

Second, the classification of green innovations assists in the creation of new managerial roles, and links the green innovations with the corporate strategy and culture and guides managers in the elimination of barriers blocking entry to play the various games (Essay 4). Taken together, this study illustrates how a sustainability leader among established business has incorporated and transformed core elements of the business model (Essay 3). In this sense, the prior empirical evidence on how sustainability goals are managed and embedded into core elements of a business model are scarce. Based on this understanding, the dissertation also indicates the managerial difficulties in adopting and managing green innovations. Third, this study proposes and illustrates several strategies of how to overcome the critical barriers based on the analysis of the sustainability leader among established businesses.

Through the empirical inquiry and theoretical reflection conducted, this study takes a step forward in the understanding of management of the process toward corporate sustainability, and in making an effort to analyze the key dimensions of business model greening in a framework capturing the four different games of managing green innovations. By exploring the management of green innovation among green pioneers in the United States, the present study makes several theoretical contributions. In the first place, it advances the discussion of the lack of a generally accepted definition of green innovation, as well succeeding in conceptually separating the concepts of incremental green innovation and radical green innovation.

This study contributes to the clarification of the concept of green innovation, and focuses in particular on clarifying the discussion around the concept of radical green innovations and the process of business model greening. Second, as the majority of the prevailing studies have addressed incremental and radical green innovation under the same "umbrella", this study clearly separates the two. Finally, this study develops its own conceptual definition of the term radical green innovation, adopting insights from the rather well established traditional innovation management literature.

### 5.1.2 Managerial contributions

This dissertation includes several important practical implications for entrepreneurs, managers, green business start-up founders, management consultants, and business educators within corporate sustainability. First, insights gained from this study can be used by executives to acknowledge that the identified and interconnected green innovation games call for different organizational resources and managerial capabilities in their management (see Table 7). Further, managers need to understand that a company's sustainability program may not succeed over the long term without mastering all of the green innovation games.

| Characte-ristics | Rationality Game | Collaboration Game | Radical Game | Clarity Game |
|---|---|---|---|---|
| *Type* | • Evolutionary autonomous innovation | • Evolutionary systemic innovation | • Revolutionary autonomous innovation | • Revolutionary systemic innovation |
| *Dominant Logic of the Game* | • Productivity improvement through better practices, processes, and technologies | • Improving partner interaction to scale up eco-efficiency | • Exploration for new value-creation logic and business models | • Defining new meanings for corporate sustainability |
| *Barriers to Playing the Game* | • Lack of urgency | • Networking and learning to play with outsiders | • Lack of funds and skills | • Uninspiring purpose and vision |
| *Outcomes of the Game* | • Cost reductions in operations<br>• Highlighting existing or latent green attributes in one's product portfolio | • Increased co-operation with customers, suppliers, NGOs, and policy-makers | • Improved profit margins via category-changing innovations<br>• Entry into new markets before competitors | • Reinvented vision, mission, and purpose of a firm<br>• Changing the rules of an industry |

**Table 7. Summary of the games and their distinctive characteristics**

The resulting framework of the dissertation guides and supports managers in (i) identifying the most suitable green innovation strategies and the key areas of focus for developing new green innovations, (ii) pinpointing the distinct characteristics and managerial capabilities per game type, (iii) acting as a simple diagnostic tool for assessing the innovation activities of each quadrant and in identifying key strengths and weaknesses in regards to required managerial roles activities. Consequently, the lack of succeeding in innovating across the differing green innovation games may not provide differentiating advantages in the competitive market place, in particular in regards to

Radical and Clarity games. Further, the identified games incorporate substantially differing managerial roles and capabilities for successful management of different green innovations.

This study identifies three different yet interconnected managerial roles for managing various types of green innovations. By understanding the necessity of adopting the roles of unlocker, connector and transformer into one's organizations and firms, and to further develop the managerial activities needed in mastering these roles, managers are equipped with a capability set to manage for radical green innovation, as well as other types of green innovations. Lack in one of the managerial roles can result in failure of creating a systemic flow of green innovations.

