The Effects of Environmental Innovation on Market Value

By

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I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

This paper describes the effects of environmental innovation, or EI, on the market value of a firm. EI involves the creation or enhancement of 'green' products or 'eco-efficient' production processes which result in improved environmental performance. The study involves the selection of a number of press releases related to EI and environmental performance. These form the basis of an event study to determine the effect of these announcements on share prices. Results indicate that the market recognizes the value of EI, especially for product-driven initiatives. It is also found that the market values good environmental performance, particularly when it has been recognized externally through an award, membership, or certification. Implications for policy and for management are discussed.

Acknowledgments

I would like to thank Dr. Bon Koo, of the Department of Management Sciences at the University of Waterloo, for his patient advice and guidance. He taught me that even though I may start out wanting to draw a tiger, it's okay to end up with a picture of a cat.

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Table of Contents

List of Figures

List of Tables

Chapter 1

Introduction

The last century has brought with it many technological advances that have allowed us to enjoy a lifestyle never imagined at the birth of the Industrial Revolution. As with most good things, this lifestyle comes at a price – in this case severe negative impacts on our natural environment, some of which are irreversible. The tide of the industrial effect may be stemmed by the flow of information from ecologists and other scientists providing linkages to the causes of degradation. The question remains though: is this knowledge enough to change the corporate and individual behaviour that will ultimately affect our future?

Public companies rely on investment from external shareholders to raise capital for R&D, patents, property, plant, and other means of production. It is through their choices as investors then that individuals can exert some control over corporate behaviour. Companies and individual investors, and of course consumers, have joint responsibility for the environmental effects of our increased industrial productivity.

Investments in the capital market, if we assume a rational market, are motivated by returns, moderated by risk and based on the perception of investment value. The value of an investment may be measured by some solely by its ethical and social merits; however the notion of profitability is normally of primary importance to the majority of investors. It is admittedly difficult to determine the true motivation behind a particular stock purchase, but we can observe the market reaction to socially responsible corporate behaviour. It becomes a moot point, however, whether a corporation is attempting to curry favour with its investors in creating a

green image through environmental innovation, or if in fact investors buy shares only for the sake of anticipated returns. Regardless of the motivation of either the corporation or the individual, the net result of their investment could result in the 'win-win' scenario of being 'green and competitive' as described by Porter and van der Linde (1995).

This is not to say that corporate executives are not capable of recognizing the intrinsic value of environmental responsibility. Ray Anderson was, in 1994, the CEO of Interface – one of the world's largest carpet manufacturers. When asked to provide an 'environmental vision' to his research group, who were attempting to respond to public concerns about their company's ecological impact, he found he didn't have one. He was struck with the realization that 'For 21 years I never once thought what we were taking from the earth', that he had been involved in 'plundering' and 'the day would come when people like me would end up in jail'. After cleaning up his own operation, Anderson became an evangelist for the cause (Bakan, 2004). Anderson may be an exception among corporate leaders – others may require the promise of sustainable competitive advantage and enhanced financial performance to 'go green'.

This research attempts to verify the relationship between environmental innovation and the market value of a firm, as well as to deconstruct the mechanism through which this occurs. Event study methodology is used to determine if a significant relationship exists between announcements of environmental innovation or reports of good environmental performance, and a change in value of the company's stock. The goal is to provide further credibility and support to investment, both corporate and individual, in environmental innovation in order to drive the 'triple bottom line' (Elkington, 1998) of financial, social and environmental performance.

Chapter 2

Literature Review

2.1 Environmental Innovation

The cycle begins with innovation. It has been the driver for the industrial expansion that has led us to this point. Ironically, innovation may also provide a solution to the problems that this expansion has caused. Environmental innovations, or eco-innovations, are considered by Rennings (2000) as contributing to 'a reduction of environmental burdens or to ecologically specified sustainability targets'. According to Rennings, technological environmental innovation must be accompanied by supporting organizational, social and institutional innovation in order to thrive. Researchers are encouraged to pursue a multi-disciplinary approach to study of environmental innovation. By combining neoclassical, environmental and innovation economics with an evolutionary approach one can avoid 'technology bias' when attempting to solve environmental problems. After all, Rennings points out, unsustainable development is the result of technological growth outpacing social organizing and without supporting regulations and economic incentives.

Although this study is limited to technology-based innovations, the author attempts to avoid technology bias by analyzing the market response (a social and institutional phenomenon) to investment in environmental innovation (organizational). It is the intersection of the technological, organizational, social and institutional environments that provides the backdrop for the study.

2.1.1. Types of eco-innovation

Eco-efficient processes. Process-driven initiatives are considered by this study to be preventative, rather than curative, and involve the improvement of existing processes, or adding new processes to production to reduce environmental impact. According to Rennings (2000) these can be additive, or end-of-pipe, solutions such as smokestack scrubbers or be integrated into the production process through substitution of inputs, optimization of production and reclamation of outputs. Figure 1 shows these various types of preventive environmental technologies and their relationships.

Green products. The full environmental impact of a product is determined by an analysis of its life cycle. Pujari et al. (2004) described life cycle analysis as involving all aspects of a product from its creation, its use, to its disposal. This of course implies that a green product can be the result of an eco-efficient process such as electricity produced from wind power. Compact fluorescent bulbs are an example of a product that is green through its use, while a CFC-free air conditioner is considered green primarily due to its reduced disposal impact.

