Enterprise Strategies for Sustainable Innovation –

Linking economic, organizational and institutional perspectives

An EIS radar paper

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1. Introduction

Over the last two decades we have witnessed a massive accumulation of scientific knowledge converging towards a consensus on prospective climate impacts from our fossil-based industrial economies. Already in 2004 Naomi Oreskes pointed to overwhelming consensus among natural climate scientists on the reality of anthropogenic climate change: *"The scientific consensus is clearly expressed in the reports on the Inter-governmental Panel on Climate Change (IPCC)."* And she added: *"IPCC is not alone in its conclusions. In recent years, all major scientific bodies in the United States whose members' expertise bears directly on the matter have issued similar statements"* (p. 1686). Of 928 papers, published in refereed scientific journals between 1993 and 2003 listed with the keywords "climate change", 75% fell into the category of endorsement of the consensus position, 25% dealt with methods or paleoclimate, taking no positions, and none of the papers disagreed with the consensus position. Nearly a decade later John Cook et al. (2013) analyzed the evolution of the scientific consensus on anthropogenic global warming (AGW) in the peer-reviewed scientific literature (natural sciences). Examining 11.944 climate abstracts from 1991 to 2011 matching the topic "global climate change" or "global warming", they found that 66,4% of abstracts expressed no position, 32,6% endorsed AGW, 0,7% rejected AGW and 0,3% were uncertain about the causes of global warming. Among abstracts expressing a position on AGW, 97,1% endorsed the consensus position that humans are causing global warming. Over time the analysis shows that the number of papers rejecting the consensus position is a vanishingly small proportion of the published work.

When we turn towards the social sciences for answers to the question, *what* to do about it – how can we create a climate-progressive economic and social development and eventually a transition to a sustainable society, many answers appear, but no consensus resides beyond the very general insight that a transition to a low carbon economy needs some kind of concerted efforts from governments/public authorities, science and technology, corporate business, consumers and civil society. Even if the different answers at first glance seem incompatible (e.g. "let the market forces sort it out" versus "national governments must lead the way", or "only collaboration on a global scale can provide a solution"), lack of consensus concerning the more specific "solutions" may also be rooted in the specialized and segmented nature of different research perspectives, paradigms and disciplines dealing with the matter. In other words, the one hand (perspective) does not know or knows little of what the other hand (perspective) is doing, hence nobody is in a position to more rigorously judge whether the perspectives are at rivalry, overlapping or complementary. In the latter case, consensus over "solutions" across social science perspectives could be achieved from aligning insights from different perspectives.

This paper proposes that explicating and confronting the (state-of-the-art) insights from different and hitherto more or less isolated social science perspectives on the transition to a low carbon economy is a prerequisite for possible learning "from the other sides" and for identifying complementarities required for developing "higher-level", integrative understandings underlying

strategies for sustainable transition.[1] The paper intends to provide an overview of, compare key insights from and point to synergistic complementarities across three broad analytical perspectives and literatures dealing with private enterprise strategies for sustainable innovation and other transition practices: 1) The economic or management studies perspective on whether or when it pays to be green. This perspective can roughly be divided into two sub-perspectives, one examining the impacts from environmental policy regulation on innovation and financial performance (henceforth termed "the regulation/economics perspective"), and the other examining the financial performance impacts more generally from "going green" (henceforth termed "the pays to be green perspective"). 2) The strategic management and innovation studies perspective on why and how companies may (or may not) engage in different ways of integrating sustainability concerns into business practices, products and services (henceforth termed the strategy/innovation perspective). Within this broad perspective we shall consider three sub-perspectives: The business economic strategy view, the institutional strategy view and the innovation (strategy) view.[2] 3) The systems and institutional view on innovation which approaches environmental innovation from a meso-level or sectoral transformation perspective according to which successful innovations result from the interplay between activities of a diversity of actors operating under different institutional conditions and not primarily by individual companies or governmental regulation.

"*During the last 20 years, a research agenda has emerged that is often termed business and the environment (B&E). Special issues in several leading management journals have advanced this agenda and it now represents a growing part of the management literature. Yet, the boundaries of this research agenda, and even the definitions of its central term, remain unclear*." (Berchicci and King, 2007, p. 513). Since Berchicci and King wrote these words the research literature has been further burgeoning while remaining highly segmented into different and weakly connected streams. We shall refrain from providing a systematic and comprehensive literature review and overview of each of the streams which would be a daunting task, and reviews have already been done in most of the respective fields. Instead we focus on finding the most relevant articles in each field (including the reviews) with the special purpose of identifying the links, commonalities and differences, and in particular complementarities across the streams. In the first stage we did a systematic search in the key A-journals within the broad field of management: Academy of Management Journal, Administrative Science Quarterly, Strategic Management Journal and Management Science. As we realized that major research streams – especially those dealing with innovation – were not well covered by these journals, we expanded our search scope to include innovation oriented journals (including Research Policy and Industry and Innovation) and follow central citation links into

[1] Of course, this procedure is also needed for better understanding possible rivaling, non-compatible and contradictory positions.

[2] We shall not engage in a separate discussion of the particular tendencies among companies to engage in servicizing (rather than exclusively material product sales) and the development of Product-Service Systems or business models associated with the so-called shared economy or collaborative consumption even if these strategies may have important sustainability impacts. The reason for this delimitation is that the academic research on these tendencies and their sustainability dimensions is still immature.

articles in other journals, including journals specialized within aspects of sustainability (e.g. Ecological Economics and Journal of Cleaner Production) as well as chapters in books.

We shall only shortly touch upon the macro- and regulation-oriented economic perspective on environmental issues and climate change which – especially in the wake of the Stern Review (2007) – has become *the* academic perspective that has gained the largest influence on governmental policy in parts of the world and reflected in international analyses on climate change, e.g. in the context of UN, EU and OECD. Since our focus is on enterprise-based transition on which the macro/regulation perspective has little to contribute, this paper more specifically addresses parts of the economics, management, strategy and innovation studies that provide insights on enterprises' opportunities and incentives for sustainable development.

Each of the literature streams that we analyze and compare has been mounting over the last two decades and has accumulated insights within their own trajectories with little cross-fertilization across them. Various literature reviews have provided some overview of each or parts of these streams. However, as of yet we have not seen a comparative overview across the streams. We do not intend to review all or most of the contributions in each of the fields. Instead we use existing reviews as well as key contributions in each field to better understand the (potential) points of complementarities. In doing this our preconception has been an acknowledgement that the perspectives dealt with here offer important complementary insights – and that none of the perspectives can (or should) stand alone in accumulating knowledge on and in informing governments, companies and other stakeholders in sustainable transition. We have explicitly refrained from a "rivalry" framing in order to argue for the superiority of one set of glasses – the "economics glasses", the "strategic management glasses" or the "institutional glasses".

While these literatures from a helicopter view may look neatly complementary (and potentially synergistic), a closer look reveals much overlap and difficulties of drawing clear boundaries or, positively framed, "meeting points" for complementarities. Thus, parts of the firm-level (economic/management and strategy/innovation) literature shares an institutional perspective that is central to the systems and institutional literature on sectoral transformation. Moreover, the regulatory/economics literature shares a central focus on the role of political regulation with much of the systems and institutional systems literature.

The paper is organized as follows:

Section 2 deals with the economics and management perspective on the interplay between firm-based sustainable development and financial performance. After a short introduction to the overall macro-economic perspective on climate change, we address the more firm-focused economics/regulation perspective as reflected in the empirical research on Michael Porter's original propositions on the impact from environmental regulation on firms' innovation and eventually on their financial performance (section 2.1). Hereafter (section 2.2), we analyze the so-called "pay-to-be-green" research which focus on the relationship between firms' sustainability measures (whether they may be termed innovations or just operational improvements), irrespective of the regulation

context, and financial performance. Section 2.3 summarizes the insights from these two research streams.

Section 3 seeks to identify key insights from the strategic management and innovation research on firm-based sustainable development. Under this heading three distinctive analytical views are scrutinized: The business economics strategy view (section 3.1), the innovation view (section 3.2) and the institutional view (section 3.3).

In section 4 we seek to identify key insights from the research tradition(s) associated with the systems view on sustainable innovation and sectoral transformation and we especially address the theme of industry dynamics and sustainability transition relating to clean-tech fields (section 4.1) and the implications for firm strategies in a systemic transition context (section 4.2).

Section 5 concludes the paper by trying to link the reviewed perspectives and identify complements that may lead to a more unified framework for understanding enterprise strategies for sustainable transition.

2. When and how does it pay to be green? The evolving economics and management perspective on sustainable development and financial performance

The traditional view of environmental regulation held by virtually all economists up until the mid-1990s was that requiring firms to reduce their negative environmental impact (externalities) would restrict their choice sets, enhance costs and reduce profits, hence – and, with the words of Friedman (1970), "*the social responsibility of business is to increase its profits*". According to this view 1) firms gain nothing by providing public goods like clean water, clean air and zero greenhouse-gas emissions from their operations, 2) market forces should drive firms to make profit-maximizing choices to the benefit of their shareholders, and 3) if significant negative externalities emerge, it is the responsibility of governments, not business firms, to take action and regulate (Berchicci and King, 2007; Friedman, 1970; Navarro, 1988).

The Stern Review (Stern, 2007, 2008) represented a comprehensive landmark by analyzing the economics of climate challenges as reflecting fundamental market failures in need of corrective governmental policy measures with the objective to internalize environmental and climate externalities/costs and create incentives to invest in sustainable technologies and practices. "*Climate change is global in its origins and its impacts and effective response must therefore be organized globally and must involve international understanding and collaboration*" (Stern, 2008, p. 26). In other words, a Global Deal is called for. Policy measures would include a carbon tax and a "cap and trade" system focused on establishing incentives for business to change practices, combined with public investments in or subsidies for "climate-progressive" research and development. The key contributions of the Stern Review are that 1) it explicitly and seriously took its point of departure in the climate sciences' (already by then) converging evidence of upcoming severe climate disturbances caused by our fossil-based industrial economies, 2) that it translated this evidence into economic terms of externalities/market failures, 3) and that it developed a set of economic policy measures by applying "*the whole range of the tools of our* [economics] *trade*" (Stern, 2008, p. 24).

This more activist version of mainstream economic analysis has since then made a significant imprint on overall policy thinking on climate change. However, in practice, an effective Global Deal on economic regulation has faced massive barriers. The individual nation state remains the key political unit of decision-making on these matters and most nations, including the largest greenhouse-gas emitters, have strong vested interests in protecting non-sustainable economic and technological infrastructures and their incumbent firms in key sectors of their economies (energy, transportation, agrobusiness, mining, manufacturing, etc). Moreover, political priorities in favor of shorter-term general economic and employment growth have tended to be further strengthened by national governments during the recent financial and employment crisis, while longer-term and costly transition objectives have tended to gain more peripheral political status. These barriers to a Global Deal can be explained by conceiving climate change as a "*commons*" problem in which the nature, magnitude and location of damages are independent of the location of emissions and therefore give rise to free-rider problems (Stavins, 2011) and a wide-spread sense of first-mover disadvantages that resonates well with the conventional economics (at least pre-Stern) trade-off position. This means that "[…] *the full social costs of greenhouse-gas emissions are not reflected in current prices for fossil fuels, meaning that these fuels are consumed in greater quantities than is desirable. The 'mispricing' of fossil fuels also suppresses the demand for technological substitutes for fossil fuel technologies […]. Any policy to address global warming must address this failure of prices to accurately reflect social costs, for example through a tax on carbon or a 'cap and trade' system of emissions targeted*" (Mowery et al. 2010, p. 1013).

While the Global Deal to effectively reduce global greenhouse-gas emissions to sustainable levels is long in coming (if it ever will), more confined – and modest in scope – environmental regulation and public technology programs have been thriving in national and regional contexts especially – but not only – among the richest nations of the world. And what is more, there is increasing evidence that increasing parts of the corporate world are engaging in improving their sustainability footprints beyond what is required by public authorities. This is reflected in much of the economics and management literature on the business-environment relationship that will be analyzed in the subsequent parts of section 2. One part of this literature focuses on the impacts from (predominantly national) environmental regulation on business innovation and financial performance, hence termed the economics/regulation perspective (section 2.1), while another part of the literature is investigating the financial performance of "green" or "green-going" companies – irrespective of political regulations or subsidies (section 2.2).