Furthermore, this research indicates that few incumbent firms seem to either recognize or to exploit the full range of green innovation opportunities available. This may be due to the issue that the green innovation games consist of unique characteristics and require diverse managerial skills and capabilities, at which only a few pioneer firms have learned to excel to date. Several empirical studies (MIT, 2010, 2012) support the notion that most Fortune 500 companies are playing the Rationality and Collaboration games, i.e. driving incremental efficiencies and/or collaborating with suppliers within the existing value chain. Many of these firms lack the will, skills, and competencies to connect green innovation to their core strategy and R&D activities. Most companies focus their time and attention only on the Rationality and Collaboration games: All of the interviewed managers of the study highlighted the *critical importance and urgency* to succeed in creating radical green innovations in order to create competitive advantage, access new markets and to gain new substantial profits from green innovations. They further emphasized the importance in *connecting green innovation*

*to one's corporate strategy and key innovation development activities*. This study's outcomes further assist managers to achieve these ambitious goals.

In addition, the results suggest that the transitions across the games are challenging and indicate a necessity to set up a profound management model for green innovation. In this sense, to play these green innovation games managers navigate between the existing managerial and organizational barriers that inhibit the playing of differing games (see Figure 5).

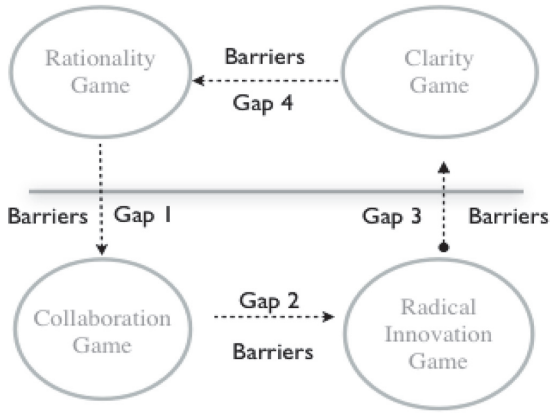


**Figure 5. Barriers and gaps of the green innovation games**

Managers need to identify these gaps, build necessary managerial skills, capabilities, roles, and strategies to be able to move to more demanding levels of green innovation. (i.e. beyond the initial Rationality game). Furthermore, this study suggests that the establishment and nurturing of three key managerial roles assists in overcoming these gaps. As Table 8 illustrates, the roles' importance, foci of change and tasks differ substantially per identified game type.

| | | Characteristics | |
|---|---|---|---|
| **Role** | **Games in Which Particularly Relevant** | **Focus of Change** | **Examples of Essential Tasks** |
| ***Unlockers*** | • Rationality Game<br>• Radical Game | • Cognitive models<br>• Institutional structures | • Allow innovative experimentation through trial and error. |
| ***Connectors*** | • Rationality Game<br>• Collaboration Game<br>• Radical Game | • Corporate strategy | • Connect the environmental vision with corporate strategy, leadership, culture, and stakeholders. |
| | | • Operations | • Connect corporate sustainability with the organization's operations through an ambitious, yet conceivable roadmap. |
| ***Transformers*** | • Clarity Game | • Dominant operational logic<br>• Organizational culture and values | • Redefine the purpose of business: deliberate about whether the organization gains more by advancing its self-interest or the collective good of people and the planet. |
| | | • Financials and revenues | • Focus on balancing short-term financial pressure with the pursuit of long-term green vision. |
| | | • Use of resources | • Change the operational logic from destructive use of materials and resources to regenerative use. |

**Table 8. Three managerial roles**

To conclude, this dissertation's outcomes allow practitioners to: (i) make sense of the basic rules and fundamentals of the different green innovation games, (ii) provide guidelines on how to play the games, and (iii) assist in building and mastering new managerial capabilities and roles – in particular towards managing for radical green innovations.

