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## **Managing Green Innovation**

Present Findings

Thomas Hordern, Sofia Börjesson and Maria Elmquist

October, 2008

WORKING PAPER SERIES

# MANAGING

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# INNOVATION

## Present Findings

**Research on the Managerial Perspectives of Green Innovation.**

**Centre for Business Innovation**

Chalmers University of Technology

Göteborg, Sweden.

October, 2008.

# Managing Green Innovation

Present Findings.

Research on the managerial perspectives of green innovation.

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## **Abstract**

'Managing Green Innovation' is a report documenting present findings found in existing publications of firms endeavouring to create competitive offerings that are also environmentally benign.

Green innovation is characterised as novel, uncertain and requiring an increased understanding of all participants. Management has a major role to play in change of this type and has been recognised as a fundamental factor for success when innovating. The focus of the report is thus on the *managerial* perspectives of conducting green innovation.

Managing green innovation is a complex operation that requires knowledge, participation and interaction from a broad range of actors. Green innovation is considered inherently radical; firstly due to that fact that is novel for all firms and secondly, due to the degree of change needed to address the environmental problems at hand. Green innovation has received calls to be a business movement/opportunity in its own right, which is said to require increased communication, collaboration and construction of a useful knowledge base.

This report concludes that there are no easy answers for managing green innovation and the field is considered mismanaged and underdeveloped. However it is also argued that there is much to be gained or lost if this challenge is not effectively addressed.

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# 1 Introduction

Awareness of the impact human activity has on the environment first came to light in the early 1960s (Carson, 1962). Since then, the consciousness of our collective negative impact has developed, where now for most it is not a matter of *'if'* but rather *'how'* to take action. But for firms today, this *'how'* is novel, ambiguous and by no means unproblematic.

This report will focus on what is known on the managerial perspectives of firm's endeavouring to undertake such environmental change, in the pursuit of green innovation. This perspective aims to give further insight into how firms may move into a competitively sustainable position to create offerings that provide competitive value to the buyer as well as harmonising the greater common good.

## 1.1 Premise

"Green innovation is a shared responsibility. It is the product of government, private sector, and individual actions" (Next 10, 2008:12). Similarly to innovation in general, green innovation is complex and requires a new mixture of competencies. To innovate successfully, a cross-disciplinary approach that utilises both internal and external knowledge, networks and resources is imperative.

Firms conducting green innovation find themselves on novel ground. The breadth and number of actors involved within the domain of 'green innovation', calls for greater understanding and clarification to ascertain the drivers, actors and existing knowledge arenas within this emerging field.

Increasingly, many commentators are stating that business needs to lead the 'greening' of industry (Makeower, 2008). The potential economic opportunity of 'going green' is also well documented, as the potential economic reward is considered a prime motivator for firms to take an eco-environmental market-driving position (Esty and Winston, 2006). As some argue that "innovation in green-tech could be the biggest economic opportunity of the 21st century" (Doerr, 2006:1). However, the required change is significant and should not be underrated, as the tension/inertia in mature industries between stability and dynamic change is immense. Change of this nature requires significant motivation and is often described as competency destroying (Schumpeter, 1942). The managerial competence of a firm is considered a defining element to overcome these barriers (Hamel, 2005). This report makes this defining distinction between 'managing' green innovation in contrast to the wider notion of green innovation, in general terms.

## 1.2 Research Context

Green innovation provides a substantial challenge, in many dimensions, for many actors. Firstly, it requires change in perhaps the two most complex systems on earth; human society and nature. Secondly, it requires understanding and action in a process that is inherently ambiguous and uncertain, innovation. Our investigation primarily aimed to define and structure business practices that (1) enhance environmental performance, (2) help create, identity and capture green prospects, and (3) successfully appropriate returns from such actions.

## 1.3 Purpose

Due to the breadth and large number of participants involved within the bounds of 'green innovation', greater understanding and clarification is needed to ascertain existing knowledge domains within this emerging field. The purpose and scope of the research underlying this report is to:

*'Explore, document and synthesise existing published literature to identify and create a structure for factors that are considered influential and integral to the management of 'green' innovation.*

This report aims to synthesise and objectively communicate knowledge gained from our research project. The knowledge domains presented are based on the results of a thematic analysis of existing published literature.<sup>2</sup>

## 1.4 Structure of the Report

The report is divided into three main chapters:

1. **What do we know about 'Green' Innovation?** provides an overview of theoretical knowledge domains considered relevant to the broader issues concerning the management of green innovation. The purpose of chapter one is to inform the reader and set the frame of reference for the following two chapters.
2. **What do we know about the Managerial Perspectives of 'Green' Innovation?** outlines existing literature identified as being specifically relevant to the managerial challenges and opportunities of conducting green innovation.
3. **Managing Green Innovation, an Analysis and Discussion of Reviewed Literature.** brings together the report through an analysis based on the previous two chapters, one and two. A discussion of the knowledge domains presented is constructed closing with a conclusion covering the main findings of the research.

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<sup>2</sup> See methodology for more information on the formulation and selection of presented knowledge domains.

## **2 A note on the Methodology**

The research conducted for this report is considered cross sectional, a snapshot of the environment at a particular time. Moreover all data gained through secondary sources, information that has already been published or is indirectly available (Remenyi *et al.*, 2005). Outline of the method used to find and select secondary sources of data is outlined below.

### **2.1 Review of Published Knowledge**

A structured literature search was conducted up until the end of June, 2008. The review commenced with a comprehensive search of library databases (including for example but not limited to Scopus, Emerald Library and JSTOR) followed by an exhaustive web search (utilising Google Search, Yahoo! Search and Google Scholar). The Key terms in each search included:

- Green innovation
- Management environment innovation
- Innovation environment
- Eco innovation
- Environmental innovation
- Environment management
- Innovation management green
- Innovation management environment
- Innovation management eco
- Sustainable innovation
- Sustainable innovation management
- Sustainable management

A book search was also conducted on [www.amazon.com](http://www.amazon.com) (North America), [www.amazon.co.uk](http://www.amazon.co.uk) (United Kingdom) and [www.adlibris.com](http://www.adlibris.com) (Sweden).

The breadth of the search captured an extensive number of sources. It was deemed somewhat unfeasible to document all search results given the large number of results, varying credibility of sources and topics outside the orientation of this research, managerial perspectives of green innovation. Moreover, the general lack of an understood definition of green innovation itself made the search even more difficult.

All search results were filtered and screened until they yielded invalid results according to the criterion below. Results were reviewed by the author and were subsequently judged. The selection and judgement of results were based on the following steps:

1. Keyword results critically reviewed until results were deemed invalid according to purpose, scope and selection criteria (below).

2. Selection criteria were based on title, abstract, citations, authors and credibility of source.
3. Results where possible were traced back to their original source, particularly of not concerning web publications.
4. All selected publications were read, documented and filed by the author.
5. Documented publications were further broken down to formulate a thematic analysis. Highlighted concepts, statements and findings were grouped according to theme opposed to overall publication.

Searches were continually conducted throughout the project creating a 'snowball effect' (according to the author's increased knowledge of relevant fields and references pointed to in the review material) as themes emerged. This was an ongoing, 'looped' process.

**General observations from the search included:**

- Most hits on the web where from the blogosphere (web logs and their interconnections, network) and online magazines.
- Perhaps the most recent publications come from the online media, including for example, reports from consulting firms, such as McKinsey & Co. and Arthur D. Little as well as governmental and non-governmental organisations.
- Journal articles and books seemed somewhat dated and it proved to be difficult to find specific articles addressing the topic and wider domain in question.

### **3 What do we know about ‘Green’ Innovation**

The following chapter presents a literature overview considered relevant to the broader issues concerning green innovation. The aim is to provide the reader with a knowledge base by which to better appreciate the complexities of this field and also to frame the following chapter.

Knowledge domains to be covered in this chapter are addressed under the following headings:

- The Current Circumstance from a Firms Perspective
- What do we know about ‘Green’ Innovation?
- Economic Theory and Green Innovation
- Globalisation and Green Innovation
- Investment in Green Innovation
- Marketing and Branding
- The Green Consumer
- Environmental Design
- Environmental Management Systems
- Summary

#### **3.1 The Current Circumstance from a Firms Perspective**

Firms are aware of the problems and also possible opportunities that exist in the current paradigm calling for sustainable development. People, thus, consumers are also increasingly aware of the problems and the need to act. So why is progress so slow? Willander (2006:1) describes the situation as a stalemate: “our collective ability or willingness to react and make the required corrective adjustments seems close to zero” This also leaves many to ask the most salient question of why? “Why are humans, with our extraordinary capacity for reflection and intelligence, soiling out nest?” (White *et al.*, 2004:22). Renowned conservationist, David Suzuki reflects: “I think it was the human mind basically that threw us out of balance with human nature. The tragedy is that it was the human mind that was the key to our very survival” (Suzuki in Connors and Petersen, 2007).

##### **3.1.1 Sustainability, is there such a thing?**

Since the industrial revolution in the late 18<sup>th</sup> century, nature was converted to a resource (Gardels in Connors and Petersen, 2007), combined with the current economic model founded on growth, this clearly postulates an unsustainable path into the future, if a ‘business as usual’ approach is maintained. Some question if there is truly such a thing as sustainability, as “all [current] industrial goods cause environmental degradation in some way, whether from their manufacturing, use or disposal” (Rehfeld, *et al.*, 2007:91). Moreover, there is also an ongoing debate if sustainable development can be defined operationally. Some believe it can be (e.g. Rennings and Wiggering, 1997), whilst others don not (e.g. Norgaard, 1994; Cary, 1998a; Minsch 1998). Such debates on the issues within the field of sustainable

development have been found to be commonplace. Perhaps this is accounted for, as the field is considered emergent and complex. Further, it has been argued that the notion of sustainability requires long term thinking for both first and also second order effects, as sustainability research needs to take a systems perspective (Blood in Medonca and Oppenheim, 2007).

### **3.1.2 The Environmental Problem in the Spotlight, Climate Change**

The sustainability dilemma has been highlighted through the current focus of climate change, brought about through society's collective detrimental effect on the environment. A situation that is recognised "amongst all the leading industrial powers that climate change is here to stay and that the world must deal with it" (KnowledgeRich, 2008:1). For example, to reduce the effect of climate change, developed nations will need to curb the current carbon emissions by up to 80% from 1990 levels (KnowledgeRich, 2008). This situation is further compounded by the expected growth in demands (e.g. US electricity to increase by 50% in the next 25 years), not to mention the increase in demand for carbon emitting resources from developing nations (China, India). Makower (2008) claims the good news is that companies are incrementally becoming cleaner and more efficient, however given the growth demands highlighted above, "we're more or less treading water" (Johnson, 2008:1). Enkvist (*et al.*, 2008) amongst others believes that economic growth must be fundamentally decoupled from emission growth. The environmental challenge that society collectively faces today, has been described to be much bigger than just climate change. As climate change is just one example of the many forms of environmental degradation.

### **3.1.3 The Current State of Knowledge on Green Innovation**

"The quantity and quality of data on business and the environment is wanting [needed] to say the least. Government agencies, non-profit groups, academic institutions, and companies themselves have done relatively little to quantify, let alone assess, simple measures of business environmental impact" (Makower, 2008:13). Further to this, it is argued that data currently being compiled is inconsistent and in many cases a number of years old. This makes comparisons and assessment on the impacts in sustainable development and business challenging (Makower, 2008).

Discussions on sustainability however are abundant. Subsequently the complexity of the dilemma and the number of actors involved also compounds the problems to sort, structure and validate the many different opinions being voiced. Much of the existing literature is primarily concerned with the reduction of common bad, hence the reduction of damage caused by current processes and systems (Williander, 2006). Rennings (2000) also states that the current theoretical and methodological approaches to analyse these processes are poorly developed.

For many firms, 'innovation' is an integral part of the solution for environmental protection (EPA, 2002). Innovation implies change, change that has the potential to avoid the creation of negative externalities in the first place and/or how they may be reduced through competition (Williander, 2006). This line of thought is gaining momentum as innovation in an ecological manner has helped current businesses to thrive, shedding the reputation (of green innovation) as being a 'budget-buster' (Kelly, 2008). An extensive survey (Keely *et al.*, 2005) however, shows clearly that such innovation is still in the embryonic stage. Given that innovation inherently requires novel actions and knowledge, further research is needed to "improve our understanding of innovation processes toward sustainability in their different dimensions, complex feedback mechanisms and interrelations" (Rennings 1998:2).

## **3.2 'Green' Innovation?**

The following will address a selection of publications on green innovation considered important to create understanding and how literature currently associates and defines the term.

### **3.2.1 Addressing 'Green' Innovation**

When it comes to existing literature on green innovation there seems to be a biased and limited focus on reducing negative environmental externalities. This generally leads to the assumption that governmental intervention is required for successful green innovation. However, this attention on policy however, tends to sideline non-regulatory influences (Bernauer *et al.*, 2006). Nonetheless, recently there have been critical questions raised of whether green innovation can be treated as a 'standard/regular' innovation or if a specific theory is in fact needed (Rennings, 2000). Increasingly, green innovation is being referred to as a 'subset' of general innovation (Williander, 2006). Magnusson (2003) finds that existing innovation theory is relevant and helpful to understand the concept and development of green innovation concluding that general innovation theory should be an integral part of the framework when analysing green innovation.

Rennings (1998) proposed three possible types of change towards sustainable development; technological, social and institutional innovation. Much of the existing literature focuses only on the integration of environmental considerations into current theories and methods of product development. Freeman (1994) highlights that organisational and social innovations should always accompany any technological innovation and that such may even have to come first. This reasoning is also supported by the level of change required with even the most drastic reductions in existing technologies not sufficient (Rennings, 2000) to meet environmental goals in the future. According to Hellstrom (2006) "if one looks at the general innovation literature ... it is clear that only a minority of all technological development is geared towards change of this type" (2007:149).

It has been argued that existing theoretical frameworks do not address the contemporary problems adequately (Rennings, 1998). Further research is put forward as a way of improving our understanding of innovation processes towards sustainability. However, it seems that present research is scattered across many different academic disciplines. “Each piece of research tends to focus on a narrow range of determinants and particular levels of analysis” (Bernauer *et al.*, 2007).

Contemporary problems cited from various sources that identify inhibitors for successful green innovation include:

- The magnitude of change required, is not only novel for all participants but also competency destroying (Williander, 2006; Hellstrom, 2006).
- The description of the environment and economy are viewed as conflicting objectives (Colby *et al.*, 1995).
- There is a biased view on government intervention, thus assuming a reactive move by industry (Esty and Winston, 2006; Bernauer *et al.*, 2006; Fondel *et al.*, 2008).
- The lack of willingness to pay for the created common goods, i.e. tragedy of the commons? (Williander, 2006).
- The difficulty to commercialise green innovations (OECD, 2008).