2.1. The economics/regulation perspective and the Porter Hypothesis

In the early 1990s Michael Porter set a new agenda for the economics/regulation research by challenging the mainstream economics trade-off view on the relationship between environmental regulation and business performance (Porter, 1991; Porter and van der Linde, 1995). Porter (and van der Linde) launched the following, by then, provocative assumptions: 1) Pollution/emissions can be considered waste of resources rather than social costs, hence reduction of such resource waste may lead to enhanced productivity and competitiveness rather than enhanced cost. 2) Many of these opportunities are often not subject to management attention, hence are not necessarily

pursued as they should according to classical assumptions of rational, profit-maximizing behavior. 3) While environmental regulation is normally considered necessary to enforce cost-enhancing compliance in a context of negative externalities, well-designed environmental regulations[3] can also trigger management attention to identify and pursue these opportunities through innovation that eventually may offset the costs of complying.

In other words, Porter and van der Linde, while acknowledging the standard market failure argument for regulation, make a strong argument for a "bounded rationality" or "organizational failure" position rather than a standard economic position of maximizing rationality. In relation to environmental investments, organizational or behavioral failure may occur due to lack of knowledge or bounded rationality more broadly (e.g. sharing stereotyped negative attitudes on such investments), or due to risk-aversion or present-biased preferences that make managers avoid or postpone costly but profitable investment opportunities (Ambec et al., 2013).

The so-called Porter Hypothesis gave rise to a large, predominantly economic, literature investigating its theoretical bases - assuming "market failure" or "organizational failure" - and its empirical validity. Jaffe and Palmer (1997) differentiate the Porter Hypothesis into three versions: The "weak version" asserts that environmental regulation leads to innovation. The "narrow version" asserts that flexible but stringent regulation instruments provide firms with greater incentives to innovate than prescriptive innovations. Finally, the "strong version" posits that innovation induced by flexible and stringent regulation may lead to competitive advantages that more than offset the cost of complying (for reviews of the literature on the Porter Hypothesis, see Ambec et al, 2013; Berchicci and King, 2007; Lanoie et al., 2011; OECD, 2010; Rexhäuser and Rammer, 2014; van Leeuwen and Mohnen, 2013).

The "weak version" of the hypothesis, that regulation stimulates innovation, is close to being self-evident, and the different studies that seek to estimate this relationship generally confirm the proposition (Brunnermeier and Cohen, 2003; Jaffe and Palmer, 1997; Johnstone et al., 2010, Lanoie et al., 2011; Popp, 2006). The "narrow" version of the Porter Hypothesis, proposing that flexible (market-based) and stringent regulation measures are more likely than traditional "command-and-control" measures to induce environmental innovation was for long not subject to rigorous testing, probably due to the fact that flexible regulation measures were not widely applied. To our knowledge the comprehensive survey by Lanoie et al. (2011) based on data from 2003, provides the first attempt to test this version of the Porter Hypothesis. The survey includes data on the level of stringency and several indicators of flexible regulatory measures. They find that policy stringency (as perceived by the surveyed firms) has a positive and significant impact on the probability of firms having a specific R&D budget (indicating innovation) devoted to environmental issues, while a perception of low stringency had a negative impact. They also find that performance standards (indicating flexible measures) have a positive impact on environmental innovation, while

[3] Well-designed regulation refers to flexible or market-based instruments, e.g. pollution charges, environmental performance standards, that in contrast to "command-and-control" regulation, e.g. technology-specific prescriptions, allow and stimulate firms to engage in broader search and autonomous innovation processes which may lead to solutions that align compliance with prospects for competitive advantage.

"inflexible" technology-specific standards had not. However, other flexible policy instruments, such as pollution taxes, had no impact on environmental innovation. They argue that these flexible instruments were not yet widespread at the time of the survey, and that, when applied, tended *not* to be stringent (Lanoie et al., 2011).

As would be expected, the results on the "strong" version of the Porter Hypothesis are inconclusive which in part may be due to the very complex methodological challenges of testing. But substantially, there does not seem to be a general (cross-sectoral) tendency for neither a negative nor a positive relationship. Lanoie et al. (2011), whose survey was the first study to test all the variants of the Porter Hypothesis using data on all elements of the causality chain (environmental regulation types, innovation, environmental and commercial performance), find that regulation motivates firms to re-allocate R&D towards environmental improvements and that environmental R&D in turn significantly increase firms' perceived business performance. However, this effect does not completely offset regulatory costs. Likewise Van Leeuwen and Mohnen (2013) do not find significant evidence for the "strong" version of the porter Hypothesis. However, they show that environmental innovation complements conventional product and process innovation and has no adverse effects on other productive investment. In another recent paper Rexhäuser and Rammer (2014) provide evidence for a contingency perspective that may better explain the mixed evidence on the strong version of the Porter hypothesis. Drawing from a cross section of German firms in various sectors, their study shows that environmental innovation that improves a firm's resource efficiency in terms of material or energy consumption per unit of output, but not necessarily its overall productivity, tends to give rise to positive profitability effects. These effects are significant regardless of whether it is a response to regulation or not, although the effect is greater for regulation-driven innovation. Environmental innovation which does not improve resource efficiency, tend to have a negative impact on firms' profitability. While this impact is not statistically significant for regulation-driven innovation, it is for non-regulation driven innovation.

These results are not colliding with the Porter hypothesis. Porter and van der Linde (1995) did not claim that a positive relationship (in the "strong" version) would generally apply, only that it sometimes would apply – especially when flexible, market-oriented regulations stimulate and trigger innovation that would realize opportunities for waste reductions and improved energy efficiency and benefit longer-term competitiveness as well as the natural environment. What Lanoie et al (2011) offer is a contingency perspective in terms of types of regulation that resonates rather well with the "narrow" version of the Porter Hypothesis. What Rexhäuser and Rammer (2014) offer is a rough specification of the contingencies for the hypothesis's strong version to apply in terms of innovation types that improves energy and material use efficiency, but not environmental innovation that does not.

The literature on the Porter Hypothesis tends to assume that individual firms respond to one set of regulations associated with one nation, mostly the firm's host country, or a group of nations. However, in most areas of environmental regulation, different regulation styles and standards reside in different countries, hence the strategy choice for internationally oriented firms with environmental compliance needs is whether it pays to adopt to the most or least stringent and

demanding requirements. Dowell et al. (2000) examine whether U.S.-based Multi-National Enterprises (MNEs) that adopt a single stringent environmental standard enhance firm market value (Tobin's q) as compared to those MNEs defaulting to less stringent or poorly enforced host country standards. They find that the former group have much higher market values and discuss three possible explanations: 1) Private valuations may tend to internalize negative environmental externalities (the less externalities, the higher the firm value). 2) Adopting stringent environmental standards is more profitable than defaulting to lower local standards. 3) Poorly managed and less competitive firms tend to adopt lower environmental standards.

2.2.The "pays-to-be-green" perspective

The "pays to be green" literature as here conceived deals with the financial performance of going or being "green" – irrespective of the regulatory context. Many studies have indicated a negative relationship while many others – in fact most – have indicated a positive relationship. An early review of the literature on the financial performance impacts from firms' corporate social responsibility engagement (Margolis and Walsh, 2003), which beyond environmental issues includes (sometimes much more prominently) broader social and ethical issues, sums up the conflicting findings as follows: "*A simple compilation of the findings suggest there is a positive association and certainly very little evidence of a negative association between a company's social performance and its financial performance*" (Margolis and Walsh, 2003, p. 277). However, they also conclude that due to limitations of the underlying empirical studies, the relationship remains contested. Based on a meta-analysis, Orlitzky et al. (2003) arrived at a similar conclusion. In a more recent review of both the academic and practitioners literature, Peloza (2009) likewise finds support for an overall positive relationship: "*Results from the academic literature* [128 articles, JFC] *show a less positive relationship than the practitioner reports [31 articles, JFC]. In the academic literature 59% of studies report a positive relationship between CSP* [Corporate Social Performance] *and financial performance, 27% report a mixed relationship, and 14% report a negative relationship (this latter includes the non-empirical studies that argue in favor of a negative relationship). In contrast, 77% of all the practitioner reports included in this review show a positive relationship between CSP and financial performance, 10% report a mixed or neutral relationship, and 13% report a negative relationship"* (Peloza, 2009, p. 4). Peloza furthermore categorized CSP into environmental and social issues: "*Interestingly, 65% of the environmental metrics of CSP show a positive relationship with corporate financial performance, whereas only 55% of the social metrics show a similarly positive relationship. This finding is not statistically significant, but it may suggest that environmental issues are more likely to be associated with positive financial returns*" (Peloza, 2009, p. 5).

A growing body of academic, empirical literature points towards an overall (if not full) consensus that investments in sustainability (the environmental challenges in corporate social performance) tends to pay off financially even if only at the mid- or longer term. Klassen and McLaughlin (1996) found significant positive returns for strong environmental management as indicated by environmental performance awards by an independent third party, and significant negative returns were measured for weak environmental management as indicated by environmental crises.

Sharfman and Fernando (2008) found that companies with a high-level environmental investment profile tend to have lower average capital costs, and Ambec and Lanoie (2008) reach a similar conclusion based on a review of previous studies using different methodologies to measure the relationship between environmental performance and cost of capital. A study by Bloom et al. (2010) shows that well-managed companies (according to a number of indicators) use energy more effectively, are more profitable and demonstrate reduced CO_2 emissions. While none of these studies has investigated how high sustainability performance over longer periods of time impact financial performance, a recent study by Eccles et al. (2014) take a long-term approach. They identify 90 U.S. companies that they term *high sustainability companies* with a substantial number of environmental and social policies adopted from the early 1990s and on to 2009 reflecting independent strategic choices for a high level of sustainability performance. These companies are through a propensity score matching technique matched with 90 comparable companies that have adopted almost none of these policies – the *low sustainability companies*. The study demonstrates that in terms of both stock market and financial accounting performance the high sustainability companies systematically and significantly outperform the low sustainability companies.

Despite this overall tendency in the findings, the question, does it pay to be green?, cannot be answered by a yes or no. The more relevant question is, under which circumstances does it pay or not pay to go green?

Some early studies point to a positive relationship between pollution prevention measures[4] and commercial performance. Hart and Ahuja (1996) analyzed the relationship between emission reduction during the 1988-1989 period and firm performance for a sample of Standard and Poor's 500 list of large corporations. Their results show that emission reductions through pollution prevention appear to drop to the bottom line within one or two years after initiation. Operating performance is significantly benefitted in the following year, whereas it takes about two years before Return on Equity is affected. King and Lenox (2002) likewise find that proactive measures drive financial gains, while reactive ("end-of-pipe") measures do not. In innovation parlance it is likely that "*end of pipe*" measures tend to be considered non-innovative from the perspective of the company installing it (while it may reflect even radical innovation from the specialized supplier perspective). By contrast proactive initiatives are more often to be considered part of a longer-term innovative learning process (Post and Altmann, 1992). Like Total Quality Management, pollution prevention, e.g. as part of a Lean or Environmental Management Systems, often initially involve incremental changes that can lead to substantial pollution/emission and cost reductions especially in terms of "*low-hanging fruit*" (Klassen and McLaughlin, 1993). The findings by Hart and Ahuja (1996) and King and Lenox (2002) seem to demonstrate such processes and these findings are in accordance with Porter and Van der Linde's (1995) proposition that pollution emissions can be considered more or less costly waste, the reduction of which may imply productivity and profitability gains. While the Porter Hypothesis suggest that regulation may trigger management attention to pursue such opportunities, the studies mentioned here show that such profitable

[4] Pollution or waste prevention measures prevent or reduce waste/emissions while reactive measures, often termed "*end-of-pipe*" measures or technologies reflect controls through which emissions are trapped, stored, treated and disposed of using pollution control equipment (Hart and Ahuja, 1996, p. 3).

investments/innovations take place also without regulatory incentives even if the profitability effect (in Rexhäusser and Rammer's 2014-study) is greater for regulation-driven innovation.

Another set of contingency for specifying the relationship between environmental and commercial performance is associated with the pollution-intensity and relative growth dynamics of industries. According to Hart and Ahuja's (1996) study, the biggest commercial benefits from emission reductions accrue to 'high polluters': "*It appears that the closer a firm gets to 'zero pollution' the more expensive it gets, as further reductions mean rising capital and technology investments…However, the results also suggest that the marginal costs of reducing emissions seldom exceed marginal* benefits" (Hart and Ahuja, 1996, p. 36). Since the data stems from 1988-89 when pollution-intensive industries (e.g. oil, forestry and automotive industries) had not yet moved far on the innovation learning curve for pollution reduction, it is likely that the findings for the industries during this period reflect good (early) opportunities to pick "low-hanging fruit". Another study from the same early period, Klassen and McLaughlin (1996), reaches different conclusions based on data on companies receiving public awards for their environmental performance. In this study the financial markets react more positively to the first-time announcement of award recipients for firms in less polluting industries than to recipient firms in more pollution-intensive industries, possibly because such announcements by companies in the latter industries were treated with skepticism by the financial markets. However, these award-receiving companies may still have improved their profitability performance – as Hart and Ahuja found for emission-reducing firms in "polluting industries".