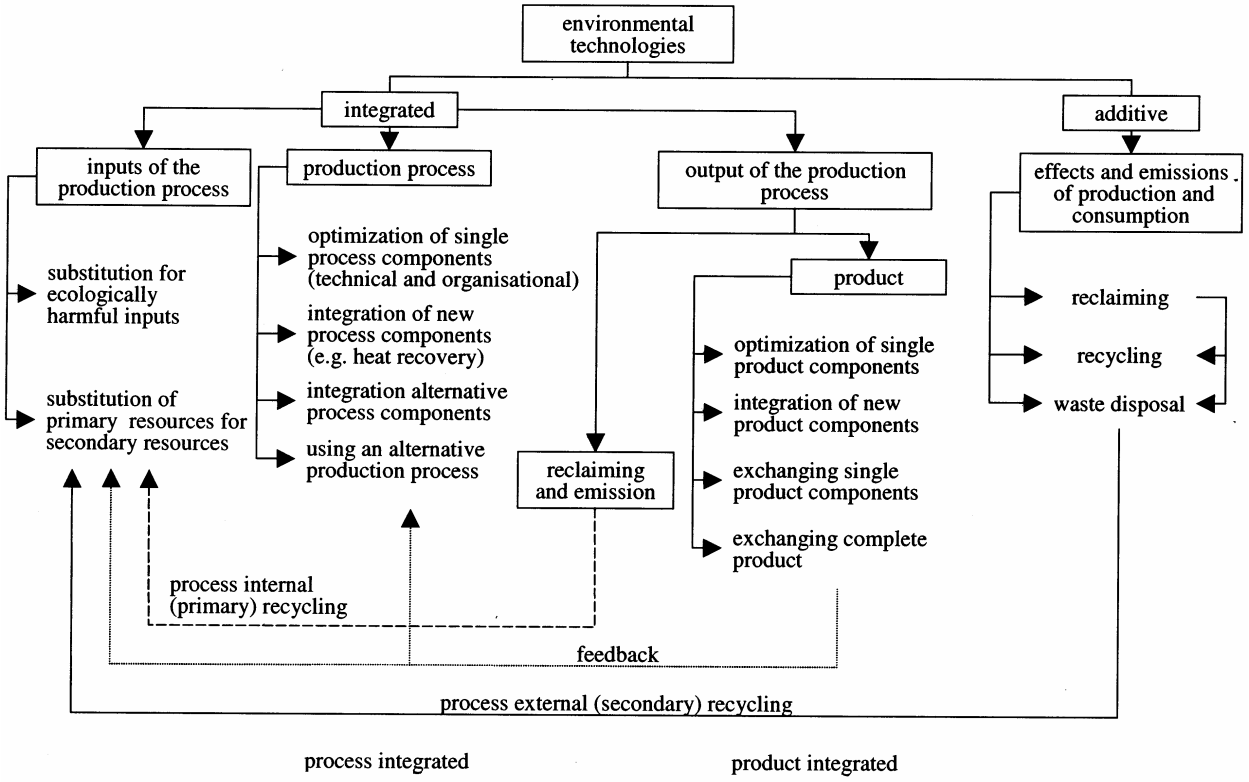

Figure 1. Preventive environmental technologies. Source: Rennings (2000).

Rennings (2000) found that firm's decisions to implement a green product innovation is determined mainly by the 'market pull' effect, while process-driven innovation is a result of regulatory pressure. Their research found that, through both the implementation of eco-efficient process and the creation of green products, a corporation is able improve its environmental and financial performance.

2.1.2. Environmental Performance

According to the ISO 14001 standard for environmental management systems, environmental performance is the measured results that an organization attains through environmental management. Most quantitative studies of environmental performance have focused on the firm's production processes: expenditure on pollution control (Spicer, 1978;

Nehrt, 1996), emissions levels (Hamilton, 1995; Hart and Ahuja, 1996), spills (Karpoff et al., 1998) or law suits as a result of environmental degradation (Muoghalu et al., 1990). Other research, including the work of Russo and Fouts (1997) and McWilliams and Siegel (2001) has expanded the scope to include green products and their role in corporate social responsibility, of which environmental performance is a part. Figure 2 shows the relationship between product or process-driven environmental innovation and environmental performance.

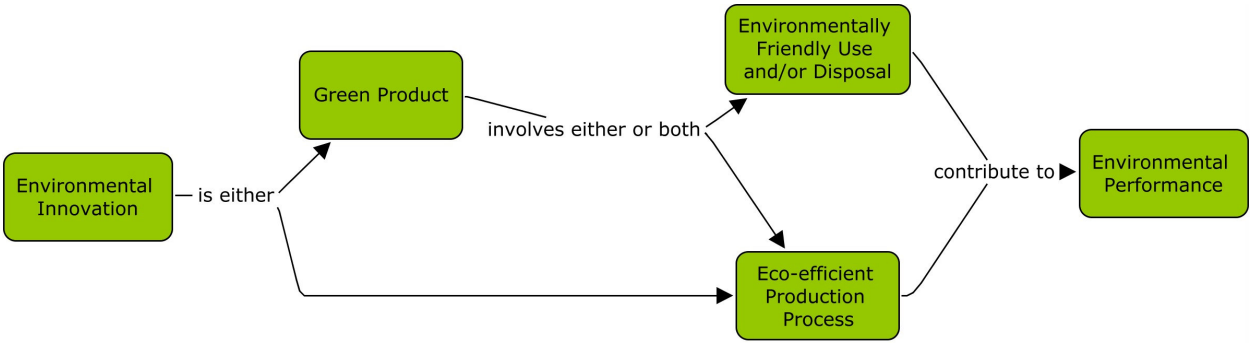

Figure 2. Relationship between environmental innovation and performance.