## *5.2 Limitations and avenues for further research*

This has been a conceptual and exploratory empirical study on the management for differing green innovations and in identifying required managerial capabilities and the managerial roles amongst sustainability leader amongst established businesses. Although the present study provides solid evidence of the value creation logic, managerial capabilities and roles for managing for differing green innovations, it is not exempt from limitations. First, research for this dissertation was limited to resource-intensive businesses, primarily to the traditional manufacturing industries. Some of the findings may be applicable to related industries or across industries, but many of the premises, such as the strategic focus areas, operating models and infrastructural requirements of businesses are markedly different.

For example when a firm operates in software based industries, i.e. companies that utilize software as a key part of their offerings, there is little need to make substantial investments into heavy machinery or large scale production facilities. Consequently, one needs be cautious about generalizing the findings to other industries. Future research should consider the extent to which the findings apply beyond the traditional manufacturing industry and how the identified managerial roles and capabilities may differ across various industries.

Second, the qualitative empirical inquiry was conducted exclusively in the US and primarily in the Silicon Valley and East Bay regions. There were only a few exceptions: one manager from a Finnish firm, two managers a Swedish company, and one manager from a Dutch firm. This may be a concern, if the focus and the required managerial capabilities of green business varies by country. Therefore, future research is needed to investigate whether the results hold between different geographical and cultural areas.

Third, a further concern is that the present study stems on data derived from senior managers' perceptions and perspectives. Typically, deep knowledge of innovation management strategies are possessed by individuals who represent the senior management of a company. However, it should be acknowledged that the phenomena investigated are complex and require multifaceted perspectives. This study also seeks to highlight the role of a broad range of strategists outside the senior management team in organizations, and the potential impact of others within the field of innovation management activities, regardless of their position or level within a company. Hence, further research can benefit from the knowledge of sustainability experts who represent different levels and sections within organizations.

Finally, future research on corporate sustainability could study the potential paths between the identified green innovation games. In doing so, future studies could investigate how the managerial capabilities and roles might change within the differing transitions. Further, the findings of the present study call for further studies to analyze how these paths and required capabilities vary by company, industry and/or across pioneering and laggard firms in regards to their environmental orientation and commitment.

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http://www.interfaceflor.co.uk/web/about_us/media_centre_landing_page/press_releases/press-Interface-Launches-Biosfera-I-The-Industry-s-Most-Sustainable-Carpet-Tiles

http://www.interfaceflor.co.uk/web/Products/fotosfera

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http://www.interfaceglobal.com/ZazzSustainabilityAssetts/pdfs/Interface_pdf_summary_report.pdf

http://en.wikipedia.org/wiki/Intrapreneurship

http://www.sustainabilityprofessionals.org/issp-sustainability-hall-fame
http://www.sfgreenbusiness.org

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http://www.sustainabilityprofessionals.org/issp-sustainability-hall-fame

## *APPENDIX 1. LIST OF INTERVIEWED MANAGERS,*

in alphabetical order per firm/organization

| Firm/organization | Interviewee | Title | Location | Date |
|---|---|---|---|---|
| As You Sow | Daniel Fibiger | Manager | San Francisco, USA | Feb 24, 2010 * |
| Autodesk | Lynelle Cameron | Sustainability Director | San Francisco, USA | Aug 26,2009* |
| Autodesk | Jon Pittman | VP, Corporate Strategy | San Rafael, Usa | Aug 4,2009* |
| Autodesk | Emma Stewart | Partner Manager | San Francisco, USA | Sep 15, 2009 |
| Axis Performance | Marscha Willard | CEO | Portland, USA | Dec 7, 2009 |
| Back to the Roots | Kai Itameri | Business Development Manager | Oakland, USA | Sep,16, 2011* |
| Blue Avocado | Amy George | CEO | Berkeley, USA | Jul 1,2012* |
| Blue Avocado | Paige Davis | Chief Inspiration Officer | Berkeley, USA | Jul 1, 2012* |
| Dow Chemicals | Tony Kingsbury | Research Director, biofuels | Berkeley, USA | Jun 14,2011 |
| EcoStrategies | Andrew Winston | Founder, CEO | Berkeley, USA | Apr 26,2011* |
| Ericsson | Ramchandar Venkatessen | Innovation Director | Jorvas, Finland | Aug 3, 2010* |
| Designers Accord | Valerie Casey | Founder | Berkeley, USA | Sep 14, 2009 |
| Fujitsu | Jeff Ubois | Manager | Palo Alto, USA | Feb 8,2011* |
| Green Media | Joel Makeower | Founder | Berkeley, USA | Jul 14, 2009 |
| Green Media & Fortune | Marc Gunther | Senior Writer | Berkeley, USA | May 3,2010* |
| Goodguide | Dara O'Rourke | Founder, CEO | San Francisco, USA | Jul 27,2010 * |