Clarkson et al. (2004) examine one pollution-intensive industry, the pulp and paper industry (known for its air and water pollution), which like other high pollution industries has been facing ever more stringent emission standards since the 1970s. The study addresses the market valuation of environmental capital expenditure (ECE) investments during the period 1989-2000 related to pollution abatement in this industry. In seeming contrast to Hart and Ahuja (1996) they find that there are incremental economic benefits associated with ECEs by relatively low-polluting but not high-polluting firms within the industry. The paper points to three possible explanations for this pattern: 1) Over-compliance may generate economic benefits in terms of "green goodwill", incentives to innovate and raising rivals' cost. 2) The market assigns a value of zero to ECE investments of high-polluting firms – capital outlays with no incremental return. 3) For high-polluting firms the market assesses the existence of unbooked liabilities (future abatement spending obligations). Compared to Hart and Ahuja's (1996) results, Clarkson et al.'s (2004) more recent data may also signify that the "*low-hanging fruit*" had already been picked through incremental innovation (and perhaps "*end-of*-pipe" solutions) by the (still relatively) high polluters in the pulp and paper industry and that the "*low polluters*" had managed through more radical technological and organizational innovation to gain first-mover advantages by difficult-to-replicate investments and set the environmental standards and rules of the competitive game that the high-polluters would eventually have to face in the future.

Russo and Fouts (1997) found evidence that the positive relationship between environmental and commercial performance was strengthened in higher-growth industries. This is attributed to the

tendency of high-growth industries to have more entry by new players that are less subject to inertia associated with sunk costs and cognitive lock-in to traditional technologies and practices (assumed to be higher-polluting) than older and larger firms that tend to dominate low-growth (mature) industries. Eccles et al. (2014) find that "high sustainability companies" have benefitted relatively more over their counterparts, "low sustainability companies", within consumer industries, industries where companies compete on the basis of brands and human capital, and in industries where companies' products depend on extracting large amounts of material resources (hence "*high polluting*" industries). Hull and Rothenberg (2008) find evidence that corporate social performance (CSP), including many other indicators than indicators for environmental performance, enhance financial performance by allowing some firms to create a competitive *differentiation* advantage, and that this positive relationship is especially strong in low-innovation firms and in industries with an overall low level of differentiation, typically commodity industries. The explanations proposed for this result are the following: 1) When innovation is essential for firms' competitive differentiation advantage, CSP has not much supplementary differentiation effect to offer, and 2) CSP provides more scope for a visible and significant effect as differentiator in industries generally characterized by low level of differentiation. Whether or to what extent these results also apply specifically for the environmental aspects of the aggregated CSP measure is not analyzed.

In an event-based study, Gilley et al. (2000) found no general positive relationship between announcements of corporate environmental initiatives and shareholder reactions; however, they found that investors reacted more positively to product-driven environmental initiatives than to process-driven initiatives. They argue that "…*the reason for this finding may be that process-driven environmental advancements do little to increase a firm's perceived reputation with stakeholders. The investment community was found to be less interested in organizational process changes and more interested in environmentally sound products and services.*" (Gilley et al., 2000, p. 1210).

A very interesting further contingency documented in the Eccles et al's (2014) paper relates to the issue of corporate governance. They find a systematic tendency that "high sustainability companies" have strong relations to sustainability-relevant external stakeholders while the "low sustainability companies" have not – they are more exclusively shareholder oriented with a shorter-term profitability horizon. This theme (narrow shareholder versus broader stakeholder orientation) is directly related to institutional perspectives on company strategy and systemic transition that will be further explored in section 3.2 and in section 4.

2.3. Concluding perspectives of and limits to the economics and management literature on sustainable development and economic performance

Generally the economics and management studies on the relationship between sustainable development and financial performance apply quantitative, econometric methods, and they focus at manufacturing companies for the good reason that they are (compared to most services companies) generally major greenhouse gas (and other pollution) emitters, but also for the reason that statistical data tend to be more available for the manufacturing sector. Even if the Porter Hypothesis (especially not the "strong version") cannot be generalized neither to the whole economy nor to all

parts of the manufacturing sector, there is robust evidence that regulation tends to lead to innovation which, again, tends to have a positive impact on business performance even if not fully compensating the direct cost of compliance. And even if "the pays to be green" studies do not provide evidence for an unequivocal "yes, it pays!" answer, the overall picture is a positive relationship. This latter stream of literature – not only the studies referred to above - provides solid evidence that much sustainability-improving measures, often also with positive commercial impacts, are *not* directly driven by political regulation. However, it is limited what these studies can tell about the specific drivers of such measures apart from some support for the original premise of the Porter Hypothesis, namely that (much) pollution and emission can be considered costly waste and, as a consequence, pollution reduction may lead to cost reductions, productivity gains as well as gains on the capital market. Furthermore, there seems (especially in high-polluting firms and industries) to be significant "low-hanging fruit" to be picked through incremental measures (innovation and procedural/behavioral changes). However, in industries with stable technological production infrastructures decreasing returns to such increasingly marginal and perhaps costly measures can be expected. This means that, eventually, further significant emission reductions may require large capital-intensive investments (in both physical and human capital) implying radical and systemic technological and organizational innovation that may only be profitable at the longer term (if ever) and may be less controllable by the individual firm (see further our discussion of the innovation view in section 3.2). This context for sustainable transition resonates well with the systemic transition perspective that will be discussed in section 4.

Even if there has evolved an increasing consensus on the need for a more sophisticated contingency framing of the "pays to be green" research, it has proven difficult to establish a cumulative learning trajectory in terms of methods and indicators to apply and contingencies to address. This means that there has not yet been revealed a clear pattern of differences across sectors, industries, technologies and types of environmental innovations and other measures. For example, there is no clear empirical message from these studies as to the extent to which the investigated "green-going" companies have engaged in disruptive versus more incremental environmental challenges. It is likely that these quantitative studies have tended to grasp incremental environmental improvements associated with production processes, which may have an inclination to "pay off" along the reasoning in the Porter Hypothesis, rather than product innovation and especially more radical technological and organizational transformation, which may not be profitable at the shorter to medium term.

The specifics of enterprise-based strategic management, innovation and technological dynamics are not subject to in-depth analysis in these research traditions. These issues are however centrally dealt with within the strategic management and innovation perspective to which we shall now turn. Especially the rise of radically new and disruptive technologies poses totally different perspectives for incumbent enterprises, even for those that have successfully managed to improve environmental performance within the old technological paradigm, and these transition challenges have predominantly been analyzed within the systemic transition perspective (section 4), to a very limited extent within the strategic management and innovation perspective, and not at all in the economics and management perspective reviewed in this section.

3. The strategic management and innovation studies perspective on firm-based sustainable development

During the same period, the last about two decades, in which the empirical economics and management studies on sustainability development and financial performance have emerged, we have also witnessed a surge of scholarly work that from a strategic management and innovation view addresses ways in which private enterprises (may) engage in more or less defensive or proactive strategies responding to the challenges of climate change and other environmental matters. This literature deals with a variety of sustainability-improving strategic management and innovation trajectories and offers different taxonomies (e.g. types of strategies), contingency frameworks (specifying the contextual contingencies for different sustainability strategies to apply and be successful also in financial terms), and evolutionary frameworks (stage-gate models dealing with how learning on sustainability in business firms may evolve). Like the economics/management literature, most of the strategy/innovation literature on sustainable development addresses *manufacturing firms*. However, a sub-stream of this literature has more recently evolved with a focus on servicizing of manufacturing companies to increasingly engage in providing/selling services rather than products and new business models associated with the so-called shared economy or collaborative consumption. However, we have refrained from including these issues in this paper. Generally companies primarily adopt "servicising" strategies in order to generate new and more stable sources of revenues in a context of threats of "commoditization" (Baines et al., 2008), and environmental impacts tend to play a marginal role. We have refrained from covering the shared economy/collaborative consumption themes, despite their relevance for enhancing sustainability, due to immature stage of the academic research on these themes. While empirics on the Porter Hypothesis and the "pays-to-be-green" agenda have predominantly been quantitative and conducted within econometric and cross-sectional methodological traditions, empirics within the strategy and innovation perspective have to a much larger extent included qualitative, case-based studies focused on particular types of companies, sectors or technologies.

Since the early/mid 1990s the strategy and innovation literature on sustainable development has exploded and proliferated into several directions and adopted different extant theories of firm strategy (e.g. the resource-based view, the competitive forces framework, and institutional theory) and theories of the drivers of innovation and conceptual frameworks of innovation (e.g. incremental versus more radical innovation, technological innovation versus business model innovation, Open Innovation models). We can roughly identify three sub-streams in this literature the key insights of which we shall explore in some detail: 1) The business economics strategy view, 2) the innovation view, and 3) the institutional view. It should, however, be acknowledged that much of this literature has no sharp boundaries between e.g. economics, institutional and innovation perspectives.

1. *The business economics strategy view* holds a predominantly business or organizational economics perspective on sustainable development and perceives the firm as a production and economic entity driven first and foremost by shareholder interests and market forces.

The literature addresses the scope for reducing the environmental impacts from material *products*, from manufacturing/operational *processes*, from the value chain system in which the focal firm is embedded, and from the use of the firm's products, their disposal and possible "take-back", redesign, reuse or recycle processes.[5] In section 3.1 we shall provide an overview of key insights from this business economics oriented literature on strategic ways of aligning sustainability concerns and commercial concerns for the short and longer term.[6]

2. *The innovation* view relates to the broader innovation studies and economics and management of innovation literature tradition and addresses the particular drivers of, competences for and features characterizing different types of sustainable innovation and its governance. In recent years this literature has increasingly emphasized that sustainable innovations are subject to particular externalities or barriers to their commercialization that make them more reliant on public regulation and support than other innovations. Furthermore, this literature addresses the systemic and relational (or "open innovation") ramifications of sustainable innovation, hence the need for firms to engage in alliances and other forms of external relationships. In section 3.2 we address this literature on firm-based environmental innovation, while section 4 entails a discussion of innovation as linked to the systemic and radical perspective on sustainable transition.
3. *The institutional strategy view* posits that "*…organizations are not simply production systems, functioning in an environment comprised of suppliers, consumers, and competitors, but social and cultural systems embedded within an 'institutional' context, comprising social expectations and prescriptions of what constitutes appropriate ('legitimate') behavior, supported by an institutional infrastructure of actors including the state, professions, interest groups, the media, public opinion and so forth, that monitored and cajoled organizations to adopt those behaviors*" (Greenwood et al., 2015, p. 324, building on Meyer and Rowan, 1977). The institutional approach emphasizes the contextual circumstances associated with broader sociological and cultural factors (beyond the strict and shorter term economical factors key to business economics strategy view) that push or inhibit organizations from moving towards higher levels of sustainability (Greenwood et al., 2015). Many studies address the particular need for companies to engage in close relations with institutional stakeholders (e.g. Eccles et al., 2014; Sharma and Henriques, 2005). In section 3.3 we shall discuss key contributions offered within this perspective to better understand the strategic management issue relating to sustainable development. These insights reinforce the relevance of and enrich the institutional systemic transition perspective

[5] Beyond material technologies associated with e.g. manufacturing, logistics and distribution, *process technologies* also include managerial or organizational technologies such as Lean and Environmental Management Systems associated with emission reduction and energy economizing.
[6] We shall refrain from reviewing the comprehensive engineering-oriented and applied management literature that focuses on applied tools for detailed analysis of particular sustainability-improving management and measurement tools and models (Life Cycle Analysis, Environmental Management Systems, Cradle-to-Cradle analysis, Product Service Systems, etc.).

(treated in section 4) by providing a better micro or agency foundation for understanding the transition of whole systems or sectors.