Products can be considered green as a result of their production process, use or disposal characteristics, as explained by Pujari *et al.* (2004). In a survey of environmental new product development, Pujari (2006) found that the majority of companies were attempting to reduce the impact of their products, to make them 'cleaner' rather than truly sustainable. The study concluded that the success of a product would be measured by its ability to displace other less environmentally-friendly products by establishing market share. This implied that the green product would have to demonstrate good 'eco-performance' without sacrificing the expected functionality. Within these constraints, green products can become an important component of a company's environmental performance.

2.2 Environmental Innovation and Corporate Reputation

Public companies have been historically profit driven for the benefit of their shareholders as the primary 'stakeholders'. The concept of stakeholders has since been expanded to include employees, customers, suppliers and investors and community as described in Freeman's (2001) review of the stakeholder approach to strategic management. According to Chun (2005), corporate reputation is the combined perception of the company of internal stakeholders (identity) and external stakeholders (image). Chun's study builds on the work of Fombrun *et al.* (2000) which defines reputation as a 'collective construct that describes the aggregate perception of multiple stakeholders about a company's performance'. Chun makes use of the RQ (Reputation Quotient) model developed by Fombrun, as shown in Table 1, in order to establish a reliable measure of reputation and determine its effect on financial performance. In this model, six factors are determined to contribute to a company's reputation, while a number of specific company attributes contribute to each factor.

In order to reflect an image of corporate social responsibility to its stakeholders, many organizations' vision or mission statements describe their commitment to environmental sustainability. The author contends however that in order to create and maintain a reputation for social and environmental responsibility and high quality products and services (two important factors in RQ model) companies will need to take visible action towards improving environmental performance through environmental innovation.

The majority of the public, including shareholders or potential investors, become aware of a company's activities directly or indirectly from announcements either issued by the company or an external source. Stakeholders' perception, or image, of the company is adjusted

as they receive new information and as stated earlier, reputation is the result of stakeholder perceptions.

Table 1. Reputation quotient (RQ). Adapted from Chun, 2005.

RQ: 6 factors and 20 items	
20 items	6 factors
I have a good feeling about the company	Emotional appeal
I admire and respect the company	
I trust this company	
Stands behind its products and services	Product and services
Develops innovative products and services	
Offers high quality products and services	
Offers products and services that are good value for money	
Has excellent leadership	Vision and leadership
Has a clear vision for its future	
Recognizes and takes advantage of market opportunities	
Is well managed	Workplace environment
Looks like a good company to work for	
Looks like a company that would have good employees	
Supports good causes	Social and environmental responsibility
Is an environmentally responsible company	
Maintains a high standard in the way it treats people	
Has a strong record of profitability	Financial performance
Looks like a low risk investment	
Tends to outperform its competitors	
Looks like a company with strong prospects for future growth	

2.2.1. Effect of Environmental Innovation on Reputation

Environmental innovation in the form of eco-efficient processes or green products has the potential to affect stakeholder perceptions upon implementation and in some cases even in the development phase. Announcements of environmental innovation, such as the creation of a high power extended life battery for hybrid automobiles or a method to drastically reduce toxic byproducts of production, are likely to effect the reputation of the company or companies involved. Assuming stakeholders are able to understand the potential of such innovations, this information will be used in forming or adjusting their perception of the company. Using

Fombrun's RQ model, stakeholders may be influenced by these announcements to believe the company 'Develops innovative products and services', 'Is an environmentally responsible company' or perhaps 'Looks like a company with strong prospects for future growth' (Fombrun *et al.,* 2000). As stated earlier, it is neither obvious nor relevant which factors of the company's reputation would be affected in these examples – social and environmental responsibility, financial performance or others. The salient point is that there would be an overall positive impact on reputation resulting from the announcement of environmental innovation.

Process-driven versus product-driven innovation. It is important to note that although both eco-efficient process and green products both contribute to good environmental performance in the long run, products stand out in their ability to enhance corporate reputation. In a study of corporate environmental initiatives, Gilley (2000) observed that a new or improved green product has a larger effect on a company's environmental reputation than changes in their production processes. Gilley suggests that consumers consider the effects of product greening in the context of product use as well as disposal. While eco-efficiency and pollution prevention are of vital importance to long-term sustainability, green products are attractive in the market and create immediate value for the company. The implication for managers is to focus on 'traditional value creating activities', namely green products, to generate revenue which could eventually spill over into eco-efficient production processes.

Environmental process changes are generally internal to the firm and receive far less media and public attention than do products. Although event studies such as those performed by Gilley focus on point-in-time events represented by company announcements, there may be other information available to the investor that contribute to his or her investment decision. For

example, the announcement of a new hybrid vehicle may remind the reader of a related newspaper article, a friend's automobile purchase decision, or an automobile magazine review a competitive product that has done well in the marketplace. In this case, the announcement may only be a trigger whereas the investment decision is actually based on a complex collage of information. Process enhancements, on the other hand, are normally complex, industry or company specific, and internal to the organization hence less accessible to the average investor. One must therefore consider the context of an announcement when predicting its effect on investment behaviour. Taking context into consideration, it is not surprising that Gilley found environmental product announcements to have a more marked effect than those for new or enhanced environmental processes. In fact, negative abnormal returns were associated with the latter.

This however does not negate the importance of environmental process innovation. As indicated in the data of this study, announcements of process innovation were found to occur with equal or greater frequency when compared to product announcements, as shown in Table 2. Compliance with government environmental regulations and response to public pressure would tend to encourage these activities within organizations irrespective of any explicit benefits to the company.