It has been stated that the most promising green innovations offer ‘triple benefit’, for the environment, the customer and the producer. However one key challenge of this approach is that innovation creates benefits above and beyond what is captured by the innovator. Due to the common (public) good dimensions of green innovation, such benefits would accrue to the public, and not to the innovator. Often this can result, at least in the early stages, to development and production costs to being uncompetitive (OECD, 2006a). Freeman (1992) concludes that “successful action depends on a combination of advances in scientific understanding, appropriate political programs, social reforms and other institutional changes, as well as on the scale and direction of new investment” (1992:124).

### **3.2.2 Defining ‘Green’ Innovation**

The values and meaning given to ‘green innovation’ have been found to be also termed by others as:

- Eco-Innovation
- Environmental Innovation
- Environmentally Driven Innovation
- Sustainable Innovation

Part of the ambiguity, which surrounds the field of ‘green innovation’, is created by the lack of a generally understood and recognised definition (Charter and Clark, 2008). Many different definitions currently exist. What is interesting to see is that most definitions however, slightly varying can be grouped into three categories. Those that view green innovation to be (1) a ‘*reduction*’ of environmental impact,

(2) the 'introduction/creation' of environmental performance, and (3) the 'improvement' of environmental performance. Examples in the above order include:

(1) Reduction of environmental impact:

- Eco-innovations are all relevant actors (firms, politicians, unions, associations, churches, private households) which:
  - Develop new ideas, behaviour, products and processes and apply or introduce them, and
  - Which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets (Klemmer *et al.*, 1999).
- Green innovations are 'new products and processes which provide customer and business value but significantly decrease environmental impacts' (James 1997).

(2) The introduction/creation of environmental performance:

- Blattel-Mink (1998) states that green innovation may include the development of new products (environmental technologies), new markets and new systems as well as very broadly the introduction of ecological dimensions in economic strategies.
- Environmentally-driven innovation means the creation of new market space, products and services or processes driven by social, environmental or sustainability issues" (Keeble *et al.*, 2005).

(3) The improvement of environmental performance:

- "As a subset of innovation, environmental innovation can then be said to have the qualification of being concerned with orientating the direction of innovation towards environmental improvements" (Mirata and Emtairah 2005:996).
- Environmental innovation encompasses 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 organisational innovations (OECD, 2008)

For the purpose of this report 'green innovation' will be described with a perspective based upon the OECD (2008) definition, above. This states the specific improvement in the environmental performance in any form of innovation, arguably a proactive point of view.

To go a step further, it is important to note that when highlighting the notion of a 'green innovation' it is generally assumed to be positive and successful. For this to be the case, elements clarified by Williander (2006:5) are crucial to further defining a 'successful' green innovation, being:

1. When it is competitive in the market place, and
2. Is profitable for the innovating firm.

### 3.3 Economic Theory and Green Innovation

Traditionally, there has been conflict between the protection of the environment and the business performance of firms (Eiadat *et al.*, 2007). This outlook being that in meeting environmental goals it damages the economic performance of the firm. This conflict identifies that the 'ever-growing' environmental demands increase capital, labour cost and diverts management's attention thus denying more positive investment (Eiadat *et al.*, 2007; Christensen and Tientenberge, 1985; Palmer *et al.*, 1995). Palmer (*et al.*, 1995) represents the argument in which environmental demands are seen to inhibit the performance of the 'polluting' firm: "even if the firm can invest and adopt a new, more efficient abatement technology, if that technology was not worth investing in before, its benefits will not be enough to raise the company's profits after the environmental standards are raised" (1995:125). This line of thought coincides with the neo-classical economic model. Porter and van der Linde (1995) however challenge this reasoning, stating that it is the static approach of the neo-classical model that is the problem. Porter and van der Linde (1995) hypothesise that to discover 'win-win' solutions between environmental regulation and business performance; a proactive approach to culture novel solutions is required. The World Bank (1992), the OECD (1997) and the European Commission (EC) (1992) also support this evolutionary economic model.

Green innovation has also been argued to help firms meet environmental goals in a cost efficient manner. "The development and diffusion of environmental innovations is often seen as an effective avenue to comply with environmental goals in a cost-effective way" (Frondel *et al.*, 2008:153). Rennings (1998) engages with both the neo-classical and evolutionary economic models, providing the following description. "Neoclassical methods are most elaborated to analyse the efficiency of incentive systems which seems to be essential for stimulating innovation. Evolutionary approaches are more appropriate for analysing long-term technological regime shifts. [...] Evolutionary approaches seem to be very useful for providing additional insight into radical technological change. Compared to neoclassical economics they follow a somewhat broader approach as they allow surprises and consider technological path-dependencies" (Rennings, 1998:1).

Rennings (1998) proposes a co-evolutionary framework that is argued to be more applicable to analyse green innovation for at least the following two reasons:

1. It includes all sub-systems, i.e. co-evolving social, ecological and institutional systems avoiding any ranking of their importance, and
2. It underscores the importance of their interactions.

However it must be noted that such a framework has not been elaborated upon for the purpose of green innovation.

The economic challenges induced by environmental degradation are of great importance. Many researchers believe we have the science and technology available to meet such demands however it is up to the economy to motivate and support

such work, urgently. “We have the technologies to build the new economy. The challenge for our generation is to build that economy in the time that’s available” (Unknown in Connors and Petersen, 2007).

### **3.4 Globalisation and Green Innovation**

Globalisation creates and supports new markets for green innovation. New markets are opening up and expanding rapidly in the emerging economies, particularly in China, India and Brazil (OECD, 2008). This great opportunity however comes with a significant responsibility as globalisation is also held accountable for increased damage to our environment. “Probably the greatest weapon of mass destruction is corporate economic globalisation” (Unknown in Connors and Petersen, 2007).

Globalisation is also on the policy agenda for many governments, as the OECD (2008) states: “Many governments are internationalising their national environmental innovation policies in order to scale up the development and diffusion of environmental technologies” (OECD2008:7). However, it is also important for governments to foster technologies within their own borders and domestic policies to shape local markets. The OECD (2008) states that it is important for green innovations to firstly succeed domestically if they are to succeed globally.

It has been argued that globalisation causes the disintegration of the value chain (Berger, 2005). This characteristic actually exhibits a positive feature of globalisation as the firms that exist and engage in the value chain also have to adhere to certain environmental requirements, usually adopted by multi-national firms. Information on the effect and relationship that green innovation has on globalisation is scarce, with the one exception of the OECD (2008) it seems that this relationship has not been explored in any real detail to date.

### **3.5 Investment in Green Innovation**

For a number of commentators, the solution to the broad environmental problems is entrepreneurship and investment. Investors in the past have seen investment in green products and sustainability in general as high risk for the benefits are considered to be in soft issues only (Charter and Clark, 2008). Some of the suggested problems with investing in green innovation include (Charter and Clark, 2008):

- Investors require a short payback period, which is not suitable for the required length of time to appropriately develop and commercialise a typical green innovation.
- There is a lack of entrepreneurs with proven track records within the field of green innovation.
- The lack of satisfactory business models presented to venture capitalists.

However, a growing number of individuals believe that it will actually be private investment that will overcome our environmental issues. As previously cited, John Doerr of Kleiner Perkins Caufield & Byers<sup>3</sup> exclaims "Innovation in green-tech could be the biggest economic opportunity of the 21st century" (Doerr, 2006). Investments in green technology are rising rapidly. One estimate of the market is said to be over USD700 billion (mainly attributed to clean-tech) (Charter and Clark, 2008).

One approach adopted by Generation Investment Management<sup>4</sup> (GIM) is to firstly, innovate on current investment models to maximize clients profits but secondly to do so in a way that fully integrates sustainability into the model. Managing Director of GIM David Blood, states, "sustainability investing is the explicit recognition that social, economic, environmental and ethical factors directly affect the business strategy" (Blood in Medonca and Oppenheim, 2007:2). There are increasing efforts to further convince the financial community to look at environmental considerations and long-term liability for firms (Kelly, 2008). For GIM a firm's response to the environmental issues communicates an enormous amount about a firm's management, which helps in addition to assess the quality of their business model. Not to mention this move also reflects the substantial change in people's preferences towards supporting, thus financing this approach/model. GIM have shown that it is possible to maximise profits and to also successfully integrate environmental consideration.

### **3.6 Marketing and Branding**

The increasing interest in consumer demand is also driving the increased efforts of firms to present their offerings as 'green' (environmentally considered) for market differentiation and advantage. The increase in green marketing and branding is however causing concern as 'green washing' (the act of misleading consumers with regards to firm and product environmental performance) is prevalent and a much abused trend.

Gottlieb (*et al.*, 1995) exclaims that the greater part of green marketing involves hyperbole and contradictory information. Another study (TerraChoice, 2007) examined 1,018 consumer products bearing 1,753 environmental claims, researchers concluded that all but one claim made are either "demonstrably false or that risk misleading intended audiences" (Makower, 2008:7). Coinciding with green washing is a symptom labelled 'green noise', describing that the amount of claims broadcast to consumers is far too much for any consumer to take note of, not to mention understand and believe. This has recently lead to increasing concern that such noise is having a reverse effect on the overall green message (Williams, 2008).

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<sup>3</sup> A celebrated venture capital firm based in the United States of America, [www.cpkb.com](http://www.cpkb.com)

<sup>4</sup> Generation Investment Management is a private investment management organisation lead by David Blood and Al Gore, [www.generationim.com](http://www.generationim.com).

There is also a view that there exists a divide within branding with regards to a firm versus its offerings. This divide mainly stems from the presentation of a firm's corporate profile (Corporate Social Responsibility) compared to the actual performance of their offerings. Firms have found value in branding themselves as being 'green' (Snider 2003; Porter and Kramer, 2006) however this representation is often not implemented successfully into their products and services. For instance, Porter and Kramer (2006) are concerned that such cosmetic representations for competitive advantage have little to no impact real environmental importance.

Many view the increased consumer demand for green innovation as a positive sign (Bernauer *et al.*, 2006) to grow customer bases and also to provide a driver for firms to take a step towards integrating environmental considerations into their organisations. Further, where there is strong demand for environmentally considered offers, government support is not likely to be important (OECD, 2008). However, firms today cannot rely solely on the green consumer (Peattie, 2001). Marketing an offering based on its environmental performance or asking the consumer to pay extra for this dimension has shown not to be accepted in the mass market (Williander, 2006; Esty and Winston, 2006). In general terms, consumers' willingness to pay for a common good (spillovers that are of benefit to society in general) has been generally found to be unappealing (Tversky and Kahneman, 1986). Instead, successful market strategy for green innovation has been labelled as the 'third button' by Esty and Winston (2006): "Most successful green marketing starts with the traditional selling points – price, quality, or performance – and only then mentions environmental attributes. Almost always, green should not be the first button to push" (Esty and Winston, 2006:129).

Williander (2006) divides the dimensions of a green offering into private and common goods, where private goods are of direct benefit to the customer and common goods are of benefit to wider society. What is important to highlight is that generally speaking, private good performance must be fulfilled (product performance, competitive pricing, etc) before the common goods can appeal to the (average/mature) consumer. "You must not overestimate the environmental performance ... it is part of the whole, but it is not sufficient to sell our machine" (ABB Alstom Power, ABB in Magnusson, 2003:3). Further to this, Williander states that "...eco-benign product offerings also must provide personal value to someone who pays, in order to become accepted, attractive and used" (Williander, 2006:8). This is confirmed by Magnusson (2003) who found that when Toyota developed the 'Prius' hybrid vehicle (widely considered an iconic green innovation), one manager's perspective was that the environmental considerations were not really an important issue at all in the development project. Rather the primary concern was the benefits created for the customer. However, Williander (2006) argues that increasingly a products ability to create and add to the customer's self-image/brand can be seen as part of its function, hence the private good.

Summing up, Chen (2001) finds that a firm's objective in the green innovation process should be to deliver equal or superior traditional attributes combined with

improved environmental performance. More research has been called for to better understand the implications of firm versus product environmental performance and various organisational implications of various strategies (Rex, 2008). Bernauer (*et al.*, 2006) submits that there is also a need for further research efforts to focus on competitiveness and customer demand as potential determinants of environmental innovation. This stems from the hypothesis made by Bernauer (*et al.*, 2006) that the increase in competition within a market will also increase the rate of green innovation, thus increasing the efforts of firms to market and further differentiate their offerings as green.

### **3.7 The Green Consumer**

Many future scenarios that consider successful long-term environmental goals presuppose that progress in green innovation must be supplemented by a change in consumer behaviours and lifestyles (Rennings, 1998). Green consumerism, in response to environmental issues is expected to increase as citizens become more affluent and aware of environmental issues (Williander, 2006), widely regarded as advantageous for firms presenting environmentally considered offerings (Eiadat, 2008). Researchers are currently observing the environmentally orientated consumer and green purchasing decisions (Peattie, 2001), which corresponds to the increased attention and understanding (of going green) in the mass market. "Climate change and the environment are higher on the minds of consumers around the world than any other socio-political question" (Enkvist *et al.*, 2008:25). Consumers have been observed to be increasingly willing to consider alternative offerings (Colby *et al.*, 1995).

Despite this positive assessment of the green consumer, according to Peattie (2001), everyone and no one is a green consumer. Tversky and Kahneman (1986) observe the discrepancies between consumer's willingness to pay for environmental good and the compensation they demand to do so. Further, Johansson-Stenman and Martinsson (2006) state that people in general look negatively to be concerned with status/brand and positive to be concerned about the environment, whilst, more than most will admit, the reverse holds more truth in actual behaviour. When buying green, choices are perceived as gains and losses opposed to status (brand) or wealth (economic trade-off) (Tversky and Kahneman, 1986; Williander, 2006).

Given that the majority of consumers do not want to be identified with something that is broadly considered 'bad' (Williander, 2006) perhaps the problem herein lies in that 'few people want to be without'. This is broadly observed in our current consumer behaviour with 'consumers typically wanting what other consumers want and have' (Williander, 2006). What is needed is a transformation in the purchasing behaviour of consumers, widely regarded as moving from 'well-having' to 'well-being'. Here, business can play a central and leading role. Business holds a key position to influence preferences for change based on what is marketed and offered to their customers (Dickson, 1992; Kumar *et al.*, 2000).

Acknowledging that customers generally do not react well to novel offerings that challenge too much of what is already established in the market place, (Williander, 2006), Sjoberg (2005) outlines some guidelines for firms that wish to capture revenue through green innovation. Sjoberg (2005) contends that this position can be achieved through influencing the consumer's possibility of finding a reference point for comparison:

- Do not market products primarily on environmental merits.
- Do not perform below consumers' expectations in any attribute.
- Decrease the transparency of the reference point.
- Raise consumers' estimation of the sellers cost.
- Add eco-related cost to a price that is already high.
- Low technology exploitation is risky.
- Build symbolic value.