3.1.The business economics strategy view

Most strategy literature integrates insights from micro-economic theory, organizational economics, organizational theory and/or institutional theory. This is also the case for the parts of the strategy literature that deals with strategy and sustainability. Still, most of the reviewed literature tends to have a predominant emphasis on one theoretical foundation. One of the pioneers in providing a distinctive economic contingency framework for companies' environmental policies, is Forest Reinhardt (1998, 1999a, 1999b). He takes his point of departure in primarily anecdotal evidence that some firms pursue proactive "beyond compliance" environmental policies, hence, in economic term, some "*…firms can reconcile the apparently competing goals of increasing the provision of environmental public goods and increasing the expected value of the firm*" (Reinhardt, 1999 b, p. 11). [7] Much in a Porterian strategy vein, he maintains that "*[…] environmental policy, like other aspects of corporate strategy, needs to be based in the economic fundamentals of the business: the structure of the industry in which the business operates, its position within that structure, and its organizational capabilities. There is no one-size-fits-all environmental policy.*" (Reinhardt, 1999b, p. 18). Since environmental problems are perceived as market failures (negative externalities), conventional economic logic would suggests that in the absence of regulation, companies cannot be expected to take into consideration the costs that their pollution imposes on society (Reinhardt, 1998, p. 44). "*However, the world does not deliver market failures one at a time: Environmental externalities coexist with market power, incomplete information, and the other departures from the competitive paradigm that make business administration interesting*" (p. 45). Like Porter and van de Linde (1995), Reinhardt argues that market imperfections and organizational/behavioral failures can explain that some firms in some circumstances move "beyond compliance" (Reinhardt, 1999b, p. 15). And by observing how business problems and opportunities arise from different departures from perfect competition, Reinhardt discerns the following basic strategies for potentially aligning sustainable and commercial performance:

1. Saving costs
2. Differentiating products
3. Managing your competitors
4. Managing environmental risks
5. Redefining markets

Re. 1. Saving cost. Some companies are able to save costs and simultaneously improve environmental performance, and this is more likely the type of "alignment" policy which is most frequently captured in the empirical literature on the Porter Hypothesis and the "pays-to-be-green"

[7] After Reinhardt wrote the paper, the anecdotal evidence has been supported by increasing research-based evidence from the "pays-to-be-green" literature, cf. section 2.2.

studies that find a "reconciliation" of environmental and commercial goals. This is also where Porter and van de Linde (1995) originally pointed to substantial "organizational failure" problems, opportunities for aligning waste and cost reductions not spotted by most firms, which public regulation could help direct attention to. And this is where an increasing number of "pays-to-be-green" studies have demonstrated that many companies proactively envision opportunities for profitable investments and innovation "beyond compliance" or even in the absence of regulation. However, Reinhardt (1999a) warns against a "free lunch" position (that it *always* pays to be green): "*Even low-hanging fruit can only be gathered after an investment of management time, and that resource is hardly free. Investments in environmental improvement, like all other investments, are worthwhile only if they deliver value after all the management cost have been included*" (p. 154-155).

Re. 2. Differentiating products.

Environmental product differentiation implies that companies create products that offer greater environmental benefits or impose smaller environmental costs than those of their competitors (Reinhardt, 1999, p. 150; see also Gilley et al., 2000). Environmental quality is a public good that everybody may enjoy regardless of who pays and from an economic standpoint there is no reason to expect that anybody would pay for a public good. However, according to Reinhardt, "*[…] that view is too narrow*" (1999a, p. 152). Some customers are actually willing to pay for some kinds of public goods. Henderson (2015) terms these "the environmental niche". However, they are mostly only willing to pay a premium price if the public good is bundled with private good qualities (e.g. convenient functionality, private health benefits) or lead to environmental cost reductions for the customer during product use (e.g. circulator pumps with improved performance and lower electricity consumption in use) (Reinhardt, 1999a, p. 152). Reinhardt specifies three conditions that need to be fulfilled for commercial success with environmental product differentiation: "*First, the company has identified customers who are willing to pay more for an environmentally friendly product. Second, it has been able to communicate its product's environmental benefits credibly. And third, it has been able to protect itself from imitators for long enough to profit on its investment. If any of those three conditions break down, the product differentiation approach will not work*" (Reinhardt, 1999a, pp. 151-152)

Re. 3. Managing your competitors

Companies that may not be able to succeed in environmental product differentiation may still be able to profit from environmental investments by coordinating (or in economic terms: colluding) with similarly positioned companies in an industry to set higher private standards – or by lobbying governments to establish regulations that favor their product and erect barriers for competitors (Reinhardt, 1999a, p. 152, Reinhardt, 1999b, p. 11ff.). Such companies may need to incur high costs to obtain the higher standards, but they can still achieve a competitive advantage if competitors are forced to increase costs even more (Reinhardt, 1999a, p. 152). The most frequently referred case of such club-based private regulation is the Responsible Care initiative set up by a leading group of companies in the Chemical Manufacturers Association establishing a set of

regulatory requirements for the members in areas such as pollution prevention, process safety and emergency response (Delmas and Terlaak, 2001; King and Lenox, 2000; Prakash, 2000). The conditions for successful implementation of such private regulation are, like for those of public regulation, that regulators set measurable performance standards, have access to information to verify compliance, and are able to enforce the rules (Reinhardt, 1999a, p. 153).

Re. 4 Managing environmental risks

The three previous types of strategies reflect ways in which the provision of public goods may increase profitability or shareholder value. However, even in cases where these strategies do not pay off in their own right, investments in environmental quality beyond compliance may still make economic sense as part of a risk management strategy (Reinhardt, 1999b, p. 16). Environmental risk management may deal with risks of liability or damaged reputation that may arise from environmental accidents, disruptions in supply of or price increases in raw materials, consumer boycott, environmental lawsuit or the risk of not being allowed license to operate. The companies most likely to benefit from environmental risk management are those belonging to pollution-intensive industries that are also heavily regulated and scrutinized by the public (Ambec and Lanoie, 2008, p. 51). The objectives of environmental investments as part of a risk management strategy would be to reduce the probability of adverse events, reduce the costs of such events should they occur, or shift the responsibility for these costs from the company to some other party, e.g. an insurance company (Reinhardt, 1999b, p. 17). While the latter category per se represents a "passive" investment, the two former require more innovative measures, thus for example the case of marine oil spills, the installment of double-hulled oil tankers would reduce the probability of oil spills while a rapid response crew would reduce the cost of an accident should one occur. Managing environmental risks is here analyzed from an economic (cost-focused) logic. But risk management can (and should) also be analyzed from an institutional perspective (cf. section 3.2) in which response to institutional expectations and pressures are needed to gain legitimacy and a positive reputation among institutional stakeholders beyond the usual economic market actors.

Re. 5 Redefining markets

This strategic option refers to companies that follow several approaches at once and "*rewrite the competitive rules in their markets*" (Reinhardt, 1999a, p. 156). Reinhardt especially mentions Xerox as a case at hand that combines materials (and cost) reductions, business model innovation (leasing and service provisions rather than product sales), take-back and recycling programs and the reuse of parts of the old machines together with new technology in new machines. Reinhardt (1999a, p. 157) maintains that such ambitious type of strategy involves significant market, regulatory and scientific risks hence are not for any company or industry: "*The companies that appear to be succeeding are leaders in industries that face intensifying environmental pressure. Those companies have research capabilities to develop new ways of delivering valuable services to their customers, the staying power to impose their vision of the future on their markets, and the resources to manage the inevitable risks. Moreover, by creating an appealing vision of a more profitable and environmentally responsible future, they may be better able to attract and retain the managers,*

scientists, and engineers who will be enable them to build on their initial success. (Reinhardt, 1999a, p. 157).

Like Reinhardt, Ambec and Lanoie (2008) provide a bridge from the predominantly economics Porter Hypothesis and "pays to be green" literature to the strategic management literature. More than Reinhardt in the 1990s, Ambec and Lanoie have been able to more systematically draw on much of the Porter Hypothesis, "pays to be green" and related research (to which they have also themselves contributed), and they systematically analyze the economic mechanisms involved in seven channels of potential revenue increases or cost reduction owing to improved environmental practices:

1. Better access to certain markets
2. Differentiating products
3. Selling pollution-control technology
4. Risk management and relations with external stakeholders
5. Cost of material, energy, and services
6. Cost of capital
7. Cost of labor

The first three channels relate to means through which firms' improved environmental performance may lead to enhanced or create new sources of revenue. While the one channel, product differentiation, was covered by Reinhardt (most in-depth in his 1998-article), the two other channels were not. One of these, "Better access to certain markets" refers to an increasing tendency for purchasing policies of public and private organizations to reward green suppliers. In other words, firms selling to governments or other businesses can obtain access to certain markets by improving their environmental performance (Ambec and Lanoie, 2008, pp. 47-49). "Selling pollution control technology" represent another way for companies in specialized cleantech or eco-industries to increase revenue through specializing in developing and selling goods and services to help prevent, limit or optimize environmental emissions and other resource waste and damages. This channel of potential revenue source from environmental measures can be considered a form of environmental product differentiation that in Reinhardt's conception seems to comprise "normal products" that beyond usual product functionalities include special environmental qualities.

The latter four channels in Ambec and Lanoie's typology relate to means through which firms' improved environmental performance may lead to cost reductions. Beyond risk management and energy/material and cost reductions which are also key in Reinhardt's conception, Ambec and Lanoie adds two more mechanisms: Reduction of cost of capital and of cost of labor. There is converging evidence that better environmental performance can be associated with a lower cost of financial capital, through the increasing significance of green (or ethical) mutual funds, through bank loans and through the stock market (for a review of the literature, see Ambec and Lanoie, 2008; see also Sharfman and Fernando, 2008). Lastly, Ambec and Lanoie (2008) find anecdotal evidence and convincing arguments for the proposition that better environmental performance lead to labor cost reductions via reductions in the cost of illness, absenteeism and/or recruitment (by

especially making the companies more attractive for young scientists, engineers and managers), and labor turnover.

Nidumolu et al. (2009), in a more normative contribution, identify five strategic approaches for sustainable development that they also claim to be stages in large manufacturing corporations' engagement in sustainable development:

1. View compliance as opportunity (to comply to the internationally highest standards)
2. Make value chains sustainable
3. Design sustainable products and services
4. Develop new business models
5. Create Next-Practice Platforms

The "Compliance" approach broadly corresponds to Reinhardt's and Ambec and Lanoie's "saving costs" of materials, energy and services beyond being an argument for complying to the highest international standards in order to reduce costs and barriers for scaling up for global market penetration. The second approach, "Making value chains sustainable", is not specifically mentioned in Reinhardt's and Ambec and Lanoie's typologies, but it has become a central sustainability (as well as broader corporate social responsibility) issue for large corporation's management of logistics and value chain management (Vachon and Klassen, 2008). The third approach is identical with "differentiating products" in the other typologies. The fourth, "Develop new business models" is also new and reflects the increasing attention in management practice and literature (but still not matured in the academic literature) to servicizing, business model innovation and the development of Product Service Systems (Tukker and Jansen, 2006; Tukker and Tischner, 2006) The fifth approach, "Create Next-Practice Platforms" is, like Reinhardt's "Redefining markets" vaguely specified, but generally points towards more radical and systemic sustainable innovation, which we will discuss in the subsequent section 3.2 and in section 4.

Another early pioneer in the field of strategic management and sustainability was Stuart Hart who published the paper, "A Natural-Resource-Based View of the Firm" in 1995, the same year in which Porter and van de Linde pioneered the "Porter Hypothesis". Hart's goal was to extend the resource-based organizational economics theory of the firm and its strategy to encompass the increasing importance of the natural environment. Following leading scholars of the Resource-Based View (RBV) (including Barney, 1991, Peteraf, 1993, Prahalad and Hamel, 1990), Hart initiates a (predominantly theoretical) investigation of three "strategic capabilities" and their potentials for creating competitive advantage by being valuable, difficult to imitate and substitute, rare, tacit and/or complex. The three strategic capabilities are: Pollution prevention (corresponding to environmental "cost reductions" in Reinhardt's and Ambec and Lanoie's strategic postures), product stewardship (corresponding to "product differentiation" in Reinhardt's and Ambec and Lanoie's terminology), and "sustainable development" signifying a more radical and comprehensive transition with a particular focus on leveraging environmental strategy into the developing countries. This latter category has similarities with Reinhardt's (1999a) most "radical" strategy category, "Redefining Markets", even if this does not address the developing world. Both

Hart's and Reinhardt's conceptions of a radical sustainability strategy are only vaguely specified and lack empirical evidence beyond Reinhardt's few anecdotal references. Hart (1995) concludes that "*…as of this writing, there were no examples, to my knowledge, of large manufacturing firms committed to a vision of sustainable development*" (Hart, 1995, p. 1068). Even more remarkable is it that this conclusion is maintained by Hart and Dowell (2011) 15 years after Hart's original paper: "*Yet while these challenges* [environmental and climate challenges] *call for bold innovation, most firms continue to focus on incremental strategies such as eco-efficiency, pollution prevention, product stewardship, and corporate social responsibility. As important as these corporate initiatives have been, it is now clear that such incremental strategies will simply not be sufficient. Companies and management scholars are being challenged increasingly to develop breakthrough strategies that actually resolve social and environmental problems, rather than simply reducing the negative impacts associated with their current operations*" (Hart and Dowell, 2011)