It may be the case though that the cost of implementing environmental process solutions outweighs the immediate economic or reputation enhancement benefits. Walley and Whitehead (1994) argue that solving environmental problems has a real economic cost to which society must commit knowingly, stating that "Talk is cheap; environmental efforts are not" (Walley and Whitehead, 1994: 2-3). This viewpoint stands in sharp contrast to the "win-win" scenario

proposed by Porter and van der Linde (1995). Given the societal need to enhance environmental performance however, this may be a moot point. Although it is admittedly difficult to separate the negative financial concerns from the positive effect of corporate social responsibility, the author expects that the low-profile high-cost environmental process innovation (as compared with product innovation) would result in an overall net decrease in company reputation.

Figure 3 shows the relationship between environmental innovation and reputation, as well as the moderating effect of product versus process-driven innovation.

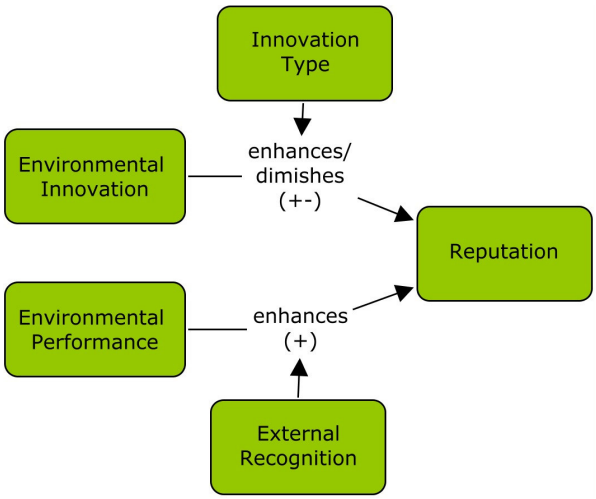

Figure 3. Relationship between environmental innovation, performance and reputation.

2.2.2. Effect of Environmental Performance on Reputation

While environmental innovation has an immediate effect on corporate reputation it also has an *ex-post-facto* effect through enhanced environmental performance, as shown in Figure 2. There is a delay between the implementation of an eco-efficient process or the introduction of a green product and its effect on corporate environmental performance. The results of process

improvements need to be monitored over time, and the resulting outputs measured, reported upon and possibly audited before their impact is publicly known, or in fact even known internally. Innovative products require time to diffuse in the marketplace before their full benefit can be realized. A durable product promising more environmentally-friendly disposal characteristics may take an extended period of time, post innovation, to prove itself. Even then, the general public is not likely to be able to judge its efficacy. Eventually though, information regarding the results of environmental innovation initiatives will reach the public and affect their perception of the company.

To illustrate the impact of environmental poor performance on reputation, one can find numerous examples of companies whose reputations have suffered as a result of environmental incidents. Research by Klassen & McLaughlin (1996) found that corporate reputations that have taken years to establish can be gradually eroded by poor environmental performance over the years or devastated overnight with a large environmental disaster. Exxon, Union Carbide and Hooker Chemical are a few of the multi-national companies that had their reputations tarnished by toxic releases and spills. It follows that reduction of the number of such incidents and related complaints, fines and litigation would be beneficial to the company.

Positive news, as would be expected, has been found to have the opposite effect on reputation – particularly news of superior environmental performance as shown in the event study of environment-related announcements by Dasgupta, Laplante, & Mamingi (2001).

External recognition of good environmental performance. Investors may not be adequately informed to assess the value of a corporate environmental initiative, especially in the early stages. Once launched, a new product takes time to prove itself in the market.

Environmental issues in general are extremely complex, and we do not understand all of the interactions. Klassen & McLaughlin (1996) observed that the market may wait for a signal to indicate that the product or process is living up to its claims. Environmental awards, certification and membership-based organizations such as the World Business Council for Sustainable Development (WBCSD) provide evidence to stakeholders of a company's exceptional environmental performance.

In a study of corporate emissions reductions, Arora and Cason (1996) determined that voluntary over-compliance was motivated by external recognition of their activities. The study concluded that awards were an effective means of motivating companies to achieve outstanding pollution reductions by creating good publicity. Figure 3 shows the relationship between environmental performance and reputation, along with the moderating effect of external recognition.

2.3 Corporate Reputation and Market Value

Several arguments have been made on the relationship between corporate reputation and market value. Some have claimed that the cost of social responsibility puts firms at an 'economic disadvantage' when compared to their competitors. Others view the benefits gained elsewhere as negating the costs. Stakeholder theory states that financial performance is dependent on maintaining the company's reputation in the eyes of a large diverse group of interested parties (McGuire et al, 1988).

Numerous quantitative analyses have confirmed the relationship between a firm's reputation for corporate social or environmental responsibility and its financial performance (McGuire *et al*, 1988; Hart, 1995; Russo and Fouts, 1997; Salama, 2003). Investors would be

expected to react favourably to positive news while the Efficient Markets Hypothesis (Fama, 1991) suggests that the news would have an immediate effect on the share price of the announcing company. Just as a company's environmental performance, as perceived by stakeholders, has an effect on its reputation, a company's reputation affects investors' expectation of its future financial performance. According to Fama (1970), news that affects investors' perception of the company's long-term value will produce abnormal returns that are significantly different from zero. The market value of a firm, based on the price and number of outstanding shares, is continually adjusted based on investors' anticipated financial performance, as illustrated in Figure 4.

Figure 4. Relationship between reputation and market value.