| | | | | |
|---|---|---|---|---|
| IBM | Peter Williams | Chief Technolgy Officer, Big Green Program | Palo Alto, USA | Oct 5, 2009, Dec 4, 2010* |
| Ideo | Jane Fulton-Suri | Senior Designer | Palo Alto, USA | Feb 9,2009 |
| Intel | Lorie Wigle | Chief Innovation Officer, Energy | Seattle, USA | May 18, 2011 |
| Intellect Partners | Greg Franklin | CEO | Palo Alto, USA | Sep 10, 2010 |
| Interface Raise | Jim Hartzfeld | CEO | Laguna Niguel, Laguna Niguel, Berkeley,USA | Apr 6,2010, * Apr 8, 2011* Oct 10,2012 |
| Interface | Mikhail Davis | Sustainability Director, West | San Francisco, USA | April 24,2011,*: Feb 10, 2011*, Nov 2012 |
| Interface | Meghan Simmons | Sustainability Director | Berkeley, USA | Aug 10,2011 |
| ID Group | Ramona Amadeo | Founder,CEO | Berkeley, USA | Nov 15, 2011* |
| Method Home | Adam Lowrey | Co-Founder | Laguna Niguel, Usa | Apr 8, 2011* |
| Natural Innovation | Midra Adron | Founder, CEO | Palo Alto, USA | Sep 6, 2010* |
| Natural Logic | Gil Friend | CEO | Berkeley, USA | Aug 19, 2011 |
| Nike | Kelly Lauber | Sustainability Manager | Beaverton, USA | Dec 12,2009* |
| Nike | Jane Savage | Designer | Beaverton, USA | Sep 12,2009 |
| Nike | Lorrie Vogle | Sustainability Director | Beaverton, USA | Jan 8,2009* |
| Nintendo | Dan Adelman | Partner Manager | Seattle, USA | Jan 20,2009* |
| Pact Inc | Jeff Dunby | Co-founder | Berkeley, USA | Oct 14,2011 |
| One World Futball | Tim Feinigen | Founder, CEO | Berkeley, USA | Oct 28 ,2011* |

| | | | | |
|---|---|---|---|---|
| UC Berkeley | Henry Chesbrough | Professor | Berkeley, USA | May 25,2010* |
| Unilever | Graham Cross | Open Innovation Director | Helsinki, Finland | Nov 13,2008* |
| Relan Bags | Tom Schaeppi | CEO | Palo Alto, USA | April 12, 2011* |
| Relan Bags | Joe Schaeppi | Manager | Berkeley, USA | Dec 13, 2010* |
| Saatchi& Saatchi S | Adam Werbach | CEO | San Francisco, USA | Sep 7, 2010 |
| Scapefarms | Mike Yohay | Founder, CEO | San Francisco, USA | Sep, 15 2010* |
| Senda Athlethics | Santiago Haltey | Founder, CEO | Berkeley, USA | Mar 9,2011* |
| Starbucks | Debra Trevino | Sustainability Director | Seattle, USA | Dec 7, 2010 |
| SteelCase | Angela Nithikian | Sustainability Director | San Francisco, USa | Oct 5,2011 |
| Sustainability Advantage | Bob Willard | CEO | Berkeley, USA | Oct 17,2011* |
| Tieto Oyj | Susannah Stewart | Sustainability Manager | Helsinki, Finland | July 28,2010 |
| Cisco | Jeffrey Tobias | Manager | Berkeley, USA | Sep 23,2011* |
| Weyerheuser | John Gunther | Open Innovation Manager | Federal Way,Usa | Dec 6, 2010 |
| Weyerheuser | Dan Bunker | Patent Manager | Federal Way,Usa | Jan 21, 2009* |
| Weyerheuser | Linda Beltz | Open Innovation Director | Federal Way,Usa | Jan 21, 2009* |