Hart's 1995-paper set the agenda for subsequent research in further developing a resource-based or a capability perspective on firms internal processes and strategies in regard to environmental issues (e.g. Aragon-Correa and Sharma, 2003; Etzion 2007; Klassen and Whybark, 1999; Orsato, 2006; Russo and Fouts, 1997)[8] as well as the needs for extensive external relations involved in sustainable innovation, an issue that will be treated in the subsequent section 3.2 on the innovation view. Hart's paper also contributed to stimulate the "pays-to-be-green" research to which Hart together with Ahuja (1996) made an early contribution (see section 2.2). Furthermore Hart's emphasis on the need to "embrace" sustainable development strategies for the poorest part of the world has inspired a particular stream of research as well as business and consulting practice under the umbrella term "Bottom of the Pyramid" (including Prahalad, 2005; Prahalad and Hart, 2002). Finally, Hart's paper also contributed to the agenda for an institutional perspective on sustainable strategic management by explicitly avoiding the introvert bias often associated with the RBV and arguing that issues of social legitimacy and reputation are also important: "*Because the three environmental strategies are rooted in costly-to-copy firm resources and capabilities, it is argued that such an external (legitimacy-based) orientation in no way jeopardizes competitive advantage and may reinforce and differentiate the firm's position through the positive effects of a good reputation*" (Hart, 1995, pp. 998-999.) Hence, Hart's early contribution also provides a bridge to the institutional view on sustainability strategy that will be discussed in section 3.3

3.2.The innovation view

The field of innovation studies has been characterized by an empirical orientation and – like must management and strategy literature – an inclination to apply theories from heterodox economics (in particular evolutionary and organizational economics into "innovation economics"), sociology, organizational and institutional and broadly management theory. This is also the case with the expanding academic literature on sustainable innovation that is here used interchangeably with the terms environmental innovation and eco-innovation, of which the two latter tends to be used in the

[8] A thorough review of this literature lies beyond the scope of this paper.

innovation-oriented literature on sustainable development. Among the early pioneers in investigating the particularities of environmental innovation, we can mention Cleff and Rennings (1999), Kemp (1997) and Rennings (2000) who centrally contributed to align environmental economics (in section 2.2. termed "pays-to-be-green" and the Porter Hypothesis literature) and innovation economics. Based on these and other contributions Kemp and Pearson's (2007) proposed the following definition of eco-innovation which is an adaption of OECD's general definition of innovation (OECD, 2005): "Eco-innovation is *the production, assimilation or exploitation of a product, production process, service or management or business method that is* ***novel to the organization*** *(developing or adopting it) and which* ***results****, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use)* ***compared to relevant alternatives***" (p. 7).[9] The early meeting place for the fields of environmental and innovation economics addressed two central features of eco-innovation, one relating to their externalities, the other to their drivers (Rennings, 2000). The first feature, termed the "double externality" problem, implies that firms may not obtain economic value from their eco-innovations due to two sets of externalities: their "public good" or "positive externality" nature (a conventional wisdom in environmental economics), and the risk of knowledge "spillovers" or leaks, a type of externality that is also pertinent to much "normal" (non-eco) innovation as has become conventional wisdom within innovation economics. The second feature of eco-innovation has become termed "the regulatory push/pull effect" and is a consequence of the "double externality" problem. It implies that eco-innovation is not - like "normal" innovation - centrally driven by technology push and demand/customer pull dynamics, but to a high degree *also* by *public* regulation ("push") and support ("pull"). While the environmental economics literature has predominantly focused on the role of environmental regulation *and* whether or when it pays to be green (cf. section 2 in this paper), the innovation studies dealing with eco-innovation also addresses the complexities and the particular dynamics of eco-innovation which go far beyond the assumptions in environmental economics that, as maintained by Rennings (2000), "*[…] suffer from a simple, mechanistic stimulus-response model of regulation, neglecting the complexities of determinants influencing innovation decisions of firms.*" (p. 325).

The particular role of public "regulatory push/pull" as an important co-driver of eco-innovation has been documented in numerous studies (including Brünnermeier and Cohen, 2003; Cleff and Rennings, 1999; Horbach et al., 2012; Horbach et al., 2013; Johnstone et al, 2010; Kesidou and Demirel, 2012). In an early study of eco-innovative German firms, Cleff and Rennings (1999) found that these firms attach significantly higher importance to goals of cost reduction and total

[9] Beyond the broad distinction between innovation in products, processes, services, management and business methods, the Community Innovation Survey differentiates nine different types of eco-innovation referring to different sorts of environmental benefits deriving from production of products and services or from the after-sales use of a product or a service. Those that derive from production of products or services are the following six: "Reduced material use per unit of output"; "reduced energy use per unit of output"; "reduced CO_2 footprint" (total CO_2 production); "replaced materials with less polluting or hazardous substitutes"; "reduced soil, water, noise, or air pollution, and "recycled waste, water, or materials". Those eco-innovations that refer to benefits derived from after-sales use of a product or service are the following 3: "Reduced energy use", "reduced air, water, soil or noise pollution"; and "improved recycling of product after use".

quality management (TQM) than other innovators, lending support to the Porter Hypothesis that (many) firms perceive environmental issues as a part of a general cost and efficiency problem. While regulation incurs a strong influence on both process and product innovation, the study also found that environmental *product* innovation is significantly driven by market pull effects, opportunities for strategic market goals, while environmental *process* innovation is relatively more driven by regulation and cost concerns. In a more recent study, Kesidou and Demirel (2012) confirm the general tendency that stringent environmental regulation positively affects eco-innovation, but they also find a more differentiated pattern in that "*[…] only the least and most innovative firms are driven by regulatory requirements. Hence, this paper brings a further insight into the Porter Hypothesis by showing that such environmental policies appear effective in encouraging the least environmentally interested firms at the bottom end of the innovation spectrum as well as the most capable and environmentally interested firms at the top end of the spectrum*" (Kesdidou and Demirel, 2012, p. 868).

Consistently adding to the above-mentioned particularities of eco-innovations as distinct from "normal" innovation, a growing research furthermore points to two interrelated characteristics of many eco-innovation processes: 1) They require very complex organizational and technological competencies. 2) They involve extensive external relations and not least with stakeholders possessing knowledge that is unfamiliar to the innovating firms.

On competencies for eco-innovation, several contributions in the wake of Hart's (1995) extension of the Resource-Based View to encompass environmental issues have emphasized that proactive (innovative) environmental strategies tend to involve substantial organizational changes affecting a broad constellation of business functions (Russo and Fouts, 1997; Russo and Harrison, 2005). The implementation of environmental management systems involves the development of competencies that facilitate eco-innovation (Horbach, 2008, Wagner, 2007). Under some contingencies in the general business environment - environmental uncertainties, perceived complexity and munificence (low hostility) - such competencies are difficult to imitate or replicate and may give rise to competitive advantage (Aragon-Correa and Sharma, 2003): "*[…] proactive environmental approaches adopted in complex environments are innovative and rare and can provide more valuable management capabilities for an organization than reactive approaches, placing the organization in a better position than other firms in the same general business environment*" (p. 80). Eco-innovation beyond the most incremental level "*[…]represents a technological frontier on which firms are still inexperienced and market and technological uncertainties increase as there are no widespread-accepted standards either in terms of specific technological solutions or of measure to evaluate the environmental performance of products and processes*" (De Marchi, 2012, p. 615).

With the exception of specialized cleantech firms and other firms with a high environmental profile accumulated over many years, most firms that engage in environmental innovation face such uncertainties and need to go beyond their core competencies (Ghisetti et al., 2015, p. 1080). This involves a broad spectrum of change and knowledge requirements: Organizational change (e.g. adoption of an environmental management system and cross-functional and inter-organizational

coordination), institutional changes (e.g. compliance to regulations, response to NGO pressure or public support opportunities), technological change (e.g. need to access new and unfamiliar scientific and engineering knowledge for product development or new production systems or components (Ghisetti et al., 2015, p. 1082). On this background it is no surprise that external cooperation tends to be particularly important for eco-innovators (De Marchi, 2012; Ghisetti et al., 2015).

De Marchi (2012), based on data on Spanish manufacturing firms, finds that external R&D cooperation is significantly more intense for environmental innovators than for other innovators and that cooperation with suppliers, universities, consultants and research centers are more important than for other innovators while the intensity of collaboration with users does not differ between green and other innovators. These findings confirm the proposition that environmental innovation is relatively more subject to technology push and public push/pull forces than to classical market pull. Rennings and Rammer (2009) find that German firms in introducing energy and resource efficiency innovations "*[…] search for innovation impulses more broadly (i.e. they use more and different information sources) than other innovators*" (p. 454). Horbach et al. (2013) confirm with respect to France and Germany "*[…] that eco-innovative activities require more external sources of knowledge and information compared to other innovations*" (p. 529). Ghisetti et al. (2015) have been able to further differentiate the specific patterns of external relations for environmental innovators in manufacturing firms in 11 European countries. They find that increasing breadth of firms' knowledge sourcing increase their probability of introducing an environmental innovation but only up to a certain beyond which the beneficial effect stops, and they explain this phenomenon with cognitive constraints in processing knowledge inputs from too many and diverse sources. Another interesting result is that also firms engaging in deep (specialized) and interactive relations have a higher propensity to introduce an environmental innovation, and this effect does not seem to be bounded (i.e. that increasing intensity of interactive relationships at a given point decreases the propensity to launch environmental innovation). When distinguishing between firms *introducing* an environmental innovation (less experienced environmental innovators) and firms that *extend their portfolio* of environmental innovations across types (cf. note 9), that is, more experienced environmental innovators, the latter group is not like the former constrained in its capacity to handle an increasing range of diverse relations.

These studies (as well as studies within the Porter Hypothesis literature) do not differentiate between incremental innovation, which probably dominates empirics, and longer-term, more radical innovation which is difficult, if not impossible, to grasp in quantitative studies. Since incremental environmental improvements and innovations are more likely to pay off commercially at the shorter term than radical/disruptive environmental innovation, we have a likely explanation why the "pays to be green" research tends to find a positive relationship between environmental and commercial performance. Radical or disruptive innovation – also "normal" (non-eco) ones – are rarely profitable at the short term (Christensen, 1997; Tushman and Romanelli, 1985). As Henderson (2015) argues such innovation requires investments in the preparation of major shifts and "*[…] rests on sophisticated understanding of the risks entailed in doing nothing and on the opportunities inherent in moving early to prepare a range of plausible futures*" (pp. 23-24)

Few firm-based studies have tried to come to grips with the particular strategic, organizational and contextual settings and uncertainties for such radical innovation and those that do, rely on qualitative, case-based methodology. While the economic strategic management frameworks for aligning business and environmental performance (including Ambec and Lanoie, 2008; Hart, 1995; Reinhardt, 1998 and 1999a, b) offer useful guidelines for practical strategic postures for enterprise sustainability (cf. section 3.1), they do not integrate the innovation view in any detail, hence the drivers of sustainable innovation, the external relations associated with environmental innovation, and the particularities of different types of innovation, and in particular more radical innovation, are not thoroughly treated. Based on a literature review and interviews with 49 senior managers responsible for corporate sustainability and innovation initiatives among sustainability leaders in the U.S.,[10] Lampikoski et al. (2014) identify four categories of green "innovation games" each characterized by different "dominant logics", types of barriers and outcomes. Two vectors are combined, whether green innovation initiatives are evolutionary (incremental) or revolutionary (radical), and whether they are autonomous (generally controllable by the focal firms) or systemic (in need of extensive collaboration with external partners). This leads to four categories (see Figure 1):