### **3.8 Environmental Design**

Design has the ability to both add and create value and is increasingly seen as a strategic capability. However, design used in the ecological/sustainable/environmental context (hereon referred to as eco-design) is found to take a narrower meaning mainly referring to the specific processes relating to planning, development and production in the innovation process (Charter and Clark, 2008). This outlook on eco-design has lead mainly to product improvement through the integration of environmental considerations (Brezet and Van Hemel, 1997; Keldman and Olesen, 1994; Simon *et al.*, 2000), also representing the focus of the majority of existing literature (Williander, 2006). "The primary focus of eco-design research is to support the integration of environmental considerations into product development" (Magnusson, 2003:7).

Researchers have also pointed to the fact there tends to be a gap between environmental management and product design, both in research and in practice. For example, Frei (1998) empirically finds that even amongst ISO 14000 certified companies, less than 20% show product design processes which systematically integrates their environmental goals (Frei, 1998). Frei (1998) states that one way to help in closing this gap is to integrate environmental considerations in the earliest design phases. This highlights the need for environmental considerations to be present at the initiation phase of the design process and thus designs to be a critical part of the strategic competence of a firm. Waage (2007) also amplifies this sentiment. "The design stage is a key point at which to introduce sustainability considerations because decisions at this stage determine more than 70% of the costs of product development, manufacture and use and have a significant impact on the end-of-life management for a product" (NRC1991 in Waage, 2007).

The integration of environmental considerations into existing new product development processes has also received a lot of attention. This has been reflected in the numerous concepts, tools and guidelines that have been put forward to assist

practitioners with this integration (e.g. White *et al.*, 2004), for a list see appendices, page 63.

White, Stewart, Howes and Adams (2008) point out that those methodologies differ in both sophistication and required literacy. It has been argued that further research is needed to evaluate such tools in the context of eliciting eco-innovation as it is currently unclear on the usefulness, success and performance of such tools and methods: "It is unclear if those tools are being used and if they have any real effect on product system developments" (Luttrupp, 2006:1397). Further the integration of environmental considerations into the design and NPD process has been described as an emergent domain. "Generally, product designers are still at an early stage of their understanding of environmental and broader sustainability issue due to a lack of awareness and education in the issues, and more importantly because of little present internal and external (customer) pressure" (Charter and Clark, 2008:38).

Design is climbing the value chain in organisations through the ability to reduce cost and performance in the early stages of NPD. Integrating environmental considerations into the initial design phase is raising the strategic importance of the design function in achieving successful green innovation. Through this, designers are increasingly considered to have a key role in achieving firm's environmental goals (Luttrupp, 2006).

Eco-design frameworks need to continue to evolve to help achieve successful integration of environmental considerations into strategic decisions (White *et al.*, 2008). White's (*et al.*, 2008) framework (A-B-C-D) is an example of a more integrative approach to facilitate ongoing learning (White *et al.*, 2008):

The A-B-C-D framework: "breaks sustainability intelligence down into four behaviours, which make design an area of dynamic organizational learning and interest:

- **Assessing** material impacts of projects and design capacity in an organization.
- **Bridging** functions and people to make valuable, tractable product redesigns.
- **Creating** generative internal and external learning projects.
- **Diffusing** lessons and accountability mechanisms that build literacy and affect better decision making around the organization" (White's *et al.*, 2008:3).

This distinction made by White (*et al.*, 2008) as eco-design is increasingly being seen as not just about making existing products better but developing the capacity of the firm to actually enable the production of better products. "...sustainability is not just about modifying products, but about modifying the way that products are made" (White *et al.*, 2008:19).

Further to this position there is growing support to re-evaluate the current approach to eco-design. Designer Bruce Mau exclaiming that we need to actually “re-design design itself” (Bruce Mau in Connors and Petersen, 2007). Subsequently, the actual role of a designer may also need to reflect such change. Moving from meeting the needs of consumers and the environment, it has been argued that designers also need to also stimulate their desires (Cooper, 1997). However, Luttrupp (2006) expresses that meeting long-term business requirements and market demands are in fact a more profound requirement than the actual semantics and production of a product.

Design is claimed to be a crucial competence in the integration of environmental considerations into a novel offering (Frei, 1998; White *et al.*, 2004; White *et al.*, 2008). However, the challenges are significant particularly when implementing systems into the existing and current commercial contexts of any organisation (Waage, 2007). There is an increasing need to create and communicate knowledge within the domain of eco-design. Also, there is a need to relate eco-design into the context of innovation and the development of organisational capabilities to meet such requirements and demands.

### **3.9 Environmental Management Systems**

The adoption of environmental management systems (EMS) is increasingly widespread across industry as found by Florida (1996) and Garrod and Chadwick (1996). EMS are described as broad and varying in complexity and application, often including standards, managerial goals and tools. It has been further argued that environmental management should be practiced and implemented with a holistic approach (EPA, 2005).

Several researches find that EMS will develop increasing profits and environmental performance (Clarke, 1994; Hart, 1997; Moore and Miller, 1994; Porter and ven der Linde, 1995; Schmidheiny, 1992; Smart, 1992, Melnyk, Sroufe *et al.* 2003). Researchers also claim that there is a positive correlation between the implementation of EMS and the successful development of green innovation (Charter and Clark, 2008; Rehfeld, 2007).

However, many of the strategies and tools proposed by EMS have however received critical feedback from research. For instance, it has been found that firms generally do not go beyond implementation and do not produce any substantial environmental improvements (Hamschidt and Dyllick 2001; Cerin and Laestadius, 2003, Theyel, 2000): “EMS do not necessarily guarantee improved environmental performance, as most EMS solely focus on the means – that is, the proactive efforts for pollution control – rather than the ends – that is, the actual environmental performance” Fondel (2008:158).

Recent developments in EMS are considered promising with approaches that are departing from existing models and existing product standards to focus on the final needs and desires that be fulfilled (Tukker 2006).

### **3.10 Summary**

From the review of literature constructing this chapter, the following observations can be made to synthesise the general overview of green innovation.

- Conversations and contrasting points of view are found to be commonplace within the wider discussion of green innovation and sustainability in general. This can also be seen in the lack of a uniform and commonly agreed upon definition of green innovation.
- Current definitions can be grouped into change that reduces, introduces or improves environmental performance. Currently classified by Rennings (1998) to include, technological, social and institutional (green) innovation.
- Green innovation from a managerial point of view is considered an emergent field due to the lack data, assessment and general understanding. Moreover, theoretical approaches are also seen to be poorly developed.
- Traditionally firms have been found to innovate to respond to environmental regulation in a cost effective way.
- Much of the marketing efforts of firms to present their offerings are green is considered to be misleading or false. With the consumers found to be currently unreliable.

The following chapter will build upon this chapter to identify and present literature considered relevant<sup>5</sup> to managing green innovation.

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<sup>5</sup> For selection criteria please see methodology.

## **4 What do we know about the Managerial Perspectives of ‘Green’ Innovation**

The following chapter outlines and presents existing literature specific to the managerial challenges and opportunities towards successful green innovation.

Knowledge domains to be covered are addressed under the following headings:

- Managing Green Innovation
- Business Opportunities in Going Green
- Drivers and Barriers of Green Innovation
- Green Innovation Strategy
- Organisational Capacity to Enable Green Innovation
- Collaboration in the Pursuit of Green Innovation
- Summary

### **4.1 Innovation versus ‘Green’ Innovation**

Several authors have deduced that traditional innovation management theory should be useful and valid for green innovation (Johansson and Magnusson, 1998; Foster and Green, 2000; Magnusson, 2003; Williander, 2006). Foster and Green (2000) state that “much of the theory that explains innovation, and the factors associated with successful innovation in a broader sense, can explain the action of innovating business in response to green issues” (2000:301). However, few have identified the relevant knowledge and theories presented in innovation management literature or endeavoured to apply such concepts to empirical work (Johansson and Magnusson, 1998).

Others disagree: “increasingly some innovation commentators believe that current innovation techniques are insufficient to achieve this goal and that different innovation models are required” (KnowledgeRich, 2008:1). Regardless of either perspective the basic principles of innovation remain the same; the innovator must create a novel offering of value to the customer, superior to the competition and profitable for the innovator.

Three areas that have been selected from existing innovation management literature that may offer further insight include:

- The managerial challenge of green innovation is poorly understood. There is a lack of analysis elaborating upon the managerial capabilities of the innovating firm (Colby *et al.*, 1995).
- Radical, discontinuous innovation, as green innovation requires new knowledge and competencies for the innovator (Hellstrom, 2006, White *et al.*, 2008).

- A high percentage of green innovation requires and utilises new technology creating technological change, a major element of existing innovation management literature (Dosi, 1998; Sanden and Azar, 2005).

A survey into the current state of green innovation (referred to as Sustainability-Driven Innovation) was conducted by management consults Arthur D. Little in 2004 (Keeble *et al.*, 2005). The survey investigated the integration of sustainability in the existing innovation processes of forty technology companies across Europe, the United States and Japan including Sony, Proctor & Gamble, DuPont, HP, Vodafone, Energia, and Edison to name but a few. The key benefits, findings and conclusions of the report are presented below.

There are several potential benefits of pursuing sustainability-driven innovation (Keeble *et al.*, 2005):

- Identification of new, untapped business opportunities
- Greater focus on longer-term emerging customer needs to avoid creeping obsolescence
- Migration into business areas that, by definition, have greater longevity
- The ability to create a genuine 'win-win' situation for both business and society.

Major findings of the report included (Keeble *et al.*, 2005):

- 95% of companies believe that sustainability-driven innovation has the potential to bring business value and almost a quarter believe it will definitely deliver business value.
- 60% of companies see potential benefits to their top line and 43% see further benefits to the bottom line.
- Most companies still have a long way to go to integrate sustainability into both their businesses strategy and product/process design – the prerequisite for pursuing sustainability-driven innovation.

Conclusions from the report include (Keeble *et al.*, 2005):

- Sustainability driven innovation is starting to offer real business value, but there are barriers to be overcome.
- In stark contrast to five years ago, leaders are now focusing on winning tomorrow's customers, rather than managing risks.
- A small minority of companies have integrated sustainability into both their business strategy and product/process design.
- A few leading companies are already exploring exciting breakthrough opportunities in Sustainability-Driven Innovation (Keeble *et al.*, 2005:4).

## 4.2 Literature relating to the field of ‘Innovation Management’

The management of innovation actively enables the development, direction and control over what is an inherently considered an uncertain process. Extensive literature covers the domain of successful innovation (e.g. Grant *et al.* 2005, Tidd *et al.* 2005). With the perspective of sustainability, green innovation has been described as a ‘subset’ of ‘standard’ of innovation in general terms. Further to this, Magnusson (2003) states that general innovation management theory should also provide a useful frame of reference when analysing and managing green innovation. However, the management of green innovation has also been described as disappointing: “Despite the massive amounts of management attention they receive, environmental issues are still mismanaged” (Colby *et al.*, 1995:33). This is of prime concern given the role and strategic importance of innovation within today’s contemporary organisation (Hamel, 2005).

The shift from a compliance-based to market and competition-based focus is reorienting the strategic importance and scope of managing environmental issues. Historically the management of green innovation faced misleading preconceived ideas. Such ‘myths’ characterising green innovation have previously acted as perceived barriers within the management of firms, including (Colby *et al.*, 1995:133):

- Environmental costs have rocketed, but the worst is almost over.
- Costs are uncontrollable and non-discretionary.
- Regulations fall uniformly on all competitors in an industry.
- Just do the right thing and the rest will follow.

Such myths have been since proved unwarranted by Colby (*et al.*, 1995).

In the past, by not acting on the above ‘myths’ managers and firms have missed the opportunity to understand how environmental problems are in fact related and crucial to other facets of the business (Colby *et al.*, 1995). Rothwell (1992) argues that “top management commitment, long term corporate strategy, long-term commitment to major projects, top management acceptance of risk, and entrepreneurship culture are all preconditions for sustained innovation to take place” (Rothwell in Eiadat, 2008:140). Moreover, the ability of a firm to manage green innovation is also considered a key competence of the firm. Kiernan (2008) states “every Wall Street analyst on earth says the No. 1 driver of company performance is management [...] If I can show you a company that manages complex environmental issues better than its competitors, I can show you a better-managed company. Period” (Kiernan in IGTBG, 2008:4).

It has also been found that managers tend to be more inclined to innovate when they personally have a more positive concern towards the environment (Eiadat, 2008). Williander (2006) also notes the difficulties caused when knowledge, power, authority and job role are given to certain types of individuals. The implication here is determining the criteria for selecting and promoting certain individuals within the

firm. When looking for an environmental manager, Henriques and Sadorsky (1999) outline one key criterion to be that of personal environmental concern.

### **4.3 Incremental and Radical Innovation**

Today many green innovations are tailored towards eco-efficiency (incremental improvements). Much of these efforts are concerned with incremental improvements of existing methods, products and services at an operational level (Cramer, 1997). This seemingly creates “a certain bias in the way that eco-innovation [green innovation] has been conceptualised that is mainly towards incremental improvements in processes and towards substitution of components or already existing products with more environmentally friendly alternatives” (Hellstrom, 2006:152). It has been argued that such bias towards incremental innovation moves green innovation further away from the type of innovation that has the real potential to impact and realise sustainable goals (Huesemen, 2003). It is underlined that incremental innovation is not enough: “Incremental improvement of today’s technology and energy consumption patterns can have a significant effect but will not come close to the necessary increase in carbon productivity” (Enkvist, *et al.*, 2008:2). Instead, the need for more radical innovation has been put forwarding meaning that products, services and systems must be significantly reconstructed. (Husesmenn, 2003; Hellstrom, 2006).

Also on the level of global business sustainable development is described in radical terms: “Climate change represents a discontinuity for much of global business” (Enkvist, *et al.*, 2008:33). For business and society to make this transition to meet the goals to prevent further damage orientates the view of Murphy and Gouldson (2000) state that there is a pertinent need to regularly generate radical green innovation in order to push the system up to a new equilibrium. It is further argued that this bold and significant move seemingly required in environmental performance may also prove to provide major opportunities for pro-active companies (Hart, 1997). However such discontinuity also receives significant resistance from incumbent firms, opposed to change.

The survey by Arthur D. Little (Keeble *et al.*, 2005) found that leading firms are moving away from incremental reductions in their own operations and are making bold radical reductions in the full life-cycle footprint of their current activities. However, Cramer (1997) makes the important point that radical changes in the function of a product cannot be made without radical and fundamental changes in production and the consumption of consumers. These fundamental changes called for is termed ‘systemic discontinuity’ by Manzini (1999) who states that this requires the direct move from one system to another to achieve the required change in the behaviour and consumption patterns of society.

It has been argued that further research is needed to create an effective framework to determining the type, impact and benefit of certain green innovation. As Hellstrom (2006) amplifies “there is a concomitant need to understand what types

of eco-innovation can also be labelled as radical innovation with high sustainability potential, and what specifically characterises these” (Hellstrom, 2006:149).