*) The interview was recorded and transcribed for the purposes of the analysis.

## *APPENDIX 2. OUTLINE OF THE INTERVIEWS*

1. Introduction

- Background and expertise in corporate sustainability.
- Confidentiality issues and asking authorization to record the interview.
- Brief explanation of the current mission and business idea of the company in relation to corporate sustainability.

2. Corporate sustainability and green innovations (general level questions)

- How would you define green innovation and corporate sustainability concepts?
- How are sustainability goals connected to your company' strategy and business model?Which areas do you focus on for green innovation in your company? What types of green innovations have you commercialized within the last 3-5 years?
- Which firms are sustainability leaders among established businesses (in the US) and why?

2. Successful and unsuccessful green innovations

- Could you give an example of successfully implemented or commercialized green innovations? What were key the managerial lessons from these?
    - Were these success cases designed within the company and/or with external partners?
- Could you give an example of unsuccessfully implemented or commercialized green innovations? What were key managerial lessons from these?

- Were these unsuccessful innovations designed within the company and/or with external partners?

- What are the observable managerial skills, roles and capabilities for radical green innovations? (If there is a lack of examples in radical innovations, describe experiences with incremental green innovations?)

3. Management model, roles for green innovation (specific questions)

- Do you use a specific management model for green innovations? If so, could you provide a description of how it works?

- How has the management model evolved over the years? (ask if applicable)

- Who is responsible for and to which entity do you report to in the organization about green innovations and sustainability progress?

- Do you have a dedicated role for corporate sustainability and green innovation in your organization? If so, could you describe the title and the role in brief?

4. Barriers to green innovation and corporate sustainability

- What kind of mental (mindset) and organizational barriers have you experienced from the management of your firm in regards to advancing and implementing green innovations?

- How have you eliminated or removed these barriers? What strategies have you utilized? Could you provide a recent example(s)?

- Who is responsible for eliminating the barriers in your organization? Could you provide a practical example?

5. Concluding questions

- In addition to yourself, is there someone else who could provide insight about the green innovation and its management in your firm? Or anyone from your external circle of influence?

- Are there any documents (about your firm's green innovation, products, green strategies & practices) available that would be useful for this research?

- Are there other important issues about green innovations models and its management that were not included in this interview?

APPENDIX 3. List of abbreviations

| | |
|---|---|
| **AFH** | **Architecture for Humanity** |
| **BCS** | **Business case for sustainability** |
| **EM** | **Environmental management** |
| **CEO** | **Chief executive officer** |
| **$Co_2$** | **Carbon dioxide emissions** |
| **COO** | **Chief operating officer** |
| **CSR** | **Corporate social responsibility** |
| **CSO** | **Chief sustainability officer** |
| **GHG** | **Greenhouse gas emissions** |
| **EMS** | **Environmental Management System** |
| **NGO** | **Non-governmental organization** |
| **OECD** | **Organization for Economic Co-operation and Development** |
| **SBM** | **Sustainable Business Management** |
| **VP** | **Vice President** |