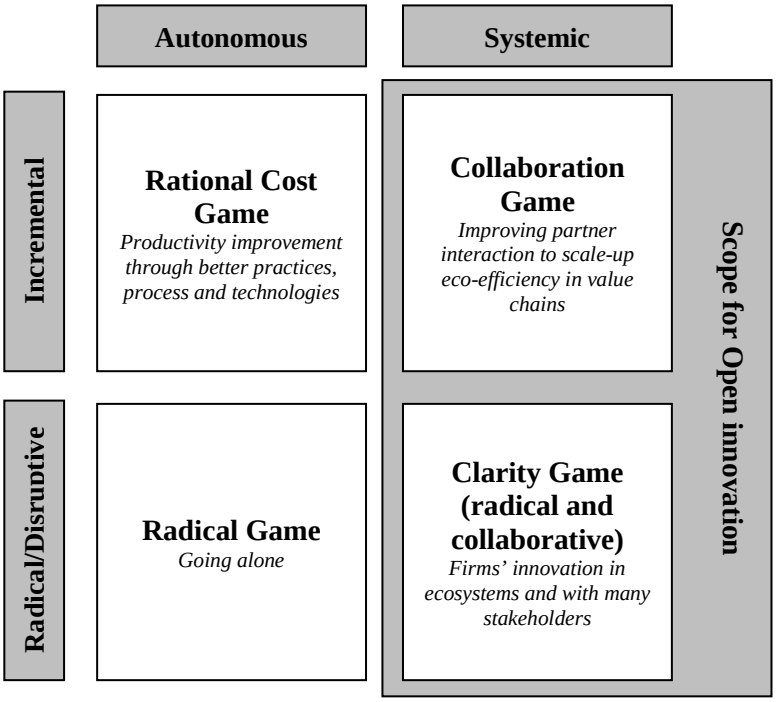
- The Rationality game implies incremental firm-focused process and product innovation focused on productivity improvements and resource efficiency very much in line with what most of the "pays to be green" literature has registered as frequent environmental measures that are often also being profitable at the shorter term. Among the examples mentioned are 3M's Pollution and Prevention program and General Motor's factories reusing and reselling waste from operations
- The Collaboration game involves incremental improvements through extensive partner interaction (creating new standards in an industry, improving eco-efficiency throughout the value chain/system). Some companies in dominant positions (like Nike and Walmart) may be able to enforce more environmentally friendly practices on their suppliers. However, for most companies the exertion of power is not possible and attempts may hamper the legitimacy of the company as network orchestrator and business partner (Lampikoski et al., 2014, p. 99). The examples mentioned are Sustainable Apparel Coalition increasing environmental transparency in material sourcing and use, and Coca-Cola-WWF collaboration to reduce water consumption in Coca-Cola's manufacturing process.
- The Radical game refers to radical and autonomous, hence broadly sought controlled by the focal firm. This category may relate to a company's attempt to develop a disruptive technology in separate organizations within the corporation or, we may add, radical ventures in small cleantech startups. However, it is likely that most of such attempts eventually face systemic challenges that add to the technological design challenges – hence while they early on believed they could "do it alone" based on internal R&D and with corporate or venture capital backing, they tend to face systemic, institutional barriers as the technological design opportunities mature and market implementation in larger scale approaches. Among the few

[10] The study does not reveal the specific criteria for selecting the companies nor their names but mentions that they include IBM, Dow Chemical, Nike, Patagonia, Starbucks, and Interface (p. 90f).

examples mentioned are Waste Management's (the biggest waste hauler in the U.S.) provision of services to support customers' zero-waste goals and its converting of collected trash into biofuels and energy.

- The Clarity game involves radical and systemic innovation (close to Reinhardt's most "radical" strategic category, Redefining markets, and Hart's "Sustainable development", cf. section 3.1). Firms engaging in this game "*[…] aim to transform their industries through a renewed purpose for being in business. This purpose may be exemplified by Patagonia, which hopes to rewrite the rules of the apparel industry through the simultaneous advancement of social and environmental goals, while balancing for financial profits. Similarly, Interface's Mission Zero goal aims to prove by 2020 that an established business in a resource-intensive industry can conduct a profitable business without leaving any environmental footprint*" (Lampikoski et al., 2014, p. 102).

Figure 1: Innovation typology for differentiating eco-innovations;
Source: Own illustration adapted from Lampikoski et al., 2014, p. 94.



Lampikoski et al. (2014) argue that the Rationality game is practiced by the majority of companies and often represent their first step in corporate sustainability as a reaction to competitors' environmental engagements or as compliance to public regulation. By contrast, the Clarity game represent the most radical and systemic strategy for corporate transition in which collaborative networking plays a crucial role and the overall goal is to rewrite the rules of a business or to create a new one which is a daunting task: "*So far, only a few established companies are engaged in the Clarity game and are trying to solve some of the world's toughest social and environmental problems, whether in the elimination of greenhouse gas emissions, strengthening worldwide*

environmental protection, or providing free access to fresh water around the world." (Lampikoski et al., 2014, p. 102). In figure 1 we have indicated that the Collaborative and Clarity games provide particular scope for Open Innovation strategies (Chesbrough et al., 2014), the former more operational and with external relations focused on value chain partners, the latter more explorative and with a broader scope for external relations with e.g. public authorities, research centers and NGOs. Chadha (2011) has provided a rare study of firm-based requirements for overcoming competence lock-in in dealing with radical technology-based innovation of biopolymer technology in eight German and Swiss companies within the petro-based plastics industry. The results suggest that firms build competencies in 1) inter-firm R&D alliances, 2) in internal "project houses" that are not controlled by overall firm policy and that are physically separated from other facilities in the organization, 3) through structured monitoring of relevant technology dynamics and regulatory/legislative issues, 4) through decentralized cross-functional project teams, and 5) through allowing and motivating employees to engage in so-called bootleg activities, bottom-up R&D that is not necessarily authorized by management.

While incremental innovation tends to be competence-enhancing, radical innovation often involve substantial competence-destroying features implying needs for overcoming lock-in to extant competencies (Anderson and Tushman, 1990). This also impacts suppliers, customers and complementary innovators (e.g. in R&D alliances), what Hall and Vredenburg (2003) term "primary stakeholders". Therefore radical technological innovation is in need of, on top of internal organizational and competency reshufflings, extensive relations with "primary stakeholders" having a primary focus on science and technology development (like in the biopolymer case). But radical sustainable innovation often requires the recognition of a much broader range of factors than the purely technological and that also requires more or less extensive relations with what Hall and Vredenburg call "secondary stakeholders", including environmental groups, safety advocates, community interest groups and the media. The case of Monsanto is illustrative in this respect. The company pioneered the development of genetically modified (GM) crops that could reduce the need for pesticides and herbicides, and the corporate slogan in 1997 was "*Sustainable development for the world's future*" (Hall and Vredenburg, 2003). Monsanto made the transition from chemicals to bioscience and developed new technical competencies through acquisitions and R&D, and customers (farmers) and partners (e.g. food producers) could continue to use the same skills and equipment as before. However, "secondary stakeholders" (NGOs, safety advocates, scientists outside Monsanto's "comfort zone", raised concerns about the risks of gene transfer from GM crops to wild plant species, increased pest resistance and the risk of developing economies to become overtly dependent on seed companies (Hall and Vredenburg, 2003, p. 62). "*Traditional approaches to innovation usually ignores such stakeholders but many of them can play pivotal roles in sustainable development initiatives. And that was Monsanto's mistake: It failed to recognize the complex, ambiguous and ultimately disruptive impact of such secondary stakeholders*" (p. 62).

This brings us directly to the "heart" of the institutional view.

3.3. The institutional view

Institutional theory has since the 1990s increasingly been applied to better understand drivers of enterprise strategies for sustainable development that are not centrally dealt with in the business economics strategy view (among others Greenwood et al., 2015; Hoffmann and Jennings, 2011; Hoffman and Ventresca, 2002; Jennings et al., 2012). From this perspective enterprise strategies for sustainable development cannot sufficiently be analyzed in economic terms of efficiency, agent rationality, market forces associated with "primary stakeholders" and compliance to public regulation. They can also not be sufficiently analyzed at the intra-organizational level of the firm – its strategic commitments, organizational processes, competencies, routines and management visions. Sustainable enterprise strategies must (also) be analyzed as a response to broader institutional factors in society (Greenwood et al., 2015). Institutional theory deals with institutions as "*symbolic and behavioral systems containing representational, constitutive, and normative rules together with regulatory mechanisms that define a common meaning system and give rise to distinctive actors and action routines*" (Scott, 1994, p. 86). Institutions tend to be relatively enduring systems and associated with different functional arenas in society, including religion, work, the family, politics, and as the case in this context, sustainability (Jennings and Zandbergen, 1995, pp. 1034-1035). Institutional theorists are interested in the role of institutions and in the processes through which phenomena, here sustainability, become institutionalized (rule-like or taken-for-granted social facts). In our context institutionalizing sustainability involves instilling values around the term and developing new rules or practices within enterprises. For this to happen institutions or organizational fields have to emerge that contribute to create, diffuse and enforce rules and practices that reflect operationalizations of the concept of sustainability (Jennings and Zandbergen, 1995). The concept of "organizational field" is similar to but broader than the industry concept in industrial economics, industrial dynamics and conventional strategic management. It comprises "*those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resources and product customers, regulatory agencies, and the organizations that produce similar services or products*" (DiMaggio and Powell, 1991, pp. 64-65). Organizational fields (e.g. around sustainability in a particular sector of the economy) are complex entailing vast arrays of constituents, e.g. governments, local authorities, activists, community groups, the media, trade associations, investors, customers, suppliers and scientists, each with different interests, knowledge, framing and views on legitimate sustainability practices (Delmas and Toffel, 2008; Hoffman, 2001).[11]

The processes through which organizational fields influence enterprise practice reflect coercive, mimetic and/or normative mechanisms or pressures, and these mechanisms may under certain circumstances (but far from always) contribute to create a common set of values, norms, rules and practices within the organizational field (DiMaggio and Powell, 1983). Diffusing sustainability through coercive pressures mostly refers to stringent government regulation, but coercive pressures

[11] The concept is similar to the notion of "eco-system" increasingly used in the economics and management of innovation (Christensen, 2014).

may also be exercised by other powerful stakeholders, large firms (e.g. Walmart or IKEA) imposing particular sustainability practices on their suppliers, highly visible and influential NGOs (e.g. Greenpeace), authoritative media channels or community actors that may create serious barriers for companies' strategies or force them to engage in strategy changes (e.g. the Monsanto case referred to in section 3.2). Institutional theory is, however, also occupied with the more subtle institutional diffusion that takes place through mimetic and normative mechanisms. Firms mimic visible and well-defined procedures of other firms, for instance environmental audits, Lean or Environmental Management Systems, especially when such activities have become acknowledged as successful, are promoted by consulting firms, are likely to increase the firms' legitimacy and reputation and/or provide them with improved access to capital and highly qualified and motivated labor. Institutional norms may over time penetrate firms' mental models and organizational processes and become intractable and taken for granted in ways that are not consciously recognized by the management (Bansal, 2005; Meyer and Rowan, 1977).

Within institutional theory sustainability is often conceived as a logic or a set of prescriptions that somehow has to be reconciled or balanced with one or more other logics – usually those of business efficiency and market logic (Bansal, 2005; Delmas and Toffel, 2008; Hoffmann and Jennings, 2011; Jennings et al., 2012). "*Sustainability, in this sense, is usually not seen as being very compatible with existing economic logics in most industrial sectors […]*" (Greenwood et al., 2015, p. 329). Rather it is perceived as a logic that competes with existing economic practice (Gladwin et al., 1995). If the institutional forces for enhanced sustainability become sufficiently powerful, the new logic may slide into economic practice to become a key element in a renewed "economic logic" or replace the old logic. Perhaps more frequently the organizational fields evolve to constitute bargaining (or even battle) fields for dialogue, discussions or "fights" between different interests and views or lobbying for particular interpretations of what is sound business and "good enough" or "responsible" sustainability, e.g. the organizational fields dealing with interpreting and implementing rules and requirements for organic versus conventional farming.

The institutional view emphasizes the contextual rather than the intra-organizational circumstances that enable or inhibit organizational change and in this respect institutional theory is *not* a theory of strategic management. At least it cannot stand alone because it cannot explain why firms subject to similar institutional pressures pursue different strategies (Delmas and Toffel, 2004). However, it has become generally recognized among institutional scholars – also among those who deal with sustainability – that managers are not simply "puppets" enacting evolving institutional prescriptions. Managers interpret and shape those prescriptions even if they are normally not the driving force behind them (Greenwood et al., 2015), and "*[…] the question of how and why organizations respond to the sustainability logic is an inquiry into the relationship between the firm and the field (or fields in which it operates*" (p. 324). It is in the interplay between the external (institutional) and the internal (firm-based) pressures that we can understand the differential ways in which firms improve (or ignore) their environmental performance (Gunningham et al., 2003). Numerous scholars (including Bansal, 2005; Bansal and Roth, 2005; Delmas and Toffel, 2004; Delmas and Toffel, 2008; Hoffman, 2001) have tried to specify how firms environmental strategies

rely on contingencies at the institutional and firm level corresponding to Stuart Hart's (1995) call to align the (natural) resource-based theory of the firm and institutional theory (cf. section 3.1).