#### **4.4 Technology Management**

Technology is popularly discerned to be a major part of the solution for short-term eco-efficiencies and also to provide the long-term radical change needed. “To meet the next generation of environmental challenges, innovative new technologies will be a key contributor to our success” (Whitman in EPA, 2002:2) Researchers discussing the role of technology to reach environmental goals include: Olson, 1994; Kemp, 1994; Green and Miles, 1996; Jamison, 2001. However in the discourse of green innovation some authors also claim that significant innovation needs to take place in social and institutional arenas (Freeman, 1992; Rennings, 1998; Kemp, 1994), contributing with relevant policy frameworks to help overcome the technology bias with a broader approach (Rennings, 1998).

Sanden and Azar (2005) draw attention to the risk that society may face in the quest for short term eco-efficient, cost efficient (incremental) technologies. They contend that a short term focus may act as a ‘blindfold’ to the more difficult but equally important advanced (radical) technologies thought to be needed and disseminated on a large scale by the year 2030, in the effort to avoid further and more serious climate risks. Another problem faced by a short term and efficiency based approach, rather than a more disruptive approach is the prevalence of a technological lock-in (Dosi, 1998). The concern is that technologies may become path dependent due to the extensive development, capabilities, resources and systems built around an offering that may not actually offer the best solution but is rather locked-in due to the rigidity for change (Leonard-Barton, 1990). David (1985) also notes that this also locks-in social practices with existing trajectories, which may also become increasingly costly to break out of.

There has also been a significant growth in patents which signals development in green innovation through supplementary supporting technology. “Clean-tech patents have grown at an average of five percent per year since 1995 [...] the rate for U.S. patents overall” (Makower, 2008:28). This denotes significant development and investment within green technology innovation. This growth can also be seen in revenue data. “The global market for environmentally-related technologies has gone from approximately USD 450 billion in revenues in 1993 to USD 652 billion in 2005” (Environmental Business Journal, 2006 in OECD 2008:21).

#### **4.5 Business Development**

It has been argued that green business has shifted from a movement to a market (Makower, 2008). Going green is “one of the biggest business opportunities in the history of commerce” (Hart and Milstein, 1999:25). Numerous recent studies have

reflected the powerful financial benefits for firms engaging in sustainable practices and green innovation (IGTBG, 2008). In a recent survey conducted by the consulting firm McKinsey & Co. (Enkvist and Vanthournout, 2008) 61% of respondents viewed the issues associated with climate change as having a positive effect on profits if managed well.

Numerous researchers however claim that environmental performance is conditional and contingent upon certain market and regulatory requirements (King and Lenox, 2001; Steger and Meima, 1998; Reinhardt 1998). Moreover, Williander (2006) also observes that the relationships between green innovation, profit and competitiveness for the innovator are difficult to generalise, given that it is largely dependent on the individual firm's internal and external dynamics.

Rehfeld (2007) identifies that economic aspects are also in fact major barriers to the commercial exploitation of green innovations. The hard truth is that environmental costs will continue to rise in the foreseeable future (Colby *et al.*, 1995). And even where such cost are clearly defined within a market and/or firm to "assume they can be passed on to customers is naïve in a world with substitute products and international competition" (Colby *et al.*, 1995:140). Although Colby, Kinsley and Whitehead (1995) argue that all costs will not hit all firms and industries, however every firm now needs to include environmental issues in their strategy. To solely avoid risks could in fact lead firms to ignore the compelling opportunities offered by this transition (IGTBG, 2008). Colby (*et al.*, 1995) further claims that the general assumption that environmental costs are non-discretionary is incorrect, as significant flexibility exists.

Proactive firms focus on green innovation as a means to capture the rewards the market presently offers. To do this, it has been argued that firms will have to identify opportunities which makes greening something that the overall business wants to do - which stimulates improvement in competitiveness and probability (Williander, 2006). However, the majority of business is still thinking and operating in the old paradigm dominated by unsustainable growth and an economy of goods. For the transition towards innovative sustainability, it has been underlined that firms will have to "learn how to compete, and possibly to make good business while decreasing the total production and consumption of (physical) goods" (Manzini, 1999:434). Outside of the environmental issues, many commentators also believe that this transition is also something that is needed for our own economy at large, as the current 'old' model is not working (Gore, 2008).

For some firms, described as proactive, the adoption and investment in green innovation is seen as a reduction in risk through the development of future competencies and resources. Thus, as noted by stock market analysts, who reward certainty and punish uncertainty. "The more successfully you manage risk - financial, social, environmental, whatever - the higher your stock usually goes" (IGTBG, 2008).

## **4.6 Drivers and Barriers of Green Innovation**

The complexity, uncertainty and number of actors involved when pursuing green innovation results in the wide variance and the number of both drivers and barriers to green innovation. The following section will outline the most prominent of these drivers and barriers identified by current literature.

### **4.6.1 Drivers of Green Innovation**

Change requires motivation. This motivation is referred to as the driver which encourages action towards increased environmental consideration. The OECD (2008) outline the following three factors which are considered to be the key driving factors for growth in the global environmental market (Environmental Business Journal, 2006 in OECD 2008:21):

- Economic growth and development in emerging markets.
- Environmental regulation.
- Multinational enterprises demanding better equipment and services to comply with environmental laws and to preserve a good reputation.

Outside of the identified market demand and regulation a key argument in the discussion as to what drives green innovation presides over the central premise of, 'technological push and market pull'. This ongoing discussion is also heavily documented in general innovation management literature (Grant, 2005). The following material outlines the common preconceptions of technology push versus market pull and will also review the extensive literature of environmental regulation as a driver of green innovation. These issues are considered central to the managerial aspects of green innovation.

Numerous discussions exist debating if it is actually technological or market factors that drive green innovation: "The main discussions in innovation economics has been whether technological innovation has been driven by technological development (technology push) or by demand factors (market pull) (Rennings, 2000:326). It has been argued that technological change mainly occurs as a result of autonomous trends and public policy. Technology push also occurs through the development of novel technologies, 'discoveries' which will develop a following and find/build a market application. However, consumer pressure may be an equally important driver of innovations in environmental technologies (OECD, 2008).

The market pull argument on the other hand, holds true that technological change must come "primarily from the business sector and depends mostly on corporate investments in response to economic incentives" (OECD 2008:13). Williander (2006) makes the distinction between market driving and market driven firms. Here, market driving firms change the rules of the game through breakthrough technologies and/or breakthrough marketing to achieve significant competitive advantage.

Pavitt (1984) provides empirical evidence that both technological and market factors are relevant. In “the case of innovation oriented towards a public good like the environment, market pull is inoperable unless governments adopt regulation and put in place measures that increase the market value of environmental technologies” (OECD, 2008:16). However, Rennings (1998) makes a distinction that green product-innovation is primarily driven by the strategic market behaviour of firms, thus market pull. Whilst on the other hand, green process-innovation has been found to be driven more by regulation.

Regulation can be seen to be legal restrictions typically created by government. Generally, regulations are set to create an outcome that may otherwise not occur or to curb an undesired outcome. Regulation can be seen as a critical element in green innovation considering the common versus private good attributes of a green offering.

“Freedom in a commons brings ruin to all” (Willander, 2006:7). Furthermore, “on the issues of climate change and environment the political system has failed us” (David Orr in Connors and Petersen, 2007). Norgaard (1994) identifies unsustainable development itself resulting “from technology outpacing changes in social organization” and postulates that, within a co-evolutionary paradigm of sustainable management of economic and ecological systems, “incentives and regulations must evolve with technologies” (Norgaard 1994:16). The view that identifies policy and regulation itself as a green innovation can be seen as extremely positive, as institutional green innovation is considered a prerequisite to construct and keep pace with the market (Freeman, 1992; Minsch, 1997). Regulation is of note for green innovation as Rennings (1998) provides empirical evidence (Green *et al.*, 1994; Porter and van der Linde, 1995; Kemp, 1997; Faucheux and Nicolai, 1998) to show that the combined factors of technology push and market pull alone are not strong enough, and thus, require regulatory support.

However, Fondel (*et al.*, 2008) finds that environmental regulation fails to motivate firms to actually adopt an environmental innovation strategy, which has been positively reflected in the performance of the firm (Eidat, 2008). Further to this, Arthur D Little (2004) also interestingly finds in their survey that “companies see the legislative driver as decreasing in importance in the future” (Keeble *et al.*, 2005:8).

Traditionally, innovation was idealised by business to offset burdens and costs induced by environmental regulations (Rennings, 2000). Although in recent times Porter and van der Linde (1995) have popularized the win-win proposition, finding that “environmental regulation could induce innovation by making industry aware of and willing to exploit otherwise missed opportunities” (Bernauer *et al.*, 2006:1). Porter and van der Linde (1995b) state that “properly designed environmental standards can trigger innovation that may partially or more than offset the costs of complying with them” (1995b:98).

Governments have an increased role to play in supporting green innovation throughout the entire innovation chain. The possible measures to take into consideration and to be dealt with are broadly categorised as (Grubb, 2006 and IEA, 2004 in OECD, 2008:17):

- Internalization measures.
- Support to technology research, development, and demonstration.
- Market engagement programs.
- Barrier removal; and deployment policies.

Environmental strategy has moved far beyond the time when it meant fending off regulation for as long as possible (Colby *et al.*, 1995). Instead the role is becoming more active: “Businesses have a lot to gain from participating in a sophisticated process of engagement, using partnerships and alliances to support their arguments and influencing policy makers both through direct dialogue and through efforts to shape public opinion” (Enkvist *et al.*, 2008:33). This dialogue holds potential to be developed and further enhanced. In a recent study by the OECD (2008) most of the interviewed companies believed that governments need to play a more active role in the commercialisation, not just R&D activities of developing green innovation. Increased calls from firms also suggest that regulators have not been able to communicate positive economic and social merits of regulation (Eiadat *et al.*, 2008). Academics are currently working to create better frameworks to stimulate green innovation initiatives (Heaton and Banks, 1997; Delmas and Terlaak, 2001; Kemp *et al.*, 1998;). Also industry is taking an active role. For instance, Gerard Kleisterlee, President of Philips “businesses will create the products and services: politicians need to provide the enabling conditions” (Philips, 2007:11).

Despite the fact green innovation creates common good and is also recognised to offer business value, Keeble’s (*et al.*, 2005) survey (of large firms across various industries) reveals that such benefits are still intangible for many firms as there are significant barriers to be overcome. Keeble (*et al.*, 2005) suggests that the current key barriers to green innovation are (Keeble *et al.*, 2005:6):

- A lack of understanding of the significance of sustainability trends and drivers, potential markets and opportunities, particularly with strategic business developers.
- A high degree of internal and external scepticism, often with perceived high levels of uncertainty and risk involved in these activities.
- An absence of suitable business models, particularly for use in emerging markets.
- A tendency to use available capital to grow ‘more of the same’ in new markets rather than to develop new business models or service offerings that could possibly offer long-term benefits in terms of responding better to sustainability drivers.
- An unwillingness to finance new projects, particularly at the bottom of the business cycle.

Given the trouble and difficulties many firms face when pursuing green innovation, it is not a surprise that substantial barriers exist, as highlighted by Keeble (et al., 2005) above. Barriers to green innovation extend across all firms and industries. However, barriers are commonly highly dependent on a firm's particular independent organisation. This perhaps resulted in a distinct lack of specific barriers found in literature, generally found to be described generically. For example:

- Economic (Rehfeld, 2007).
- Lack of knowledge (Makeower, 2008).
- Lack of experience (Charter and Clark, 2008).
- Technological and capability lock-in (Dosi, 1998, Sanden and Azar, 2005).
- Underdeveloped regulation (Rennings, 1998; Kemp, 1994)

Leading firms, organisations and researchers are working to break through these cited barriers. However, it should be noted that green innovation is a moving target. Standards, targets and competition continually evolve. Firms need to understand this and be proactive in not only addressing their current difficulties but also preparing for possible future ones to come.

#### **4.7 A Strategic View on Green Innovation**

Williander (2006) states that the motivation to innovate (in terms of environmental performance) is activated by 'triggers' in terms of objectives, perceived urgency and feasibility. These factors combined with a plan of how to meet these objectives are at the most basic level of a firm's strategy. A firm's strategy should be active at every level of the organisation, which in general terms is a central function of managing the traditional business playing field (Esty and Winston, 2006). Generally for industrial organisations this includes suppliers, customers, competitors (Porter, 1979). Esty and Winston (2006) explain that when introducing environmental issues into this mix, the basic reality does not change but rather 'smart' companies manage such changes proactively for strategic advantage, opposed to reacting to them.

However, introducing environmental performance into an organisation does create significant change. As Noci and Verganti (1999) find "considering 'green' issues is a major source of strategic change" (1999:3). The move to include environmental concern in business strategies has been found to result from change in the social system and competitive arena (Welford, 1995), and regulation/policy (Kemp, 1994; Rennings, 1998).

Eiadat (2008) empirically finds that there is a significant positive relationship between green innovation strategy and a firm's overall business performance. "So the question is not one of whether or not to adopt an environmental innovation strategy but rather of how to do so successfully" (2008:142). Though, such a move should not be underestimated, as the challenges for large firms to change are

significant. This unwillingness to move, often referred to as inertia, is a result of significant tension between stability and risk, and short-term efficiency/performance and long-term competitive advantage. Transformations within firms and industries of this maturity are competency destroying (Schumpeter, 1942) so for a firm to willingly take this path, it is no surprise that there may exist significant internal resistance. One current example is the need for the United States Environmental Protection Agency (EPA) to lead and take this transition. "Clearly, EPA must innovate to move forward. But the process presents us with a challenge – to maintain those vital elements of the existing system, such as the standards, permits and compliance assurance efforts that are part of our basic mandate while simultaneously pursuing creative new tools and approaches to complement and enhance its efficiency and effectiveness" (EPA, 2002:2).

Numerous researchers state that firms need to innovate to remain competitive (e.g. Grant, 2005; Tidd *et al.*, 2001, Hamel, 2005). It has also been argued that balancing the short term and long term business requirements is a critical aspect for every organisation (O'Reilly and Tushman, 2004). Successful green innovation provides considerable challenges, however through the recognition of the potential market and arguably long-lasting competitive advantage (Williander, 2006) many firms are voluntarily attempting this transition, integrating environmental considerations into the core of their business strategy. To do this, firms are currently faced with the challenge of determining how to identify, develop and diffuse green innovative capabilities into the relevant business functions of the firm (White *et al.*, 2008).