## *Appendix 4. Interface Inc.- a sustainability leader amongst established businesses*

The selected case company, Interface Inc., was founded in 1973. It operates in a highly resource-intensive industry, the carpet manufacturing business, and is listed on the stock market in the US. The idea for the company was based on the founder Ray C. Anderson's recognition of an emergent need for flexible floorcoverings (i.e. carpet tiles) that would facilitate the emerging technologies of the modern office. After researching the benefits of a tile-based business model, Anderson noticed that 20% of a carpet typically suffers 80% of the wear, so the carpet's life could be considerably increased by rotating the tiles. In comparison, being able to skip the traditional model of removing the large sized and worn-out broadloom carpet and sending it to a landfill, the new tile based model could potentially provide a significant economic (and later environmental) benefit. By 1997, Interface was the world's largest producer of commercial floor coverings; it manufactured and sold about 40 percent of all the carpet tiles used in commercial buildings in the world. It had 25 production facilities in six countries and 6,300 employees. Annual sales were approximately $1 billion according to the Interface Annual Reports 1997-1998.

By the early 1990s, the carpeting business received increasing attention from environmentalist organizations. Carpet manufacturing was highly toxic because of the use of petroleum and petroleum derivatives as components of synthetic carpet and to power its production. The carpet dying process was distinctly water and energy-intensive and, in addition, the overall carpet manufacturing process produced a mass of waste. By 1994, Interface Inc.'s plants sent six tons of carpet trimmings to the landfill each day (Andersen, 2009). Moreover, by the end of 1994, customers started asking

what Interface was going to do about its environmental performance and began refusing to purchase carpets from Interface until the company implemented a trustworthy environmental strategy to manufacture carpets with substantially less greenhouse gas emissions. As a result, CEO Ray Anderson issued a strategic urgency report in 1994 to radically reinvent the way the carpets were manufactured, produced, and sold by adopting an environmentally friendlier approach to its business (see Essays 1 through 3 for more details).

The core aspirations of the company's new green vision included taking a leadership position in sustainability and integrating sustainability holistically in five core focus areas:

- *People* – this area referred to catalyzing change in the managerial and organizational belief systems, integrating sustainability goals into strategy, leadership, business model, culture and values of the firm.
- *Process* - this area aimed at transforming the operational and managerial processes to support environmental objectives and goals.
- *Product* – this area was targeted at "greening" the existing products and creating new incremental green process innovations, and particularly enabling the creation of novel radical green product innovations.
- *Place* – this area involved transforming the manufacturing plants to switch to alternative energy.
- *Profits* – this area illustrated that a publicly traded company could advance both

environmental ambitions and operate financially profitably over the long term.

CEO Anderson believed that businesses had the power and resources to take the environmental leadership role. Early on during the transformation process, the CEO and senior leaders emphasized the need to eliminate mental resistance from managers through internal entrepreneurship and via the support and creation of green ideas and innovations. The first steps of corporate sustainability took place between 1994 and 1999 and focused on eliminating waste from operations. During the process, senior leaders noticed the urgent need to create a new management model for managing green innovations in order to make significant progress on the route of eliminating the company's greenhouse impacts.

They emphasized the importance of integrating the core principles of sustainability to the organization's core strategy, leadership, culture and values. The top management of Interface continuously highlighted the critical need to create a systematic flow of radical green innovations to succeed in their green vision. Therefore, this dissertation examines Interface Inc. from the perspectives of the types of radical green process and product innovations initiated and commercialized, how they were managed, and what kind of barriers were experienced in 1996-2010 from a business model point of view.

Please, note.

The essays/articles related with this publication have been omitted due to issues related with copyright.

The present study identifies and organizes green innovation into four different value creation strategies-referred to ″green innovation games″, and recognizes key managerial capabilities required in mastering these games.
In addition, the research uncovers and elaborates three managerial roles in managing for green innovations, specifically associated with managing for radical green innovations in resource intensive businesses. Finally, the findings show that establishing and nurturing the identified managerial capabilities, roles and the ways to master the diverse innovation games can support the longevity and survival of strategic green programs in organizations.

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