Based on qualitative data from 53 firms in the United Kingdom and Japan, Bansal and Roth (2000) identify three generic drivers or motivations at the firm (management) level for "ecological responsiveness": 1) Competitiveness (the potential for ecological responsiveness to identify a business opportunity that can be profitable); 2) legitimation (the pragmatic wish to comply to an established set of regulations, norms and beliefs); 3) environmental responsibility (a sense of social obligation or ethical values as a driver for environmental initiatives, irrespective of whether they are financially optimal). The study points to three contextual factors that may strengthen or weaken firm-based motivations: "Issue salience" (whether environmental issues are characterized by certainty, transparency and emotivity), "organizational field cohesion" (the intensity and density of network ties within a field), and "individual concern" (the degree to which organizational members value the environment and are able to act on these values. Among the findings are that a high level of individual concern encourages managers motivated by "environmental responsibility" to take unique environmental initiatives; furthermore, that high organizational field cohesion and issue salience encourage firms that are motivated by "legitimation" to engage in regulatory compliance which, however, does *not* give rise to competitive advantage, since firms share the same (the organizational field's) understanding of acceptable practices.

Based on data on Canadian firms in the oil, gas, mining and forestry industries, Bansal (2005) find that both resource-based and institutional factors influence corporate sustainability development. Among the institutional variables especially mimicry and media attention are found to be positively associated with corporate sustainable development. Of the firm-based variables especially international experience had a positive influence. They also find indications that institutional pressures, such as the media, decreased over time as did the firm-based variable "organizational slack" which was relatively more important in early periods when firms accommodated new changes in respect to sustainable development. This supports more general institutional theory that institutional pressure exerts the greatest influence during periods characterized by uncertainty before new practices have become institutionalized (Delmas and Toffel, 2008; Goodrick and Salacik, 1996)

Delmas and Toffel (2008) analyze the adoption of two sets of environmental management practices using survey and archival data for nearly 500 U.S. facilities in heavily polluting industries. They find that institutional pressures exerted by different stakeholders are channeled to different organizational functions (legal affairs, marketing etc.). Thus, for example, corporate legal affairs is more aware of and sensitive to pressures from non-market (or secondary) stakeholders, while the marketing department is more susceptible to pressures from market (or primary) stakeholders.

Institutional pressure is reflected in stakeholder action, but to the extent that firms proactively engage with primary and secondary stakeholders within their organizational field (related to sustainability), they may obtain competitive advantages that are not obtainable if the adaptive, pragmatic compliance mode of response to pressures reside. In the recent study by Eccles et al.

(2014) on corporate sustainability, referred to in section 2.2, it was not only found that companies committed to a long-term "high sustainability" profile tended to financially outperform "low sustainability" companies. The study also demonstrated – consistent with recent innovation studies referred to in section 3.2 and the institutional studies referred to above - that the "high sustainability" companies are significantly more likely to establish a more comprehensive and engaged stakeholder management process. "*Our findings suggest that, to a large extent, by 2009 the adaption of these sustainability policies reflects their underlying institutionalization within the organizations rather than 'greenwashing' and 'cheap talk'*" (Eccles et al., 2014, p. 2836).

Interestingly, while the significance of stakeholders is strongly emphasized in both the innovation view and the institutional view, there is close to zero cross-references in these literatures. The perspectives are complementary: While the institutional view emphasizes external stakeholders' role as "pressuring" agents influencing firms' to adopt changes, the innovation view emphasizes the role of external actors as sources of knowledge for firms' "own" innovation initiatives. Both perspectives are needed to more fully understand enterprise strategies for sustainable development.

4. The institutional and systems (of innovation) perspective on sustainable transition

Building on insights from the innovation and the institutional view of strategic management and innovation studies, a stream of literature has emerged over the past twenty years that approaches environmental innovation and sectoral transformations from a "meso-level" perspective. This means that neither firms nor national context conditions are seen as the primary driving force for innovation. According to this view, successful innovations result from the interplay between strategies and activities of a diversity of different actors operating under diverse sets of institutional conditions. The objects of analysis are therefore framed as "socio-technical systems", "innovation systems" or "sustainability transitions". These conceptual frameworks have in particular gained traction among policy makers in science, technology and innovation policy who were discontent with the seemingly mechanistic and reductionist advice that they gained from mainstream neo-classical economics on the core challenges of public policy making (Sharif, 2006). The search for meso-level explanatory frameworks was early on inspired by the challenges of maintaining economic competitiveness when confronted with an increasing globalization of industry (Nelson 1993). Later on, the dedicated efforts of many national policy initiatives aiming at a sustainable transformation of entire industry sectors such as energy, urban water, transport, food or health called for a broader understanding of success conditions for innovations (Hekkert et al. 2007). Intellectually, the frameworks build on insights from evolutionary economics, the history of technology as well as science and technology studies that expanded strongly since the early 1990s. These approaches proved in countless empirical cases how social contexts conditioned innovation success, and as a consequence, that firm strategies were not sufficient to explain the actual course of historical technology development (David 1985; Arthur 1994). Furthermore, they showed that the alignments between technological designs, actor competences and institutional arrangements (so called socio-technical regimes) lead to rather narrow variations in the innovation alternatives and

therefore exhibited strong path dependencies. Therefore, technological development could be characterized by long phases of incremental innovation that were only occasionally interrupted by periods of fundamental restructuration (Tushman and Anderson 1986; Geels 2002).

With regard to the analysis of sustainable innovation, the institutional and systems perspective therefore aims at endogenizing the relationship between firm strategies and environmentally oriented policies. The research interest in this tradition is also much more geared towards identifying conditions for radical or disruptive innovations. Incremental innovation are said to be insufficient for tackling the upcoming grand challenges for global society such as climate change. One of the most far-reaching proposals claimed that what is at stake is ultimately the development of a new techno-economic paradigm that would substantially reduce the impact of industrial activities (Stern 2008; Freeman 1996). As a consequence, this literature complements the accounts reported in earlier sections of this paper in that it emphasizes the sectoral and regional contexts in which firms engage in sustainable innovation but also highlight the conditions of longer term and fundamental transformations of technological paradigms and dominant designs. Compared to the approaches elaborated in earlier sections of this paper, particular emphasis is put on the role of coordination networks and institutional arrangements under which firms operate, which sometimes comes at the expense of analyzing the leeway for strategic action by these same firms. In the following, we will first elaborate some salient conceptual frameworks in this field before elaborating on potentially fruitful interfaces with enterprise strategies for sustainable innovation.

4.1.Clean-tech industry dynamics and sustainability transitions

Among the different literature streams that have emerged over the past two decades, we will elaborate those that constitute a field of scholarship of “sustainability transitions” (Markard et al., 2012; van den Bergh et al., 2011, Smith et al., 2010). A starting point of this literature had been the observation that there has been a surge in national regulatory, technology and industrial policies aimed at supporting (and pushing) transition endeavors of aggregate business systems (whether termed industries, sectors, innovation systems, socio-technical regimes or niches) or creating leveraging conditions for particular clean or green technologies like wind, solar or zero-emission engine technologies or systems. Major empirical fields of application of the transitions literature have therefore been in policy realms that were not in the conventional focus of innovation studies or the strategic management literature, namely utility services and infrastructure sectors. The majority of cases was therefore selected from the energy, transport, urban water sectors but increasingly also from health and agriculture (Markard et al., 2012). Sustainability transitions in these sectors are considered as especially important in order to confront global climate change or to ensure global development issues.

Within transition studies, we may distinguish two subfields of scholarship that are distinguished with regard to the primary focus of analysis:: i) research analyzing conditions for emerging clean-tech industries and ii) conditions for the transformation of entire sectors towards more sustainable future structures of production and consumption.

The first approach may be represented by technological innovation systems (TIS) framework. Emerging industries are characterized by the interplay of actors in networks, which are shaping/being shaped by specific institutional structures that support and/or hinder specific technological development trajectories. Over time industry formation has been shown to follow quite recognizable development patterns, which can be characterized by the interplay of a limited set of core processes: knowledge development, resource mobilization, entrepreneurial experimentation, guidance of the search, market formation, legitimacy formation. Lack of success in developing new technologies is said to not only depend on market or state failures. Very often early formation processes are hindered by deficiencies in the structure and function of the innovation system, so-called system failures (Weber and Rohracher, 2012; Klein-Wolthuis et al. 2005). Policy makers as well as strategically operating industry managers may therefore be informed by these analyses about potential intervention points in terms of actors' capabilities, network failures or institutional failures. In its approach, the TIS framework is member of a broader class of innovation systems frameworks, which have become influential in industrial and regional policy over the last three decades. Prominent examples are national and the regional innovation system concepts that are particularly important in European policy context but increasingly also inform governments in emerging economies (Lundvall et al. 2013). However these complementary literature streams were until recently not particularly explicit about environmentally-related innovation (Truffer and Coenen, 2012). However, the situation is rapidly changing, as more and more sustainability-oriented topics enter the policy agendas of countries, regions and cities. As a consequence, we see an increasing number of studies using RIS and NIS concepts to tackle sustainability issues (Truffer et al. 2015; Murphy 2015).

The second approach emphasizing the fundamental restructuring of entire economic sectors has been analyzed with the concept of changes in socio-technical regimes and became widely known as the Multi-Level Perspective (MLP) to socio-technical transitions (Smith et al. 2010; Geels 2004). The core analytical interest here is on the interplay between institutional dynamics (building on neo-institutional theory) and emerging technologies/infrastructures. This interplay is conceptualized as the struggles between a dominant socio-technical regime, and several (however still immature) alternative configurations that can only survive if actively supported by specific actor groups (constituting so-called technological niches). There has been a strong prevalence of historical studies of regime transitions in the literature. However, more recently we find also a number of studies that look at the dismantling of regimes (Turnheim and Geels, 2013) or that provide guidance for more future oriented analyses of sector transformations.

Transitions studies also gave rise to new policy frameworks to promote innovation in environmental products and technologies. A very early form considered the management of real world experiments. It was conceptualized as Strategic Niche Management, which promotes a system view on how to protect early technology formation processes by compensating for normal market selection pressures (Hoogma et al., 2002). This protection can be in the form of subsidies, special regulations, the definition of temporary experimental regions in which the new technology is tested and tried out. Emphasis is put on the mutual co-determination of early technology designs and institutional context conditions such as regulatory frameworks, business models or also use patterns

of early user groups (Schot and Geels, 2008; Truffer et al., 2003). In its most encompassing form, these policy-oriented conceptualizations gave raise to integrative policy programs for steering sustainability transitions, like the Dutch Transition Management approach have been proposed and tested in several countries (Rotmans et al., 2001; Kern and Smith, 2008).

Both streams of literature put the analytical focus on collaborative arrangements, network structures and institutional configurations. Linkages between meso-level structures and strategies of individual actors (especially firms) have recently been identified as a topic needing more attention (Bergek et al. 2015).

4.2. Firm strategies in context

Even though the vast majority of studies that use an innovation system or a multi level perspective highlight the meso-level dynamics of the emergence of green innovations and the transformation of current industries some studies explicitly deal with analyzing firm strategies within the context of an innovation system or a socio technical regime.

The starting point of the TIS literature is that a specific socio technical environment emerges around radical (green) innovations. When innovations are in an early stage of development the innovation system is also weakly developed and by a co-evolutionary processes the innovation system becomes more structured (more actors move in, specific institutions emerge, networks are formed) as also the innovation matures. The success chances of the innovation are highly dependent on how well the innovation system is functioning (Hekkert et al., 2007). Therefore, firms and other organizations that have an interest in the development and diffusion of the innovation are expected to contribute to a well functioning innovation system. When organizations do this purposefully it is labeled as ”system building” (Musiolik at al., 2012). The key characteristic of system building is that organizations contribute to the mobilization of resources that not only benefit the focal organization but also other organizations within the same innovation system. Sometimes these resources are labeled as network or system resources (Musiolik et al., 2012). Examples are research programs (Musiolik et al., 2012), changed regulatory frameworks (Kukk et al., 2015) and higher expectations regarding the new technology (Budde et al., 2015). The literature on system building relates to the literature on institutional entrepreneurship (Fligstein, 1997; Greenwood and Suddaby, 2006; Maguire et al., 2004), however more categories of change processes are included besides institutional change. However in some studies the focus is purely on institutional change in innovation systems. Sotarauta and Mustikkamäki (2015) describe the process of institutionalization of regenerative medicine in Finland while Geels and Verhees (2011) highlight the problematic legitimacy of nuclear energy in the Netherlands and the corresponding framing strategies of the nuclear energy industry.