Arguably the attention environmental issues are receiving has resulted in higher momentum for change. Dutton and Duncan (1987) contend that when there is high momentum for change, decision makers are more willing to consider an increased level of change (radical). This is a promising notion as it has been well documented that the required change considered necessary to meet the desired environmental performance is indeed significant for all. To succeed in green innovation, Keeble (*et al.*, 2005) outlines that firms need to develop creative new ways of thinking and place sustainability at the heart of strategic decision-making and innovation processes. Philips is one example of a firm currently moving to meet such demands as formulated by CEO Gerard Kleisterlee: "To address the challenges with suitable products, Philips needs to identify early enough changes in the environment, understand the expectations of its stakeholders, integrate the findings into a product, have high regard for the environment and people in manufacturing, and finally reach the target customers. Sustainability thinking plays an important role in every aspect of this process" (Philips, 2008). Further he clarifies the reasoning to make this transition: "in terms of growth opportunities, we are convinced that combining the principles of economic growth and environmental stewardship will offer long-term rewards to all of our stakeholders... [sustainability] is at the centre of our strategy and rightfully so" (Philips, 2008:8)

However, other indicators are less promising. A survey conducted by McKinsey & Co. revealed that (Enkvist and Vanthournout, 2008):

- 70% of global executives report that their companies don't include formal targets related to climate change in the performance dialogues or reviews or relevant executives, and
- 60% of CEO's around the world say climate change is a somewhat or very important consideration in overall strategy, yet 44% also say that climate is not a significant item in their agenda.

#### **4.8 Environmental Strategy and Business Performance**

Esty and Winston (2006) find that a number of studies have demonstrated that environmental strategy and performance is a strong indicator of a firm's overall management quality. Eiadat (2008) further identifies the following factors to support this notion (Eiadat, 2008:133):

1. Firms that consider resource productivity, process change, and product innovation as priorities can achieve competitive advantage over competitors by having lower costs or offering differentiated products (Cairncross, 1992; Faucheux and Nicolai, 1998; Lampe *et al.*, 1991; Porter and van der Linde, 1996).
2. It [environmental strategy] may lead to firms to explore new ways of converting waste into saleable products that can provide additional revenues.
3. It offers the potential to cut emissions well below required levels, reducing the firm's compliance and liability costs (Hart, 1995).
4. It helps firms to improve their environmentally based leadership reputation relative to competitors, which should result in enhanced cash flow and consequently enhanced business performance.

Esty and Winston's (2006) own extensive empirical study supported the proposition that firms utilising environmental considerations are generally more innovative than their competitors. This is said to be achieved through being able to spot and react to emerging issues ahead of the market, responding to customer needs through products and services and increasing customer loyalty, all argued to drive increased revenue growth.

It has been argued that green strategy, like strategy in general, is firm and situational specific - there is no single green strategy that will work and for all industries, firms and circumstances (Esty and Winston, 2006). Green performance does not always have to drive the innovative efforts to produce a green result: "industries, such as electronics (case studies of Nokia and Ibsen), food and health care (Unilever), as well as industries in the utilities and energy-related sectors (case studies of Endesa, Isofotón, Philips Lighting, Neste Oil, Sharp, Vestas, and Viessmann) are also investing in environmental research and development and developing environmental innovations that have significant environmental benefits, even if the companies do not consider them environmental innovations *per se*" (OECD, 2008:16). Nike's strategy is similar, as stated by executive Phil Berry, "we

have two maxims. Number 1: it's our nature to innovate. Number 2: Do the right thing. But everything we do around sustainability is really about number one – it's all about innovation" (Berry in Esty and Winston, 2006:127).

This highlights a notion described by Williander (2006) that for innovative firms, going green can be done differently, for example by looking at the possible negative externalities early and developing a strategic response. A strategy whereby associated costs are not created in the first place or are reduced to ways that appeal and are absorbed by the paying customer, and like any successful innovation, is profitable for the firm. It should be noted here however, that not every environmental effort produces a 'win-win' result. Like any form of competition, if there is someone who wins, often there are others who loose. For the EPA, their green innovation strategy is based on strengthening partnerships, targeting priorities, expanding the current tools, creating a more innovative culture and addressing challenging problems (EPA, 2002).

Esty and Winston (2006) offer the following lessons from their empirical research for consideration when creating a strategy for environmental advantage (Esty and Winstons, 2006):

- Meet customer needs that actually exist
- Don't ignore the customers non-environmental needs
- Control costs
- Remember that green attributes rarely can stand alone: the environmental story is the second or third "button"
- Market to different niches differently
- Don't expect a price premium

#### **4.9 Organisational Capacity to Enable Green Innovation**

Integrating environmental considerations into product development is said to require the creation, development and diffusion of practices and communication channels within the organisation (Simon, *et al.*, 2000). Green innovation relates to organisational factors that include management, internal and external relationships, development processes, knowledge, capabilities, resources and motivation. Many commentators now believe "its time to embrace sustainable innovation as a core competency" (Kelly, 2005:28). This is further embraced by the iconic Toyota Prius case, which has been described as strongly linked to Toyota's organisational and corporate culture (Magnusson, 2003:1). However, Williander (2006) found that to develop successful green innovations it is required that firms develop their organisational capabilities beyond those of the incumbent firms.

A critical challenge for green innovation is building an organisation that makes it achievable (White *et al.*, 2008) and successful. One of the keys to this is to recognise the wide variety of organisational actors whose decisions may impact a final offering, as green innovation generally requires interaction and coordination amongst perhaps previously unconnected parts of the organisation. Moreover,

enabling the organisational capacity to absorb these evolving insights is paramount. Critical areas to enable this are considered to be organisational learning, knowledge and organizational capabilities. These areas are further examined below.

#### **4.9.1 Organisational Learning**

The difference between learning and innovating is subtle (Williander, 2006). White, Stewart, Howes and Adams (2008) reason that going green holds a learning orientation, as sustainability is fluid, contextual and evolving, resulting in a moving target. However, given the embryonic status of the field of green innovation, many organisations fail because they are not aware and do not possess the required knowledge to innovate successfully (Christensen, 2002). A central issue to successfully innovate with environmental considerations is for the organisation to obtain the required knowledge. "Certain knowledge domains must be known in order for the organisation to manage the eco-environmental challenge" (Williander, 2006:10). Sanden and Azar (2005) also state that to bring new (green) technologies to the shelf (market), the key issue is learning.

A key step to ensuring continual reorientation and learning within the organisation is to develop a knowledge innovation system as opposed to a technology innovation system (Williander, 2006). Mirata and Emtairah (2005) state that the innovative capacity of an organisation is enhanced by the density and level of interaction through intra-organisational and inter-organisational learning. The required learning models for an innovative culture are generally referred to as higher-order which is said to require an organisational culture which honours openness, truth and transparency (Williander, 2006). Green innovation has generally been found to be associated with risk. Williander (2006) outlines the positive correlation between risky projects and learning for the participants involved. Lundvall and Johnson (1994) also highlight the importance of 'learning through interaction' and 'learning by doing'. This closes the loop in how learning creates knowledge which results in increased capacity to innovate.

Nieto and Quevedo (2005) state that firms innovative efforts are positively related to their level of absorptive capacity, a notion introduced by Cohen and Levinthal (1990) and defined as the ability of the firm to recognise, assimilate and apply new knowledge. Williander (2006) proposes that a firm's absorptive capacity may actually influence their ability to create successful green innovations whilst also noting that there is often a critical gap between potential and realised absorptive capacity, a distinction introduced by Zahra and Goerge (2002). The development of individuals' absorptive capacity within the organisation has also been found to have a positive influence on total firm performance (Williander, 2006). In the context of green innovation, the United States Environmental Protection Agency (EPA, 2002) finds further that innovation may increase when internal staff perceive their individual job to be concerned with environmental problem solving.

#### **4.9.2 Knowledge Management**

Amidon (2002) describes knowledge as information with a meaning, which is fully actionable. Grant (*et al.*, 2005) explains however, that the critical source of competitive advantage is not knowledge itself but rather the integration of knowledge into the organisation. This creates a need for knowledge to be created, developed and diffused suitably within an organisation, thus managed. The management of knowledge is found by Campos and Sanchez (2003) to be a matter of creating the right contexts within the organisation as opposed to the management of other resources. Knowledge management in the context of innovation is centrally about promoting an understanding to inspire ideas and reveal previously unseen connections (Nonaka, 1994; Haragadon, 2003). The resulting factor is that knowledge creation and communication is a critical base for any innovation system and thus holds a critical role in the competitiveness of the firm. Building such a system though is recognised to be time consuming and costly (Mirata, 2005).

Von Krogh, Ichijo and Nonaka (2000) identify enablers of knowledge creation to include instilling a knowledge vision, promoting conversation between employees, mobilizing knowledge activists, and creating the right context for knowledge sharing. Also, Albers (2000) outlines further methods to “promote knowledge transfer in an organization is to have clear organisational goals, provide employees with a certain amount of autonomy, and encourage diversity of views” (2000:9).

Knowledge management has been put forward as a practice “for sharing experiences and expertise, integrating knowledge, and generating new knowledge. What organizations need is a better understanding of how knowledge management is related to the innovation process and how it can be used to help foster innovation within organizations [...] While organizations demand the latest and the greatest information gathering they often struggle with how to handle the information overload and to turn the information into knowledge, i.e. actionable information. Knowledge management includes two aspects, ‘managing’ the knowledge that already exists in the organization, as well as enhancing the ability to create new knowledge. Knowledge management deals with the creation, acquisition, integration, distribution, and application of knowledge to improve the operation effectiveness and competitive advantage of an organization. Knowledge management is providing the right information to the right people at the right time” (Albers, 2003:1).

#### **4.9.3 ‘Green’ Organisational Capabilities**

Bernauer (*et al.*, 2006) describes green capabilities as consisting of a firm’s attitude towards knowledge of environmental issues, relevant to its own business and procedures for responding and acting on such issues. Further it is noted that incorporating environmental considerations into an organisation does require a significant change in thinking (Kelly, 2005). However, organisations find it difficult to determine which information to collect and therefore do not have the tools to capture relevant information (Flint, 2002).

It has also been argued that organisational capabilities need to be developed across relevant business functions (Charter and Clark, 2008). Abernathy and Clark (1985) introduce the concept of a 'transilience map' which aims to track the capacity of an innovation to influence the companies existing resources, skills and knowledge. Magnusson (2003) uses the concept of the transilience map to help classify green innovation and thus discover what influences it has on the organisation.

The required change to incorporate environmental consideration to meet the future environmental goals is considered significant by many authors. Furthermore, the level of innovation for most firms to orientate towards this market is extremely novel. Today, most green innovations are typically based on eco-efficiencies generally related to incremental levels of change (Hellstrom, 2007). This is of concern for incumbent organisations as incremental improvements entrench the existing capabilities into the organisation often causing a lock-in effect, thus, making it increasingly difficult for a firm to stimulate and react to change. This concept of an organisations core competencies becoming their core rigidities was first popularised by Leonard-Barton (1990).

In the past companies generally engaged in green innovation to meet external demands. Typically firms react "when they are forced to do so or see a direct cost or quality advantage" (Cramer, 1997:9). Green innovation for many commentators infers a long-term perspective (Rennings, 1998) which generally requires a proactive strategy to meet this movement with success. Sharma and Vredenburg (1998) empirically find that firms develop green organisational capabilities after having adopted a proactive environmental strategy. Strategy is critical to ensure that environmental considerations are continuously integrated into organisational and business processes (Charter and Clark, 2008) and as a result helping the organisation develop smarter and more flexible green innovative capabilities (White *et al.*, 2008).

Rumizen (2002) explains that investment in organisational capabilities to handle such change is critical for long-term green innovation and market success. With sustainability being described as more of a journey than a destination (Esty and Winston, 2006) it is considered that the capabilities of the firm should be able to react to such market dynamics. Therefore it can be argued that in the context of green innovation, it is important to strengthen social and organisational innovative capabilities to clearly identify, absorb and execute future business opportunities.

Green organizational capabilities, which can also be seen to include the previously discussed areas of organisational learning and knowledge management, are increasingly referred to as the innovative capabilities of a firm. Le Masson (*et al.*, 2006) defines innovative capabilities as the "collective capacity to permanently and simultaneously recreate new sources of value (products, concepts, patents, environmental values etc.) and competencies (knowledge, know-how, professions etc.)" (2006:21).

#### **4.10 Collaboration in the Pursuit of Green Innovation**

Collaboration and networks are considered essential for generating and pursuing novel ideas (e.g. Grant, 2005). Engaging in such relationships is about developing a setting that sparks and embraces innovation (O'Reilly & Tushman, 1997) whilst benefiting from external knowledge. It has been underlined that the shift of focus towards green innovation requires information, knowledge and participation from many different sectors, including business, governments, non-government organisations, universities, consumers and individuals to name but a few (Esty and Winston, 2006). Jackson (1996) further states that to achieve this transformation, innovation is needed at every level of society. This is confirmed by the OECD: "It is generally agreed that many environmental problems require concerted action, international cooperation, and partnerships among countries, as the increasing number of multilateral environmental agreements and related initiatives show. It is also widely recognised that, in order to address global environmental problems, environmental innovation and technology development are required on a global scale, and this, in turn, calls for strengthened international co-operation" (2008:25).

Paul Hawken (Hawken in Connors and Peterson, 2008) declares that there are over one million environmental, social justice and indigenous organisations present today, and that this is the fastest growing movement on earth. What is important to state here is however, that despite the sheer number of actors there is a distinct lack of engagement between key players and organisations (Charter and Clark, 2008). Recreating the communication infrastructure is an important step towards capitalizing on the breadth and range of existing knowledge (White *et al.*, 2008). This is fundamentally about orchestration and the ability to integrate knowledge from a variety of sources and competencies into existing practices (Enkvist *et al.*, 2008).

The generation and development of successful green innovation requires involvement, knowledge and participation from a breath of participants. "The only quick and efficient way to do this is to build extended collaborative networks" (KnowledgeRich, 2008:1). The ability to do this is said to be not so much dependent on the technology or resources of the innovator but rather the capability to create orchestrate and manage the capabilities needed. This is could be seen as a role and challenge for management.

#### **4.11 Summary**

From the review of literature constructing this chapter, the following observations can be made to synthesise a general overview of the managerial perspectives of green innovation.

- Green innovation has been described as a 'subset' of green innovation.
- Several authors have found innovation management theory to be valid for green innovation.

- In the past green innovation has been found to be poorly developed and subsequently mismanaged.
- Green innovation has been conceived with a particular bias towards incremental innovation.
- Technology has been highlighted as a solution to meet both short and long term environmental goals.
- 'Smart' companies have been said to manage change proactively, with the environmental aspect being one example of this.
- Eidat (2008) exclaims that the question is not whether or not to adopt a green strategy but rather the challenge is how.
- An organisations knowledge and attitude towards green innovation is argued to be a critical element in long-term market success.

In the following chapter, chapter three will present an analysis and discussion combining the previous two chapters, one and two.

## 5 Managing 'Green' Innovation, an Analysis and Discussion of Reviewed Literature

The following chapter presents an analysis bridging together the two previous chapters. A discussion will then outline and examine areas for further development derived from the analysis.