Since the short-term costs of pollution prevention may be higher than the penalties for polluting, many companies fail to take into account the value of reputation when considering the cost of pollution prevention as noted by Lanoie, Laplante, & Roy (1998). Their event study determined that business value losses did occur after announcements related to poor environmental performance. They also found a strong correlation between the company's history of pollution and its size with the magnitude of the effect. Klassen & McLaughlin's (1996) study found that reports of incidents involving environmental degradation caused an average decrease of 1.5% in market value, or $390 M. Arora (2001) found that companies, especially those in particular industries and with history of pollution problems, were not

rewarded for meeting or exceeding the stakeholders' expectations for pollution prevention. They were however heavily penalized for failing to meet expectations and are under enormous public pressure to improve.

Klassen also analyzed the reputation enhancing effects of environmental awards which resulted in average abnormal stock price increases of 0.82%, representing $180 M of increased business value. The study concluded that an environmental award 'signals to the public strong historical environmental performance and the likelihood of continued strong performance and higher earnings for firm in the future.' (Klassen & McLaughlin, 1996)

Reputation is considered an intangible asset of the company and can be quantified as such. Hall (2006) asserts that the stock market values firms as a 'bundle of tangible and intangible assets' comprised of a risk adjusted total of the book value of tangible assets, knowledge assets gained through R&D, and other intangible assets.

Konar (2001) developed a method, based on Tobin's *q*, to measure the value of intangible assets based on the assumption that the replacement value of tangible assets (V_T) plus intangible assets (V_I) equal market value, or $MV = V_T + V_I$. The value of intangible assets could be derived as the other terms are available through standard accounting methods. The authors created a regression equation to incorporate elements that they believed could influence the value of intangible assets including the company's toxic release inventory and the number of environment-related law suites. This was run using 1989 corporate financial and market data for 321 S&P 500 firms to determine the correlation between the environmental variables and market value from which intangible asset value was derived. The paper explains the relationship between market value, Tobin's *q* and profitability and that 'market valuation is based on

expected value of future performance' (Konar, 2001). The implication is that intangible asset value represents the market's expectation of returns in the long term.

Konar determined that his sample of S&P 500 companies had lost, as a result of diminished environmental reputation, business value equivalent to 9% of their tangible assets or $380 M. The study concluded that the value of lost reputation was far greater than the cost of any associated fines or lawsuits. This 'reputation deficit' was found to be much higher for industries with a history of polluting including chemical, manufacturing, metals and paper. The low-tech sector may have the most to gain both through environmental innovation for the purposes of cost cutting, compliance and reputation enhancement.

The message for industry however is that this value can be recovered through proactive efforts to restore their environmental reputation. Konar (2001) projected that a 10% reduction in emissions would result in a $34 M increase in market value entirely attributable to reputation.

Chapter 3

Hypotheses

3.1 Introduction

This study will attempt to test whether announcements related to environmental innovation and environmental performance will have a positive effect on the firm's reputation and consequently affect investors' anticipation of financial performance, as shown in Figure 5.

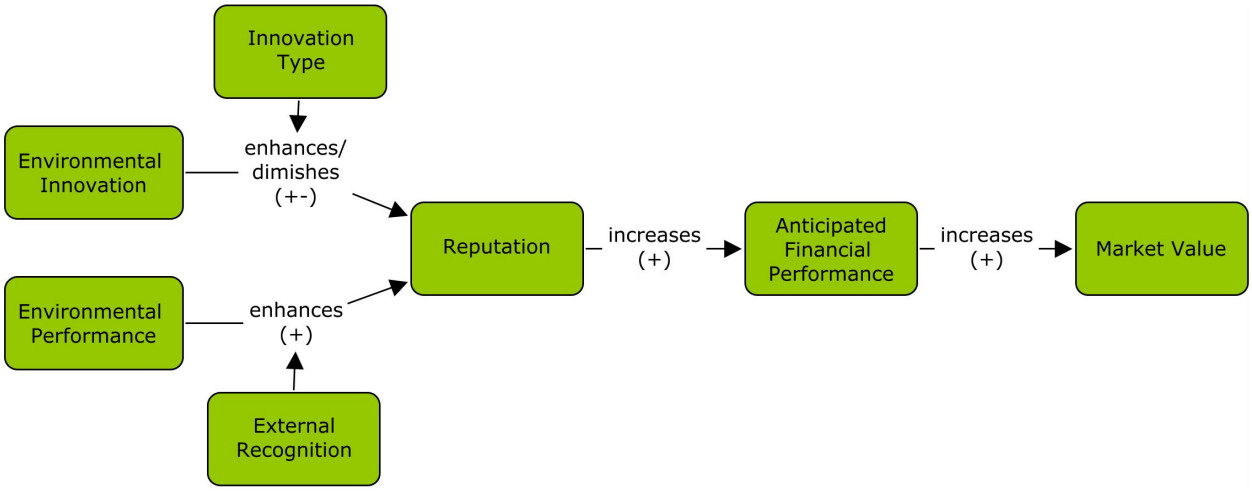

Figure 5. Effect of environmental innovation and environmental performance on market value.