Often system building is a collaborative activity. Kukk et al. (2015) for example show that a very large pharmaceutical firm strategically cooperates with patient groups, hospitals and other firms to create a market for personalized cancer therapeutics through becoming part of the reimbursement scheme of the National Health Service. Musiolik et al. (2012) show that firms interested in the development of fuel cell technology in Germany join forces to secure government funding for R&D

and form collective knowledge networks. Thompson et al (2015) show collective strategies of entrepreneurs engaged in torrefaction technology to increase the societal legitimacy for this technology. Hermans et al. (2013) highlight the division of labor between different organizations in developing and diffusion of agricultural innovations. These collective strategies are in line with the business literature on industry emergence that stresses the benefits of collective strategies (Aldrich and Fiol, 1994) also labeled as running in packs (van de Ven, 1993). In some cases the system building literature also highlights heroic individuals who have a pervasive effect on the structuring of a new technological field (Hellsmark and Jacobsson, 2009). A topic that has received very limited attention in this body of literature is the interdependencies between different products and the additional advantage for consumers when products complement each other. The strategies that follow from this insight are highlighted in the innovation ecosystem literature (Adner, 2006). In the system building literature only Kukk et al. (2015) has analyzed complementary technologies - in this case for personalized cancer medicines and testing equipment.

A related set of articles does not focus on the firms that are involved in developing and diffusion of a radical innovation but instead on the firms that are confronted by changes in their business environment. The cause of these changes may be the emergence of radical innovations that threated existing business models and markets or changing societal preferences. The firms confronted by these changes are labeled as incumbents or regime actors. Geels and Penna (2015) and Penna and Geels (2015) analyze the strategies of large automobile firms when confronted with shifts in their environment related to changing perceptions regarding car safety and climate change. They nicely show that incumbent firms initially ignore the issue, then develop defensive strategies and when the environmental pressure becomes too high the firms shift towards proactive strategies to deal with changes in their environment. A similar process where firms gradually shift from purely defensive strategies towards more pro-active strategies is also shown by Wesseling et al. (2014a, 2014b and 2014c). These studies show how large automakers react to the clean air act in California that has the aim to force zero emission vehicles to the market. Where large automakers were initially strongly against the regulation and developed intensive (collective) lobby activities to either reduce the stringency of the regulation or to remove it completely, in later years this attitude shifted. The authors show that differences in innovation capabilities may be an important explanation for this change in attitude. Highly innovative firms at a certain moment in time recognize that the regulation may provide them with a competitive advantage.

The defensive nature of incumbent firms when confronted with green innovations is highlighted by Smink et al. (2015) who have described a range of defensive strategies by incumbents. The article shows that incumbents effectively use their network positions and resources to raise entry barriers of new entrants that have developed radical innovations.

The studies on incumbent strategies and those on system building strategies of innovative firms both highlight the intense battles between incumbents and new entrants. Both incumbents and new entrants use a wide range of strategies to either build up a favorable environment for the innovation or reproduce existing structures that favor incumbents firms. Contrary to the literature reviewed in section 2 and 3.1 in this body of literature institutional strategies receive much attention.

5. Conclusion: Linking the perspectives and identifying complements

The point of departure for this paper was the observation that central social science streams dealing with the increasing need for sustainable enterprise strategies have largely been unconnected, hence knowledge accumulation has tended to take place narrowly within each stream and not across the streams. The objective of the paper has *not* been to do an extensive review of all the literature fields covered in this paper (that would be far beyond the scope of one paper), but to seek to explicate key insights from each field and explore complementary bridging potentials for a more balanced and comprehensive analysis of the nature and drivers of companies' sustainability strategies. A sound and balanced research foundation that draws on insights from the different streams is needed for informing policy makers, business managers and institutional stakeholders engaged in sustainable enterprise strategies.

Complementary insights from the different perspectives

The research in the wake of the Porter Hypothesis has shown that regulation tends to lead to innovation which, again, tends to have a positive impact on business performance even if not fully compensating the cost of compliance. The "pays to be green" studies do not provide a unequivocal "yes, it pays", but the overall pattern shows a positive relationship between environmental practices and commercial performance. This latter literature stream provides solid evidence that many sustainability-improving initiatives pay off. On the whole these findings support the original premise of the Porter Hypothesis that (much) pollution and emission can be considered costly waste. However, these studies tend to cover relatively incremental environmental measures or innovations that help to reduce the negative environmental impact, but mostly only marginally so.

The business economics strategy research complements the "pays to be green" research by specifying strategic mechanisms through which companies may commercially benefit from aligning sustainability (conceived as a public good) with their competitive business strategies (e.g. through cost savings, product differentiation, private club-based regulation, risk management or addressing cleantech market niches). Together with the "pays to be green" research this strategy literature has demonstrated that it can – under particular circumstances – make good business sense to "go green" even if not forced to by political authorities. However, this literature also tends especially to address more incremental measures and innovation and only vaguely refer to potentials for more radical sustainable development.

While the economics and management streams of research (Porter Hypothesis and "pays to be green") do not consider the particular features characterizing "green innovations", these topics are subject to special attention in the subsequent streams of research covered in the paper: The innovation and institutional views on strategic management and the systemic transition perspective. Research on environmental innovation has addressed special barriers and features that tend to make sustainable innovation more difficult to conduct than other innovation: The double externality problem (the public good nature and the risk of knowledge leaks), the dependency of many

environmental innovations on public push/pull policies, the high complexity of competencies required and the need for external collaboration with a wide array of stakeholders, both market and non-market stakeholders, the latter of which are often outside the "comfort zone" of the companies. While the quantitative innovation studies – like the "pays to be green" studies - have a bias towards incremental innovation/measures, recent more case-based innovation studies have begun to also address the particular challenges facing more radical innovation which is increasingly considered needed to face the challenges of climate change and resource depletion: "*Yet while these challenges call for bold innovation, most firms continue to focus on incremental strategies such as eco-efficiency, pollution prevention, product stewardship, and corporate social responsibility. As important as these corporate initiatives have been, it is now clear that such incremental sustainability strategies will simply not be sufficient. Companies and management scholars are being challenged increasingly to develop breakthrough strategies that actually resolve social and environmental problems, rather than simply reducing the negative impact associated with their current operations*" (Hart and Dowell, 2010, p. 13).

The more incremental sustainability measures and innovations seem better reflected in the theories and assumptions of Porter Hypothesis, the "pays to be green" and the business economics strategy view emphasizing the significance of the market factors, including public regulation to eliminate market failures, and a fairly short-term shareholder logic. By contrast, the more radical and systemic sustainability strategies fit less well into these frameworks and are better reflected analytically in the innovation, institutional and the systemic transition perspectives that emphasize the significance of broader institutional factors, secondary stakeholders and a longer-term (evolutionary) time horizon.

Institutional/stakeholder forces play central but different roles within respectively the innovation and institutional view on strategic management as well as in the systemic transition view. Research within the innovation view demonstrates that external stakeholders (market and non-market) are key sources of knowledge needed to realize firms' innovation strategies – and increasingly so when moving from "normal" to incremental and radical sustainable innovation strategies. Still, the innovating firms are assumed to drive or control (more or less) the innovation process through engaging in collaborative interaction with a variety of stakeholders. Research within the institutional view demonstrates that institutional forces exert pressures on firms' to change or adapt their sustainability practices. Here the firms are conceived as less autonomous in that they have to respond strategically to demands and pressures (more or less) beyond their control even if their response is also influenced by their internal conditions such as competence profiles and management motivations. In the systemic transition perspective, firms are considered part of the overall institutional and interactive stakeholder game that – together - are considered prerequisites for the *system* (polycentric agency) to undergo sustainable transition.

Firms as more or less autonomous agents

Even if the title of the paper, "Enterprise strategies for sustainable innovation" acknowledges some level of strategizing agency at the individual firm level, that is a capacity to make autonomous

decisions and act for the longer term, the different perspectives have different framings of the degrees to which enterprises have autonomy in strategy-making. The regulatory/economic part of the economics/management perspective as reflected in the Porter Hypothesis literature identifies the central or driving agency to be the *political or governmental authorities*, while firms are assumed to respond more or less rationally to the regulatory incentives or requirements that authorities impose. The "pays to be green" research stream as well as the business economics strategy view assume the *individual firm* to possess the primary strategizing agency role even if constrained by external contingencies and bounded rationality. These latter views address the economic and market factors underlying firms' strategic agency and research within these traditions show that some (many) firms find commercially attractive channels to integrate sustainability beyond regulatory requirements. The institutional and innovation views on strategic management put more emphasis on the constraints and opportunities stemming from the broader institutional context - beyond the narrow market forces - for firms' capacity to strategize. This institutional framing is shared by the systemic transition perspective which takes the further step to dismantle the individual firm as *the* sole or primary strategizing agent. This perspective does not subscribe to a monolithic firm-focused agency underlying systemic changes, nor does it accept the regulatory/economics view of the political regulator as the driving agency. By contrast, this perspective assumes a distributed, *multi-agency* or interactive *stakeholder view* typically within the scope of an industrial sector or a technological system. Such agents may not only comprise political actors and enterprises and their market forces, but also a broader set of institutional stakeholders (e.g. NGOs, professional associations, media, community agents, research and standards institutions) that are often characterized by divergent interests, strategies and resources/power bases. And the political actors are not only designers of "regulations" as conceived in the economics/regulatory perspective but also of a vast array of innovation promoting policies (e.g. R&D programs, applied research centers, university-industry collaborations) and infrastructural investments (e.g. in smart grids, city planning and in public and private transportation systems).

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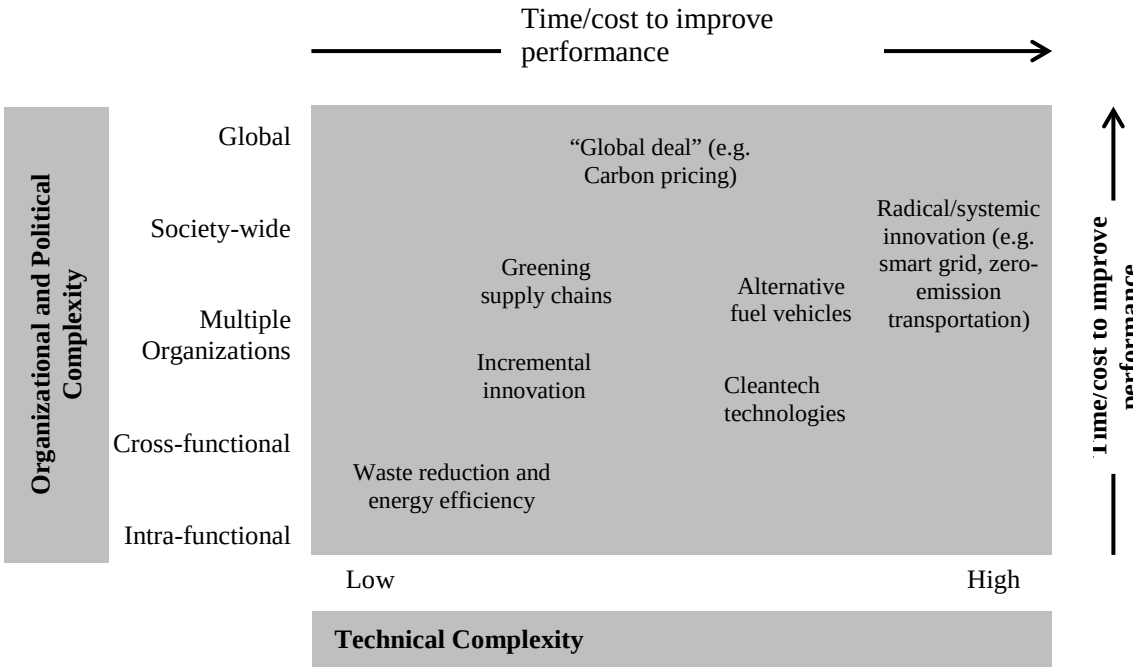
John Sterman (2015) has proposed a way to qualitatively map different types of sustainability initiatives/programmes into a space of technical (technological) and organizational and political complexity. The idea is that technically and organizationally simple (incremental) sustainability measures will yield quick financial returns and quick, but incremental, environmental improvements, while more technically and organizationally (and politically) complex (more radical) measures (investments, programs) will prove more difficult to implement , be more risky but potentially yield larger returns and large-scale environmental improvements at the longer term. We have slightly adapted this framework for our purpose: Firm-based agency, incremental improvements and "pays to be green" returns reflected in the economics and management perspective tend to be located in south-west part of the space, while the radical, systemic transition endeavors tend to reside in the north-western end where the firm-based autonomy is much smaller and the systemic transition perspective provides a more relevant means of analysis.

Figure 2: Sustainable development strategies in the context of organizational/political and technical complexity



Source: Inspired by and adapted from Sterman (2015), p. 56.

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