### 5.1 Interpreting what we know about 'Green' Innovation

Debate within the field of sustainable development is rife and commonplace, even to the point where sustainability itself has been questioned (Rehfeld *et al.*, 2007). The abundant discussions have led to many different perspectives being voiced (Makeower, 2008) creating difficulties in interrupting and creating a uniform, generally understood definition for green innovation (Charter and Clark, 2008). This extends to defining green innovation operationally (Rennings and Wiggering, 1997; Norgaard, 1994; Cary, 1998a and Minsch 1998) and points to the fact the green innovation from an organisational/management point of view is an emerging field. This notion is confirmed by Makeower (2008) who states that the current knowledge of green innovation is insufficient and there is a critical lack of assessment of the impacts of green innovation due to inconsistent and dated data.

For the definitions that exist, three main concepts can be identified. Green innovation is argued to be either: reducing environmental performance (Klemmer *et al.*, 1999, James 1997), introducing environmental performance (Blattel-Mink, 1998; Keeble *et al.*, 2005) or improving environmental performance (Mirata and Emtairah 2005; OECD, 2008). Further it has been stated that green innovation includes technological, social and organisational innovation (Rennings, 1998). Freeman (1994) identifies that change within one dimension requires change in the other two as well. Rennings (1998) highlights that further research is needed into green innovation to improve our understanding and that current theoretical and methodological approaches to analyse such work are also poorly developed (Rennings, 2000).

Traditionally firms have been shown to conduct green innovation to respond to environmental regulation in a cost-effective way (Frondel, 2008) thus taking a reactive approach. However, current environmental degradation has been widely recognised by most industrialised governments (KnowledgeRich, 2008) and now firms must respond to more ambitious targets. Therefore firms arguably need to reconsider their approach towards the environment. Makeower (2008) also states that green innovation has shifted from a movement to a market in its own right, meaning that many firms may now have to introduce environmental performance into their current offerings for the basic right to compete. On the contrary, 'going green' has been touted as a tremendous business opportunity (Hart and Milstein, 1999, Doerr, 2006) and if managed well, associated with positive effects on a firm's profit line (Envkvist and Vanthournout, 2008). This is indicated by the rapidly

growing investments made particularly in green technology (Charter and Clark, 2008). Yet, as Williander (2006) points out, the relation between green innovation and profit is difficult to generalise. Rehfeld (2007) goes further and identifies economic aspects to also represent a barrier for conducting successful green innovation.

Businesses have found value in representing their offerings as being 'green', environmentally considered (Snider, 2003; Porter and Kramer, 2006). This increase in interest has been hypothesised by Bernauer (*et al.*, 2006) to stimulate and drive green innovation. However, it has been found that a greater part of green marketing contains false and misleading connotations (Gottlieb *et al.*, 1995; Makeower, 2008) referred to as 'green washing'. Research has shown that the traditional selling points of price, performance and quality must be met before the green message can be leveraged (Chen, 2001; Williander, 2006; Esty and Winston, 2006). This may be due to the fact that the green consumer is fickle and cannot be relied upon (Peattie, 2001). Further, consumers have been found to be currently unwilling to pay for common environmental good (Tversky and Kahneman, 1986). Researchers are looking to comprehend the critical position businesses hold based on what they offer to their customers (Dickson, 1992; Kumar *et al.*, 2000). Other research (White *et al.*, 2008) is revising how business offerings are created and designed within the firm which is said to be about creating a capable organisation.

## **5.2 Understanding the Managerial Perspectives on Green Innovation**

Despite the current attention green innovation receives it is considered poorly developed and mismanaged (Colby *et al.*, 1995). Moreover, Hellstrom (2006) states that one problem is how green innovation has been conceived to hold a particular bias towards incremental innovation where it is actually radically green innovation that offers the real potential to impact and meet environmental goals (Hellstrom, 2006; Murphy and Gouldson, 2000). Integrating environmental performance into the current innovation practices of any firm is considered to require radical change (Nochi and Verganti, 1999; Husesmenn, 2003; Hellstrom, 2006).

Technology is popularly highlighted as a solution to meet both short and long term environmental goals (Olson, 1994; Kemp, 1994; Green and Miles, 1996; Jamison, 2001). It has been argued that for green technology innovation to succeed, innovation also often needs to take place in the surrounding social and organisational arenas (Freeman, 1992; Rennings, 1998; Kemp, 1994). Sanden and Azar (2005) highlight the importance in not being blindfolded and locked into short-term solutions (David, 1985; Leonard-Barton, 1990). Where others have argued a more disruptive approach is required (Dosi, 1998). This approach is further elaborated by Sanden and Azar (2005) who state that to successfully get long-term disruptive technology to market, the key issue is learning.

Numerous drivers of green innovation (e.g. technology, market and regulation) have been highlighted; however there is a lack of understanding relating to the identified barriers (lack of knowledge and experience, perception of risk, incremental innovation lock-in and financial aspects) of green innovation.

Esty and Winston (2006) have labelled 'smart' companies those who manage change proactively, using green innovation as an example. Also, Eidat (2008) finds there is a positive relationship between firms implementing green innovation strategies and overall performance. Eidat (2008) further exclaims that the question should not be whether or not to adopt a green innovation strategy but rather how to do so successfully.

An organisation's attitude and knowledge towards environmental issues (Bernauer *et al.*, 2006) is viewed as a central element in long-term market success (Rumizen, 20020), described as green organisational capabilities. Green organisational capabilities, is the capacity of the organisation to continually create novel value and competencies in the pursuit of green innovation. Organisational learning and knowledge management are key domains of green organisational capabilities. To achieve the required radical level of transformation Jackson (1996) argues that transformation is required at every organisational level. It is also widely recognised that collaboration is a crucial aspect to successfully generating and implementing novel ideas (O'Reilly and Tushman, 1997). Management holds the responsibility to coordinate and orchestrate the firm's capabilities of the firm.

### **5.3 Current Knowledge on Managing Green Innovation**

The required knowledge to create successful green innovation has been found to be vast, complex and dynamic. **Exhibit 1** presents results from the qualitative analysis of the current literature on the management of green innovation.

The knowledge domains/topics presented were developed through an extensive thematic analysis of the literature review. Domains are plotted according to the amount of literature pertaining to the particular domain in question.



**Exhibit 1:** Current knowledge (literature) and Future desired knowledge in aid of successful management of green innovation (Source: Author)

In Exhibit 1, it can be seen that there is considerable current knowledge regarding regulation, policy and environmental management systems. That being the case, it must be noted that much work still needs to be conducted all areas these areas, as firms grasp the complexities of the challenge.

Exhibit 1 also identifies knowledge domains that are significantly underdeveloped in aid of the successful management of green innovation. It can be seen that there is a weighted need to further develop and diffuse knowledge specifically related to business and organisational aspects; including business opportunity, strategy,

organisational capabilities, marketing, consumerism and collaboration. This focus, notably absent in terms of current literature and illustrates the considerable 'gaps' that exist.

There is a continual need to clarify the variance and many complex approaches that are currently found. From a practical point of view, firms know quite little on '*how*' to actually respond. Key to this outcome is the availability and access to the required knowledge to plan and undertake this transition successfully. The collaboration and integration of actors is one suggested approach. Through the horizontal collaboration of actors interacting in the development to advance green innovation, a universally focused framework could be adopted.

The following section will now provide a discussion addressing key issues derived from the above analysis.

## **5.4 Managing Green Innovation, a Discussion**

The following discussion is derived from the above analysis, outlining and examining areas considered central to the development and enhancement of managing green innovation.

### **5.4.1 Defining Green Innovation**

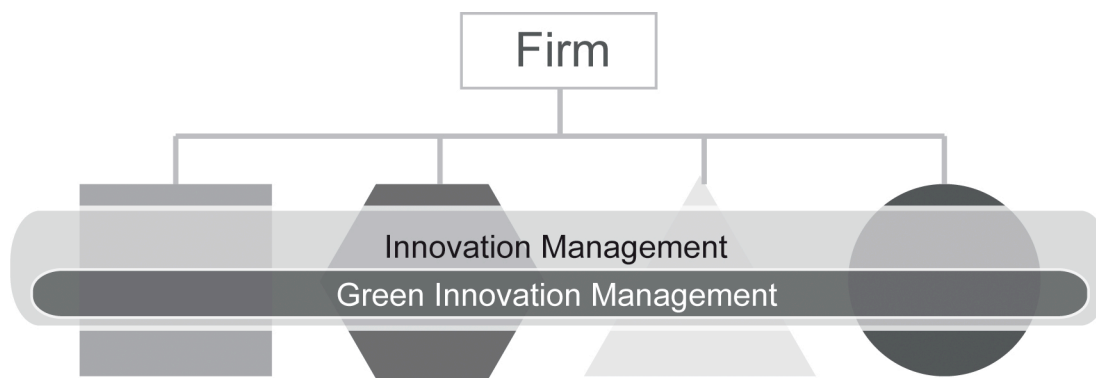
It is argued here that the current reference to green innovation as a 'subset' of 'standard' innovation could be reconsidered. Green innovation has been found not to be a separation from or division of 'standard' innovation. Rather green innovation requires the introduction of a new performance dimension into the current theories and methodologies of conducting innovation in general. Green innovation can be considered a 'derivative' of standard innovation, thus an ensuing concept.

Similarly to innovation in general terms, green innovation is novel and uncertain to varying degrees. When considering environmental performance in the discourse of innovation the basic reality does not change. The innovator must create value to successfully capture and appropriate returns. Perhaps the integration of environmental issues into the current processes is where present approaches perceive green innovation as being a departure from standard innovation (Rennings, 2000). Moreover, considered to require a radical change (Hellstrom, 2006).

A definition of green innovation should ideally consider all forms and mediums of change that has the potential to create a significant positive increase in environmental performance. Moreover, it is important for a definition of green innovation to consider holding such breadth as green innovation is fluid, evolving and as a result a moving target. Environmental targets and standards will continue to evolve and so too should the concept of green innovation.

The standpoint taken here is that it can be deduced that green innovation could be considered the environmentally considered (green) exploitation of novel commercially successful ideas (standard innovation). Green innovation management is the organisations collective capacity to leverage on internal and external resources and competencies to drive, generate, explore and experiment with new sources of value and to develop them into commercially viable and desirable offerings.

Another perspective is to view green innovation as an extension of the organisations core competencies. Assink (2006) describes innovative capabilities as the ability to generate, explore and experiment with new ideas to develop these into marketable and effective innovations, here it is argued that this definition can be expanded to also include environmental performance. Resulting in environmental performance being considered as a core innovative capability of the firm (Kelly, 2005). **Exhibit 2** depicts this position. Hence, green innovation and its management an integrated competence of a firm, thus a derivative to ‘standard’ innovation.



**Exhibit 2:** Green innovation, an ensuing concept to ‘standard’ innovation, thus an integration into the current innovative efforts and operations of an organisation (Source: Author).

It is clear that further knowledge and experimentation through social science has the potential and is arguably need to improve our understand of green innovation processes in their different dimensions and interrelations, a sentiment also argued by Rennings (1998).

#### 5.4.2 Working Strategically with ‘Green’ Innovation

On of the way to consider green innovation is to create and deliver equal or superior traditional attributes with improved environmental performance. Here the objective is to integrate environmental performance into the traditional selling points of price, performance and quality. Esty and Winston (2006) verify this sentiment, stating that almost always the green message should not be the first delivered. This is in line with what Williander (2006) argues, that in most cases, private good must be fulfilled before the common good appeals to a consumer. Integrating a significantly

novel performance dimension into existing offerings is a tough challenge for any organisation. In addition, to deliver offerings with equal or better attributes and successfully appropriate returns without expecting a price premium.

Leveraging on the environmental performance only after traditional attributes have been met extends from the typical consumer currently not willing to pay for environmental performance (Tversky and Kaheman, 1986). However, environmental issues have been said to be 'higher' on the minds of consumers (Envist *et al.*, 2008) who have been observed to be increasingly willing to consider environmentally considered offerings (Colby *et al.*, 1995). Williander (2006) expects the response to environmental issues to increase as society becomes more affluent towards the environment. Further to this, an offerings brand, in many cases is enhanced by environmental performance can increasingly be seen as part of its function. Thus a traditional selling point, considered a private good.

Research and experimentation focusing on green consumerism behaviour and physiology is quite limited. However, Peattie (2001) found that the current green consumer is fickle, being everyone and no one. This has led to business marketing their products as green to gain competitive advantage without a target audience in mind. Through broadcasting mixed messages to consumers it has resulted in 'greenwashing', the hyperbole and false portrayal of products claiming to be environmentally benign (Gottlieb *et al.*, 1995; Makeower, 2008). This orientation towards green marketing has missed an opportunity to understand the consumers and their buying behaviour. By failing to gain reliable feedback and assessment of market strategies concerning the effective balancing act between private and common goods.

The prevalence of business attempting to sell their offerings as 'green' can be interpreted as a positive sign. Firstly, with business seeing the value in the messages (Makeower, 2008). Secondly, as Bernauer (*et al.*, 2006) hypothesises, the increase in competition may also lead to the increase in green innovation. In line with this outlook, there is a need for further research efforts to draw upon market competition and consumer demand for green innovation.

### **5.4.3 Managerial Implications of Green Innovation**

Management has been described as a key performance dimension for an entire firm (Hamel, 2005) this assessment does not differ when managing green innovation (Kirnen in IGTBG, 2008). The role of and strategic importance of innovation within today's contemporary businesses has been well documented (e.g. Grant, 2005; Tidd *et al.*, 2001; Hamel, 2005). Given the shift of green innovation from a compliance-based to a market-based focus confirms the strategic importance of effective management of green innovation. The resulting effect being that many firms may now have to integrate environmental performance into their current innovative efforts. Which has been found to be by no means unproblematic.

The current management of green innovation has been found to be underdeveloped and subsequently poor. This is of concern for all participants in the pursuit of green

innovation. Despite the fact that basic innovation theory has been found relevant to green innovation (Johansson and Magnusson, 1998; Foster and Green, 2000; Magnusson, 2003; Williander, 2006) as the basic principles remain the same - the innovator must create a novel offering of value to the customer, superior to the competition and profitable for the innovator. The main issue is the discontinuous discourse green innovation calls for to meet environmental targets. Further to this is the simple fact that environmental performance is considered inherently new to all firms. Green innovation requires new knowledge within the organisation and a new set of competencies (Williander, 2006). Rennings (1998) states that the current frameworks, grounded on what firms have relied on and done in the past, do not address the contemporary problems adequately. Green innovation at this point in time should be considered a radical departure from what has been previously done and approached with the necessary effort.