Studies by Konar (2001) and Hall (2006) concluded that a company's reputation can be considered an intangible asset and quantified using Tobin's Q, which has been used as a proxy for expected financial performance. Reputation enhancement, due in this case to environmental innovation or enhanced environmental performance, would tend to encourage investment thereby increasing the market value of the firm. This line of reasoning is supported by the Porter

Hypothesis (Porter and van der Linde, 1995) that asserts that companies can be both green and competitive in response to Walley and Whitehead's (1994) "win-lose" position on the cost of implementing environmental solutions. McGuire (1988) provided empirical evidence to support a link between a firm's reputation for corporate social responsibility and financial performance. It was found however that past financial performance was related to future corporate social responsibility rather than the reverse as might be expected. In Chun's (2005) study, corporate reputation was broken down into its eight components including financial soundness, innovativeness and social responsibility which were considered to contribute to future financial performance.

3.2 Environmental Innovation

There are three economic determinants of investment in environmental innovation, according to Rennings (2000): technology push, regulatory push and market pull. Whereas new or improved technologies or processes are driven by technology or regulatory push, market pull describes consumers' preference for environmentally friendly products or an environmentally responsible company. The author claims however that the market would react positively whether the innovation was pushed by regulations or pulled by consumer demand. In this case it might be an announcement of an alternative to chlorine-based bleach in a pulp and paper mill. Whether the environmental innovation was voluntary or as a result of stricter environmental policy the net result for the company would be the same. As explained by Konar (2001) the company would likely recover some reputation, or intangible assets, lost due to environmental concerns.

Pujari (2006) emphasizes the link between green products and corporate financial performance while Gilley (2000) notes that product based environmental innovation tends to

have a more marked effect on reputation than do processes, therefore innovation type will have a modifying effect on the relationship with market value. In fact, Gilley's results showed negative abnormal returns for process based environmental innovation. With this in mind, the following two hypotheses are proposed for environmental innovation:

Hypothesis 1a: Announcement of process-driven environmental innovation will have a negative impact on the firm's market value.

Hypothesis 1b: Announcement of product-driven environmental innovation will have a positive impact on the firm's market value.

3.3 Environmental Performance

Environmental innovation, whether through the introduction of eco-efficient processes or green products eventually results in improved environmental performance and subsequently reputation. As with environmental innovation, enhanced reputation due to good environmental performance will influence investors' expectation of firm financial performance and result in increased market value as shown in figure 6. Hart (1995) found a direct relationship between a firm's reputation for environmental social responsibility and a sustained competitive advantage. This was later confirmed empirically by Russo and Fouts (1997) in a longitudinal study of a firm's environmental performance using a multiple regression model and accounting measures of profitability. Based on the resource-based view of the firm, this study analyzed 243 firms over a two year period finding a link between environmental and economic performance which is modified by industry growth.

Past research has found that managers are aware of this link and will in fact exceed compliance levels for environmental performance voluntarily. Konar's (2001) study may explain why large companies tend to invest more than the minimum required to achieve regulatory compliance as the additional spending on environmental performance results in reputation enhancement which is rewarded in the market. It is not certain however that the relationship is causal, or perhaps that profitable companies, already with substantial reputation-based intangible assets, can invest more to improve environmental performance. Arora and Cason (1996) found evidence that managers will push to exceed environmental compliance levels in competing for government sponsored awards, as they obviously appreciate the value of external recognition. Klassen & McLaughlin's (1996) event study concluded that the market may need the external recognition or validation of an award, certification or membership to signal that a company in fact has exhibited excellent environmental performance. The author expects a different market reaction from a report of good environmental performance and, for example, an award for pollution prevention. The following hypotheses are therefore proposed for environmental performance:

Hypothesis 2a: An announcement reporting good environmental performance will have a positive impact on the firm's market value.

Hypothesis 2b: Announcement of an award, membership, or certification for good environmental performance will have a positive impact on the firm's market value.

Chapter 4

Methodology

4.1 Introduction

Event study methodology, as noted by MacKinlay (1997), is considered an effective tool for determining the impact of firm-specific, industry, or economic events on the value of firm. The assumption of a rational market and the Efficient Markets Hypothesis (Fama, 1991) suggests that news will be immediately reflected in the marketplace, observed as changes in the security prices of affected companies. These changes can be measured over a short period of time to determine the magnitude and sign of the effect of the news on company value. Developed in the 1930's, the technique was improved over the next three decades, for example by removing market effects and confounding events, to resemble what is now in common use.

The study begins with the definition of the event of interest and the period, or event window, over which security prices will be measured. This window is often defined to include the event day and the day after, as well as the day prior to the announcement to capture the effect of any pre-announcement information. The effect is measured in terms of abnormal returns – the difference between the return of the security and the normal, or expected, return for the firm during the event window. The two methods used for determining expected returns are the *constant mean return model* and the *market model*. The former uses the mean value of the security, as implied, while the latter assumes a linear relationship between the market and the security. Normally a period of 120 or more days before the event is used to determine the parameter estimates for the model (MacKinlay, 1997). Abnormal returns are then calculated,

using the market model, by taking difference of the actual security return, R_{it}, and the market return[1] during the holding period as follows : $AR_{it} = R_{it} - (\alpha_i + \beta_i R_{mt})$, where t is the day number in a series of days, i is a security and R_{mt} is the market return which is adjusted for risk with using the alpha and beta of the security to arrive at the expected return. The market-adjusted model is a restricted market model which removes the risk adjustment calculation by constraining alpha to zero and beta to one, resulting in: $AR_{it} = R_{it} - R_{mt}$. This model may be used when estimation data are unavailable. MacKinlay explains the advantage of the market model is that it removes that portion of the return related to changes in the value of the market thus reducing the variance of the abnormal returns. The success of this method depends upon achieving a high R^2 value for the market model regression in order to account for as much of the market-related variance as possible.

Other statistical models can be used, depending on data characteristics, including cross-sectional regression models to test the influence of contingency factors on abnormal returns. The market-adjusted return model is a restricted version of the market model that constrains alpha to zero and beta to one which does not require an estimation period. The Capital Asset Pricing Model (CAPM) was initially developed by Sharpe (1964) was commonly used until the 1970s but has been all but replaced by the market model. It is an economic model that determines the expected value of an asset based on its covariance with the a market portfolio.

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[1] In the CRSP (Center for Research in Security Prices) value-weighted portfolio or index, securities are weighted by their market capitalization. Each period the holdings of each security are adjusted so that the value invested in a security relative to the value invested in the portfolio is the same proportion as the market capitalization of the security relative to the total portfolio market capitalization. (CRSP, 2007)

The procedure for recording abnormal returns involves the indexing of security returns by trading date relative to the event date. For each of the days in the index, the null hypothesis implies normally distributed returns with zero mean and variance. Ordinary least squares (OLS) is then used to calculate the market model parameters as well as abnormal returns. Cumulative abnormal returns (CAR) are simply the sum of the abnormal returns (AR) for the event window for a particular security. The average abnormal returns are calculated for each security then summed to establish the average cumulative abnormal return for each day in the event window. Standard statistical techniques are then applied to determine the predictive power of the model and significance of the results. Additional non-parametric tests such as the sign test which assumes an equal distribution of positive and negative abnormal returns under the null hypothesis.

There are a number of inherent issues in this methodology including sampling interval, event date uncertainty and robustness, as noted by MacKinlay (1997). With the availability of databases such as that of the Center for Research in Security Prices (CRSP), access to daily stock data has have solved the solved the first issue. It is of course critical that the event date be clearly determined. While this may have been difficult for printed sources, it is the opinion of the author that immediate updates through electronic sources have eliminated this problem. Another concern is that the statistical methods rely on normality assumptions, however this is not usually a problem with event studies (Brown and Warner, 1985). Finally, MacKinlay cautions that event studies are less useful for observing changes that occur over time, such as regulatory regimes, as the information related to these changes is absorbed by the market over time rather than being isolated to a particular date.

4.2 Experimental Design

The population of interest for this study is a cross-section of U.S. listed public companies of various sectors and sizes. Archive data of press releases available in the Lexis-Nexis research database was used as the source of environmental innovation and performance-related announcements. Relevant announcements were selected from the database by date, weighted keyword and source, for which representative samples can be found in Appendix B. The newswire services PR Newswire and Business Wire were chosen as the sources since they provide the most up-to-date information on business activities. The announcements were then read individually to establish the final data set using the following criteria:

- The announcement had not been previously released and the event date was clear.
- The subject of the announcement pertained directly to either environmental innovation (process or product) or good environmental performance (recognized or company reported).
- The company name or stock symbol was clearly identified with the required market and company data available in the CRSP and Compustat databases.

Lanoie, Laplante, & Roy (1998) noted that abnormal returns calculated over more than three days are likely to be confounded by unrelated announcements for the companies studied. For the purposes of this study, various event windows were tested using between one and three days beginning with the day before the event and ending with the day after. The event window size was selected to include the event date (day 0) only as larger windows provided no additional significance.

The market-adjusted model described by MacKinlay (1997) was used to determine abnormal returns for each company's stock during the post-announcement period. This is a

variation on the market model chosen due to missing beta values for a number of observations causing these announcements to be dropped from the regression analysis. As sample sizes were already relatively small, it was decided that use of the adjusted model would produce more accurate results.

From each announcement in the final selection, the two key data elements required for an event study were obtained, that is announcement date and company name. The company's unique CRSP database identifier was entered along with the date to produce a list of events. Using SAS running on the Wharton Research Data Services (WRDS) server, the required CRSP market data was extracted and joined to Compustat company data. Abnormal returns and variance were determined for each security over the event window. Appendix A contains a detailed description of the data structures, queries and various statistical tests.

A number of regression models were tested in order to determine the relationship between various factors and the cumulative abnormal return (CAR_i). The following model, using common financial ratios combined with the announcement type modifier variable, was found to have the most significance for both environmental innovation and environmental performance:

$$CAR_i = \beta_0 + \beta_1(modif)_i + \beta_2(roa)_i + \beta_3(ros)_i + \beta_4(acidtest)_i + \varepsilon_i$$

where β's are regression coefficients; ε_i is a disturbance term.

Chapter 5

Results

Table 2 provides the cross tabulation of announcements for environmental innovation and environmental performance with their respective modifiers – process or product innovation and self-reported or externally recognized performance.

Table 2. Tabulation of announcements (total $N = 82$)

Announcement Type	Modifier	Frequency
Environmental Innovation	Process	17
	Product	14
Environmental Performance	Self-reported	12
	Externally recognized	39

The mean cumulative abnormal returns were estimated using the market-adjusted model for the day 0 window using the CRSP data and SAS software separately for each type of announcement and for each modifier. The results of this analysis are presented in Table 3

Table 3. CARs for market model

Announcement Type	Number of observations	Mean CAR	Std. Error	*t* Value	Pr > |*t*|
Environmental Innovation	31	0.00494	0.01164	0.42	0.6741
Process	17	-0.00572*	0.00267	-2.14	0.0483
Product	14	0.01789	0.02565	0.70	0.4978
Environmental Performance	51	-0.00055	0.00195	-0.28	0.7795
Self-reported	12	0.00395	0.00523	0.17	0.4658
Externally recognized[2]	39	-0.00106	0.00217	-0.49	0.6260

* significance at 0.05.