It can be deduced that firms do not currently hold adequate organisational capabilities to address such problems adequately. To amend this situation, firms are firstly faced with the challenge to determine how to identify, develop and diffuse green innovative capabilities into the relevant and existing capabilities of the firms (White *et al.*, 2008). Secondly, firms are facing a reorientation of their capabilities within the firm, often considered as competency destroying. The internal inertia created by such a transition should not be underestimated. Keeble (*et al.*, 2005) states that firms need to develop creative new ways to place sustainability at the heart of the strategic decision-making and innovative processes. It is critical to ensure that such environmental strategy is continuously integrated into all organisational and business processes aiding in the development of more flexible green innovative capabilities (White *et al.*, 2008). As argued by Kelly (2005) it is time for firms to embrace green innovation as a core competency. Eidat (2008) confirms that it is not question whether or not to adopt a green strategy but the main concern over 'how' to do so successfully. The critical challenge for green innovation as it stands is to build an organisation to make it achievable.

#### **5.4.4 The Need to Act**

Many firms in the past have been found to conduct green and/or to mitigate costs and/or to comply with market regulation, thus taking a reactive approach. This however, has lead firms to engage with green innovation with a certain bias which is argued to have caused firms to miss out of previous opportunities green innovation has presented.

Green innovation is currently observed to be driven by social (consumer demand), environmental/sustainability issues economic growth, emerging markets and environmental policy and regulation (Rennings, 2000; Keeble *et al.*, 2005). Environmental regulation and policy are widely regarded by the majority of existing literature to be the main drivers of this discipline. The dominance of this perspective has lead to a bias that government intervention is required to offset the negative externalities created (Williander, 2006). The legislative driver is now considered to have a declining impact by many firms (Keeble *et al.*, 2005) due to consumer

demand and market competition (Makeower, 2008). Conducting green innovation solely avoid risks, may have caused firms to previously miss out on business opportunities of going green. However, increasingly businesses themselves are starting to see the real stand-alone opportunities and benefits in going green (Hart and Milestien, 1999; Philips, 2008; Makower, 2008).

One proactive approach is presented by Williander (2008) who exclaims that going green can be done differently reasoning that negative externalities should not be created in the first place and/or should be reduced through market competition. Although it has been found that environmental costs do not hit all firms evenly there remains significant flexibility in how such costs are managed (Colby *et al.*, 1995). However it must be underlined that such contemporary approaches are still in the embryonic stage with many commentators describing the need to further understand green innovation in the relative different dimensions and complex interrelations (Keely *et al.*, 2005; Rennings, 1998). Despite this need for further investigation and also given the biased and reactive perspective previously portrayed. Green innovation has begun to show the potential to be of real business value if managed well and viewed in a proactive manner.

#### **5.4.5 The Need for Collaboration**

The development of green innovation requires the interaction and cooperation from a variety of actors on all levels (OECD, 2008). White (*et al.*, 2008) describes creating an effective communication infrastructure is an important step towards capitalising on the breadth of existing knowledge. However, Bernauer (*et al.*, 2006) finds that the widespread research is being conducted within the field of green innovation however tends to concentrate within a narrow range of fields concentrating on specific predetermined levels of analysis. This deep, vertical exploration is highly commendable however there is a clear lack of engagement between key players (Charter and Clark, 2008). It seems the lack of 'horizontal' collaboration holds back the true value of the research conducted for the greater common good. It is apparent that there is no generally understood framework and or cooperation within the field of green innovation. To benefit fully from ongoing work, the only way to do so effectively has been argued to be through building collaborative networks (KnowledgeRich, 2008). Enabling the facilitation and integration of knowledge from a variety of sources into existing practices and competencies (Enkvist *et al.*, 2008) in the pursuit of green innovation.

## 6 Conclusion

The aim of this report is to contribute to the dialogue on managing green innovation. The findings of this report are underlined below and are hoped to encourage further development:

- A universal frame of reference is considered urgently needed. The much-needed future work within this domain needs to be conducted with voices in unison to provide clarity to the sheer number of actors and complexities that exist. The objective being to empower the diffusion and understanding of generated knowledge. This universal (collaborative) approach is also immediately needed to formulate a satisfactory data set.
- Environmental considerations need to infiltrate and be integrated into existing knowledge and operations of all activities. Particularly of note in the frame of this report, is the management of green innovation and its assimilation into the existing industrial engineering, innovation management literature.
- Further we argue that horizontal networks need to be established across those fields of research that are currently involved with the different aspects of green innovation. Admirable efforts are currently conducted in specialised fields but we argue that it essential is for these participants to reach out and collaborate to incorporate and communicate their knowledge contribution. This also supplements the need to broadcast best practices to stimulate action in all areas of society.
- Consumers are principal stakeholders who are today more aware and astute towards environmental performance, increasingly being shown to exercise their buying behaviour. Further, we find that consumers require greater transparency in the products that they purchase whilst conversely, firms require a much greater understanding of a consumers buying behaviour when going green.

There is thus a pressing need to further investigate several knowledge domains of green innovation and its management. These areas relate specifically to business and organisational objectives including:

- What competencies should a firm strategically invest in to integrate and profit from green innovation? And thus how?
- What characteristics of an offering should be promoted?
- There is a need to understand how to create and pass down value in the 'value chain' when going green.
- Investigation and prototyping of effective green business models, i.e. 'how to make money on money'.
- How to promote first mover advantages to encourage change in all industry sectors.
- Understanding how to introduce incentives into the commercialisation of green innovations, not just research and development.

- Increased understanding on why and how companies are currently approaching the strategic management of green innovation.

In this report, it has been identified that the managerial perspectives of green innovation are considerably underdeveloped. This result is attributed to the direct findings from existing literature also coinciding with the thematic analysis and all material found. The thematic analysis found the following knowledge domains, specifically related to business and organisational aspects, in need of further development. These domains include: business opportunity, strategy, organisational capabilities, marketing, consumerism and collaboration.

Green innovation management is an organisation's collective capacity to control internal and external resources and competencies, to prototype new sources of value, and develop them into commercially viable and desirable environmentally considered offerings.

Green innovation is not a single discipline and should be actively managed across the entire organisation. Innovating with environmental consideration is a radical reorientation for all people, firms, industries and the world at large. Green innovation is fast becoming a prerequisite for any competitive business.

## **6.1 Suggestions for Further Research**

The following suggestions are offered based on the above research discerning the managerial perspectives of green innovation:

Suggesting future research in an field considered emergent is of course a difficult task, quite clearly impossible all needs and potential directions. Nevertheless, a few areas that are considered important to be further explored are listed below (outside of the:

- A concerted effort needs to be made to create networks with those individuals and entities working in the field of green innovation. This study has found the tendency for collaboration where it exists, to be vertical and limited. Great gains can be made through the cooperation
- There is a need to investigate innovative 'green' business models, particularly in terms of the appropriation of returns. Although such models are situational specific, the wider business community can gain a lot from contemporary examples and implications.
- There is a growing case for governments to look at supporting the commercialisation of green innovation, perhaps more so than on current intensive research and development assistance initiatives
- Strategies and the potential of public /private sector joint ventures presents as a way to hedge the risk of investing in considered 'high risk' green innovation. More knowledge and understanding of this issue could act to motivate such actions within the business community.

## 7 Bibliography

- Abernathy, J. and Clark, K. (1985) Innovation: Mapping the winds of creative destruction, *Research Policy*, 1, pp. 3-22.
- Albers. J and Brewer. S (2003) Knowledge Management and the Innovation Process: The Eco-Innovation Model, *Journal of Knowledge Management Practice*, 4, pp 1-10.
- Amidon, M. (2002) *The Innovation Superhighway: Harnessing Intellectual Capital of Collaborative Advantage*, Butterworth-Heinemann.
- Berger, S. (2005) *How We Compete*, MIT Industrial, Performance Center, Boston.
- Bernauer. T, Engels. S, Kammerer. D, and Seijas. J (2007) Determinants of Green Innovation - Ten Years after Porter's Win-Win Proposition: How to Study the Effects of Environmental Regulation? *Politische Vierteljahresschrift* 39: 323-341.
- Blattel-Mink, B. (1998) Innovation Towards Sustainable Economy – the Integration of Economy and Ecology in Companies, *Sustainable Development*, 6, pp. 49-58.
- Brezet, H. and Van Hemel, C. (1997) *EcoDesign: a promising approach to sustainable production and consumption*, United Nations Environment Program.
- Cairncross, F. (1992) *Costing the Earth*, Boston, MA, Harvard Business School Press.
- Campos, E. B. and Sanchez, M. P. S. 2003. Knowledge management in the emerging strategic business process: Information, complexity and imagination. *Journal of Knowledge Management* 7: 5.
- Carson, R (1962) *Silent Spring*. Boston: Houghton Mifflin.
- Cary, J. (1998) Institutional innovation in natural resource management in Australia: the triumph of creativity over adversity. In: Abstracts of the Conference 'Knowledge Generation and transfer: Implications for Agriculture in the 21st Century'. University of California-Berkeley, June 18-19, pp. 11-13
- Charter. M and Clark. T (2007) *Sustainable Innovation: Key Conclusions from Sustainable Innovation Conferences 2003-2006 Organised by The Centre for Sustainable Development*, University College for the Creative Arts, May.
- Chen, C. 2001. Design for the environment: A quality-based model for green product development. *Management*
- Christansen, G. and Tietenberge, T. (1985) Distributional and macroeconomic aspects of environmental policy, In Kneese, A. and Sweeney, J. Eds. *Handbook of natural resource and energy economics*, Vol. 1 (pp.345-393), Amsterdam: Elsevier Science Publishers.
- Christensen, C (2002) The rules of Innovation, *Technology Review*, MIT, June, <http://www.technologyreview.com/Infotech/12843/page4/>

Cohen, W. M. and Levinthal, D. A. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*, Vol. 35, No. 1, Special Issue: Technology, Organisations and Innovations, 128-152

Colby, S, Kinsley, T and Whitehead, B. (1995) The Real Green Issue: Debunking the Myths of Environmental Management, *The McKinsey Quarterly*, 1995, Number 2.

Conners, N and Petersen, L (2007) *The 11th Hour*, Warner Bros.

Cooper, R. G. 1997. Fixing the fuzzy front end of the new product process: Building the business case. *CMA* 71: 21.

Cramer, J. (1997) Towards Innovative, more Eco-Efficient Product Design Strategies, *the Journal of Sustainable Product Design*, April, pp. 7-16.

David, P. (1985) Clio and the Economics of QWERTY, *Economic History*, 75, pp. 332-337.

Delmas, M. A. and Terlaak, A.K (2001) A Framework for Analysing Environmental Voluntary Agreements, *Management Review*, 43, 3, pp. 44-66.

Dickson, P. R. 1992. Toward a General Theory of Competitive Rationality. *Journal of Marketing* 56: 69.

Doerr, J (2006) Kleiner Perkins Launches Award to Spur Green Innovation, *San Francisco Business Times*, May,

[http://www.bizjournals.com/sanfrancisco/stories/2006/05/15/daily30.html?f=et78&hbx=e\\_du](http://www.bizjournals.com/sanfrancisco/stories/2006/05/15/daily30.html?f=et78&hbx=e_du)

Dosi, G. (1998) The Nature of the Innovation Process, In: Dosi, G., Freeman, C., Nelson, R., Silverberg, G., Soete, L.: *Technical Change and Economic Theory*, London, pp. 221-238.

Dutton, J. and Duncan, R. (1987) The Creation of Momentum for Change through the Process of Strategic Issue Diagnosis, *Strategic Management Review*, 8, pp. 279-295.

EC (1992) *Towards Sustainability: A European Community Programme of Policy and Action in relation to the Environment and Sustainable Development*, Brussels, Commission of the European Communities.

Eiadat, Y, Kelly, A, Roche, F and Eyadat, H (2008) Green and Competitive? An Empirical Test of the Mediating Role of Environmental Innovation Strategy, *Journal of World Business*, 43, 131-145.

Elmquist, M. (2007) *Enabling Innovation, Exploring the Prerequisites for Innovative Concepts in R&D*, Chalmers University of Technology.

Enkvist, P-A. and Vanthournout, H (2008) How companies think about Climate Change: A McKinsey Global Survey, *The McKinsey Quarterly*, February.

Enkvist. P-A, Naucler. T and Oppenheim. J (2008) Business Strategies for Climate Change, The McKinsey Quarterly, 2008, Number 2.

Enkvist. P-K and Vanthournout (2008) How Companies Think About Climate Change: A McKinsey Global Survey, The McKinsey Quarterly, April, 2008.

Environmental Business Journal (2006) Global Environmental Markets Driven by Emerging Economics, EU Regulations and Globalisation of Major Corporations, Environmental Business journal, 19, 1-6.

EPA (2002) Innovating for Better Environmental Results: A Strategy to Guide the Next Generation of Innovation at EPA, United States Environmental Protection Agency, April, EPA100-R-02-002.

Esty, D. and Winston, A. (2006) Green to Gold: How smart companies use environmental strategy to innovate, create value and build competitive advantage, Yale University Press, New Haven and London.

Faucheux, S. and Nicolai, I. (1998) Environmental Technological change and governance in Sustainable Development Policy, ecological Economics, 27, pp. 243-246.

Flint, D. (2002) Compressing New Product Success-to-Success cycle time – deep customer value understanding and idea generation, Industrial Marketing Management, 31, pp. 305-315.

Fortune.com (2006) It's Good to be Green: Increasingly Companies are recognizing the Benefits of Eco-Efficiency, October, 2006,  
<http://www.timeinc.net/fortune/services/sections/customprojects/environment.html>.

Foster, C. and Green, K. (2000) Greening the innovation process, Business Strategy and the Environment, September –October, pp. 287-303

Freeman, C. (1992) The Economics of Hope. Pinter Publishers, London and New York.

Freeman, C. (1994), 'The Economics of Technical Change', Cambridge Journal of Economics 18: 463-514.

Frei. M (1998) Eco-Effective Product Design: The Contribution of Environmental Management in designing Sustainable Products, The Journal of Sustainable Product Design, October, pp 16-25.

FrondeL, M., Horbach, J. and Rennings, K. (2004), 'End-of-Pipe or Cleaner Production? An Empirical Comparison of Environmental Innovation Decisions Across OECD Countries', in ZEW Discussion Paper No. 04-82, Mannheim: Center for European Economic Research (ZEW).

- Fronzel, M., Horbach, J. and Rennings, K (2008) What Triggers Environmental Management and Innovation? Empirical Evidence for Germany, *Ecological Economics*, 66, pp 153-160.
- Gore, A. (2008) Al Gore: New Thinking on the Climate Crisis, TED, [http://www.ted.com/index.php/talks/al\\_gore\\_s\\_new\\_thinking\\_on\\_the\\_climate\\_crisis.html](http://www.ted.com/index.php/talks/al_gore_s_new_thinking_on_the_climate_crisis.html)
- Gottlieb, R., Smith, M. and Roque, J. (1995) Greening or Greenwashing?: the evolution of industry decision making, in Gottlieb, R. (Ed.), *Reducing Toxics*, Island Press, Washington, DC.
- Grant, R.M. (2005) *Contemporary Strategy Analysis*, Fifth edition, Blackwell Publishing, UK/US/Australia
- Green, K., McMeekin, A. and Irwin, A. (1994) Technological Trajectories and R<sup>D</sup> for Environmental Innovation in UK Firms, *Futures*, 26, pp.1047-1059.
- Grubb, M. (2006) Technology Innovation and Climate Change Policy: An Overview of issues and Options, *Keio Journal of Economics*.
- Hamel, G. (2005) The why, what and how of management innovation, *Harvard Business Review*, 84(2), pp. 72-84.
- Hargadon, A. (2003) *How Breakthroughs Happen, The Surprising Truth About How Companies Innovate*, Harvard Business School Press
- Hart, S. (1995), 'A Natural-Resource-Based View of the Firm', *Academy of Management Review* 20(4): 986-1014.
- Hart, S. and Milstein, M. (1999) Global Sustainability and the Creative Destruction of Industries, *Sloan Management Review*, Fall, 41, 1, pp. 23-33.
- Heaton, G. R. and Banks, D. R (1997) Toward a New Generation of Environmental Technology, *The Need for Legislative Reform, Policy Prescriptions, Technology policy*, 1, 2, pp. 23-32.
- Hellstrom, T (2006) Dimensions of Environmentally Sustainable innovation: The Structure of Eco-Innovation Concepts, *Sustainable Development*, 15, pp 148-159.
- Henriques, I and Sadorsky, P. (1999) The Relationship between Environmental Commitment and Managerial Perceptions of Stakeholder Importance, *The Academy of Management Journal*, Vol. 42, No. 1, (Feb., 1999), pp. 87-99
- Huesemann, M. (2003) The Limits of Technological Solutions to Sustainable Development, *Clean Technology and Environmental Policy*, 5, pp. 21-34.
- IEA (2004) *Renewable Energy: Market and Policy Trends in IEA Countries*, Paris, OECD/IEA.

IGTBG (2006) Its Good to be Green, Increasingly Companies are Recognising the Benefits of Eco-Efficiency, October, [http://www.timeinc.net/fortune/services/sections/customprojects/sections/061002\\_GreenBusiness.pdf](http://www.timeinc.net/fortune/services/sections/customprojects/sections/061002_GreenBusiness.pdf)

Jackson, T. (1996) Material Concerns Pollution, profit and quality of life, London/NewYork.

James, P. (1997) The Sustainability Cycle: a new tool for product development and design, *Journal of Sustainable Product Design*, 2, 52-57

Johansson-Stenman, O. and Martinsson, P. 2006. Honestly, why are you driving a BMW? *Journal of Economic Behaviour & Organization* 60: 129.

Johansson. G and Magnusson. T (1998) Eco-Innovations – A Novel Phenomenon? *The Journal of Sustainable Product Design*, October, pp 7-15.

Johnson, K (2008) Greenwashing or Green Business? *The Wall Street Journal*, 30th January, <http://blogs.wsj.com/environmentalcapital/2008/01/30/greenwashing-or-green-business/>.

Keeble. J, Clarke. R, Lyon. D and Keeble C. (2007) *Managing Integrity and Innovation for Sustainable Performance*, Arthur D. Little, Prism, 2, 2007.

Keeble. J, Lyon. D, Vassallo. D, Hedstrom. G and Sanchez. H (2005) *Innovation High Ground: How Leading Companies are Using Sustainability-Driven Innovation to Win Tomorrow's Customers*, Arthur D. Little.

Keldman, T. and Olesen, J. (1994) Design for Environment-A Framework, *Journal of Engineering Design*, 5,1, pp. 45-54.

Kelly. K (2008) *Going Green: The Challenges & Solutions*, *Automotive Design & Production*, January, 120, 1, pp 26-31.

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

Kemp, R. (1997), *Environmental Policy and Technical Change - A Comparison of the Technological Impact of Policy Instruments*, Cheltenham, UK; Brookfield, US: Edward Elgar.

Kemp, R. (1998), 'Environmental Regulation and Innovation - Key Issues and Questions for Research', in Leone, F. and Hemmelskamp, J., eds., *The Impact of EU Regulation on Innovation of European Industry*, Technical Report Series EUR 18111 EN, Sevilla: Institute for Prospective Technological Studies.

King, A. and Lenox, M. (2001) Lean and Green? An empirical examination of the relationship between lean production and environmental performance, *Production and Operations Management*, Fall, 10, 3, pp. 244-257.

Klemmer, P., Lehr, U. and Lobbe, K. (1999) Environmental Innovation. Volume 3 of publications from a Joint Project on Innovation Impacts of Environmental Policy Instruments. Synthesis Report of a project commissioned by the German Ministry of Research and Technology (BMBF), Analytica-Verlag, Berlin.

KnowledgeRich (2008) Innovation Matters: Issue10 – How Green is Your Innovation, January, <http://www.knowledgerich.com/InnovationReport.aspx?reportid=1668>.

Kumar, N., Scheer, L., and Kotler, P. 2000. From market driven to market driving. *European Management Journal* 18: 129.

Lampe, M., Ellis, S., and Drummond, G. (1991) What Companies are doing to meet environmental protection responsibility: Balancing legal, ethical and profit concerns, In proceedings of the international association for business society, pp. 527-537.

Le Masson, P., Hatchuel, A., and Weil, B. (2006) *Les Processus D'innovation. Conception Innovante et Croissance des Entreprises*, Herms, Paris, France.

Leonard-Barton, D. (1992): Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development, *Strategic Management Journal*, Vol. 13, pp. 111-125 Review, July-August, pp 100-109

Lundvall, B-A. and Johnson, B. (1994) The Learning Economy, *Journal of Industry Sciences*, 1, pp. 23-42.

Luttrupp, C and Lagerstedt, J (2005) Eco-Design and The Ten Golden Rules: Generic Advice for Merging Environmental Aspects into Product Development, *Journal of Cleaner Production*, 14, pp 1396-1408.

Magnusson, T. (2003) *Managerial Challenges in Environmental Innovation*, Thesis, Linköping University, Linköping, Sweden.

Makower, J (2008) *State of Green Business 2008*, Greener World Media, Inc., [www.greenbiz.com](http://www.greenbiz.com).

Manzini, E (1999) Strategic Design for Sustainability: Towards a New Mix of Products and Services, First International Symposium on Environmentally Conscious Design and Inverse Manufacturing, pp. 434-437.

Marhusson, N (2001) *Drivers of Environmental Innovation*, VINNOVA, ISBN 91-89588-01-0.

Medonca, L. and Oppenheim, J. (2007) Investing in Sustainability: An Interview with Al Gore and David Blood, *The McKinsey Quarterly*, May.

Minsch, J. (1997) Nachhaltigkeit und institutionelle Innovationen. In: Rennings, K., Hohmeyer, O. (Eds.), *Nachhaltigkeit*. NomosVerlag, Baden-Baden, pp. 297–329.

- Mirata, M and Emtairah, T (2005) Industrial Symbiosis Networks and the Contribution to Environmental Innovation: The Case of the Lanskrone Industrial Symbiosis Programme, *Journal of Cleaner Production*, 13, pp 993-1002.
- Murphy, J. and Gouldson, A. (2000) Environmental policy and industrial innovation: integrating environment and economy through ecological modernization, *Geoforum* [Geoforum]. Vol. 31, no. 1, pp. 33-44.
- Next 10 (2008) California Green Innovation Index, 2008 Inaugural Issue.
- Nieto, M. and Quevedo, P. (2005) Absorptive Capacity, technological opportunity, knowledge spillovers and innovative effort, *technovation*, 25, pp. 1141-1157.
- Noci, G and Verganti, R (1999) Managing 'Green' Product Innovation in Small Firms, *R&D Management*, 29, 1, pp 3-15.
- Nonaka, I. 1994. A dynamic theory of organizational knowledge creation, *Organization Science* 5: 14.
- Norgaard, R. (1994) *Development Betrayed*. Routledge, London and New York.
- O'Reilly III, C.A. and Tushman, M.L. (2004) The Ambidextrous Organisation, *Harvard Business Review*, 82, 74-83
- OECD (1997a), *Reforming Environmental Regulation in OECD Countries*, Paris: Organisation for Economic Co-operation and Development (OECD).
- OECD (1997b), *The Oslo Manual - Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, Paris: Organisation for Economic Co-operation and Development (OECD).
- OECD (2008) *Environmental Innovation and Global Markets*, Paris: Organisation for Economic Co-operation and Development (OECD).
- OECD (2008) *Environmental Innovation and Global Markets, Working Party on Global and Structural Policies*, JT03241008.
- Palmer, K., Oates, W., and Portney, P. (1995) Tightening environmental standards: The benefit-cost or the no-cost paradigm? *Journal of Economic Perspectives*, 9(4): 119-132.
- Pavitt, K. (1984), 'Sectoral Patterns of Technical Change - Towards a Taxonomy and a Theory', *Research Policy* 13(6): 343-373.
- Peattie, K. (2001), 'Golden Goose or Wild Goose? The Hunt for the Green Consumer', *Business Strategy and the Environment* 10(4): 187-199.
- Philips (2007) *Becoming Simpler and Greener, The Philips Way* Philips Sustainability report.

Porter, M (1979) How Competitive Forces Shape Strategy, Harvard Business Review.

Porter, M and van der Linde, C. (1995a), 'Green and Competitive - Ending the Stalemate', Harvard business review 73: 120-134.

Porter, M and van der Linde, C (1995b), 'Toward a New Conception of the Environment- Competitiveness Relationship', Journal of Economic Perspectives 9(4): 97-118.

Porter, M. and Kramer, M. (2006) Strategy and Society: the link between competitive advantage and corporate social responsibility, Harvard Business Press.

Rehfeld. K-M, Rennings. K and Ziegler. A (2007), 'Integrated Product Policy and Environmental Product Innovations - An Empirical Analysis', Ecological Economics:

Reinhardt, F. (1998) Environmental Product Differentiation: Implications for Corporate Strategy, California Management Review, Summer, 40, 4, pp. 43-74.

Remenyi, D., Williams, B., Money, A and Swartz, E. (2005) Doing research in business and management: An introduction to process and method, SAGE Publications Ltd, London

Rennings, K. and Wiggering, H. (1997) Steps towards indicators of sustainable development — linking economic and ecological concepts. Ecological Economics 20, pp. 25–36

Rennings. K (1998) Towards a Theory and Policy of Eco-Innovation - Neoclassical and (Co-)Evolutionary Perspectives, in ZEW Discussion Paper 98-24, Mannheim: Center for Economic Research (ZEW).

Rennings. K (2000) Redefining Innovation – Eco-Innovation Research and the Contribution from Ecological Economics, Ecological Economics, 32, 319-332.

Rex, E. (2008) Marketing for Life Cycle Thinking, Environmental Systems Analysis, Chalmers University of Technology, Sweden.

Rothwell, R. (1992) Successful Industrial Innovation: Critical Factors for the 1990s, R<sup>^</sup>D Management, 22(3), pp. 221-239.

Rumizen, M. (2002) The Complete Idiot's Guide to Knowledge Management, OLW Publishing.

Sanden. B and Azar, C (2005) Near-Term Technology Policies for Long Term Climate Targets –Economy Wide Versus Technology Specific Approaches, Energy Policy, 33, pp 1557-1576.

Schumpeter, J.A (1942) Capitalism, Socialism and Democracy, Harper & Brothers.

Sharma, S. and Vredenburg, H. (1998), 'Proactive Corporate Environmental Strategy and the Development of Competitively Valuable Organizational Capabilities', *Strategic Management Journal* 19(8): 729-753.

Simon, M., Poole, S., Sweatman, A., Evans, S., Bhamra, T., and Mcalooone, T. 2000. Environmental priorities in strategic product development, *Business Strategy and the Environment* 9: 367.

Sjöberg, M. 2005. "The Hybrid Race." Chalmers University of Technology, Department of Technology Management and Economics, Division of Project Management, Göteborg.

Steger, U. and Meima, R. (1998) *The Strategic Dimensions of Environmental Management*, Macmillan, Houndmills.

TerraChoice (2007) *The Six Sins of Greenwashing: A study of Environmental Claims in North American Consumer Markets*, November, TerraChoice.

Tidd, J., Bessant, J. and Pavitt, K. (2001) *Managing Innovation, Integrating Technological, Market and Organisational Change*, Second Edition.

Tversky, A. and Kahneman, D. 1986. Rational Choice and the Framing of Decisions. *Journal of Business* 59: S251-S278.

Von Krogh, G., Ichijo, K. And Nonaka, I. (2000) *Enabling Knowledge Creation: How to Unlock the Mystery of Tacit Knowledge and release the power of Innovation*, New York: Oxford University Press.

Waage, S (2007) Re-considering Product Design: A Practical "Road Map" for Integration of Sustainability Issues, *Journal of Cleaner Production*, 15, 638-649.

Welford, R. (1995) *Environmental Strategy and Sustainable development: The Corporate Challenge for the 21st Century*, Rout Ledge, London.

White, P, Mora, R, Meurer, B and Richarson, J (2004) *EcoDesign Information Needs: 2004 IDSA Survey Results*, Information Gap Workgroup, IDSA/EPA Partnership, San Francisco, USA, October, 2004.

White, P., Belletire, S. and St. Pierre, L. (2004) *Okala, Learning Ecological Design*, Industrial Designers Association of America.

White. C, Stewart. E, Howes. T. and Adams, B. (2008) *Aligned for Sustainable Design: An A-B-C-D Approach to Making Better Products*, Business for Social Responsibility and IDEO, May.

Williams, A. (2008) That Buzz in your Ear may be Green Noise, *The New York Times*, June 15.

Williander, M (2006) On Green Innovation Inertia: An insider research perspective on the automotive industry, Department of Project Management, Fenix Research Program, Chalmers University of Technology.

Zahra, S.A. and George, G. (2002) Absorptive Capacity: A review, Reconceptualization and Extension, *Academy of Management Review*, 27, 2, 185-203.

## **8 Appendix**

### **8.1 Environmental Strategies, Methodologies and Tools**

#### **8.1.1 A list of Environmental Design Strategies**

Below is a list of existing popular environmental design strategies, methodologies and tools:

- Closed-loop or Closed-cycle Design
- Design for X (DfX)
- Eco-Compass
- Ecological Footprint
- Extended Produces Responsibility (EPR)
- Factor X/Factor 10/Factor 4
- Fair Trade
- Life-cycle Analysis (LCA)
- Life-cycle Design
- Life-cycle Management (LCM)
- Product Stewardship
- Sustainable Manufacturing
- Sustainable Manufacturing Standards
- Zero Emissions
- Zero Waste

#### **8.1.2 A List of Environmental Management Strategies**

Below is a list of existing popular environmental management strategies, methodologies and tools:

- Environmental audits
- Total quality management
- Pollution prevention plans
- Environmental training for employees
- Total cost accounting
- Life-cycle analysis
- Hiring a designated environmental manager
- Research and Development
- Environmental standards (ISO 14000)
- Employee incentive programs for environmental suggestions