The CARs and significance of the t statistic shown in this table supports hypothesis 1a and allows for rejection of the null hypothesis. The lack of significance of the other three cases does not allow us to reject the null hypotheses for 1b, 2a or 2b, nor is does it provide support for the alternate hypotheses.

A multiple linear regression model was used to assess the relationship between cumulative abnormal returns and the announcement modifier variable as well as several variables related to the firm. A number of candidate variables were tested, yet the use of common financial ratios (defined in Appendix A) appeared to produce the most significant results. Table 4 shows the results of the regression analysis. The model is highly significant and significant for environmental innovation and environmental performance respectively, while explaining much more of the variance in returns for the former than the latter.

[2] Environmental performance may be recognized by an external organization in the form of an award, certification or membership in an index or association.

Table 4. Cross-sectional regression model[3]

	Environmental Innovation CARs	Environmental Performance CARs
N	31	51
	Parameter Estimates	
Intercept	-0.0215 (0.0126)	-0.0065 (0.0058)
Modifier	0.0023 (0.0104)	-0.0028 (0.0046)
Return on assets	0.2495 (0.1064) *	0.1770 (0.0589) **
Return on sales	-0.1104 (0.0098) ***	-0.0963 (0.0324) **
Acid test	<0.0001 (<0.0001)	0.00033 (0.0030)
	Analysis of Variance	
F Value	39.71	3.93
Adjusted R^2	0.84	0.19
Dependent Mean	0.00494	0.00012

* significance at 0.05; ** significance at 0.01; *** significance at 0.001.

[3] See Appendix A for definition and derivation of the independent variables used in the model.

Chapter 6

Discussion

Although not all of the hypothesized effects of corporate environmental innovation and performance were supported by the results, announcements of process-driven environmental innovation do appear to have both a significant negative impact, both statistical and economic, on the value of the firm.

In the case of product-driven innovation, the low significance may be related to the relatively small sample size (n = 14) resulting in relatively large variance. This variance may be due to major differences in product characteristics regarding market potential and profitability. Although the results are not significant, the relatively high CAR for products, as compared to the negative returns associated with process-driven innovation, may indicate the potential for products to do better in the market as suggested by Puraji (2006) and Gilley (2000). The variance in self-reported performance CARs may also be affected by small sample size (n = 12), while externally recognized performance has a relatively large sample size (n = 39) and, by the Central Limit Theorem, would approach a normal distribution. Although CARs for the combined environmental performance related announcements are not statistically significant, the negligible (<0.06%) difference from the market mean does not suggest rejection of the null hypotheses for 2a and 2b.

Examination of the regression model parameter estimates reveals a significant relationship between the dependent variable and the return on sales and return on assets ratios of the firms. The acid test ratio has less significance, but did appear to add to the overall

explanatory power of the model as removing it resulted in lower F and R^2 values. Of particular interest in the model is the modifier variable, which on its own did show significance. Nor does it appear to contribute to the significance of the above model. This therefore provides no justification for separate hypotheses for process and product-driven innovation or self-reported and externally recognized environmental performance. The use of financial ratios in the regression model was intended to show the effect of some of the 'traditional' investment drivers that may be contributing to the variance in CARs for environmental announcements during the event window. This may allow one to determine the relative effects of the components of reputation, in this case financial and environmental or social responsibility, as listed in Table 2.

A number of financial factors influence an investment decision including risk, expected return and timeframe. Investors, and the market as a whole, will estimate the value of each of these factors based on information about the company in which they are investing. The information, or announcements, considered in this study are related to environment innovation. In this case, both social and financial concerns can be expected to play a part in the mental accounting of the investor.

It is apparent though from the results of this study that the market does not reward firms' investment in new or enhanced environmental processes. If future financial performance were determined using traditional accounting methods such investments may not seem cost effective. Standard economic and financial metrics may fail to account for what enhances or diminishes the state of the environment or society. Financial markets are driven by short-term goals such as paying back high-interest loans for plant or equipment combined with a tendency for investors to heavily discount future value. The short-term cost of using natural resources may be

undervalued, as well as the long-term costs and risk associated with environmental problems. This type of implementation is normally quite complex and may be difficult for investors to understand and thus quantify the benefits. In addition, there are no guarantees that a new technology, even one that is new to firm, will perform exactly as expected. For these reasons it is perhaps not surprising to see a negative overall impact in the market for environmental process innovation as the effect of enhanced environmental reputation is more than offset by the expectation of negative financial concerns.

It is important to note that the market is influenced by many factors, and attempts to isolate individual causes of stock price fluctuations are extremely difficult. The best expected result of an event study such as this is to observe a statistically significant increase, or decrease as the case may be, in the post-announcement period of the event window. This alone cannot be considered proof of causation, but when combined with the exercise of judgment by the researcher to establish a 'scientifically sensible perspective' (Trochim, 2006) it may be taken as sufficient to reject the null hypothesis.

Chapter 7

Conclusions

7.1 General

The study has found that there is in fact a significant relationship between environmental innovation and market value in the case of process-driven environmental innovation. As hypothesized, however this relationship is negative as the net overall effect of on reputation for future financial performance and environmental responsibility is expected to be negative. This provides further support for the results observed by Gilley (2000) in which announcements of process-driven environmental innovation were associated with negative abnormal returns.

High positive values observed for product based innovation are promising and warrant further investigation. Environmental performance announcements, whether in the form of corporate environmental statements or awards for outstanding performance, were however found to have a negligible effect on the market value of the firm in question. This contradicts a number of previous studies (McGuire et al, 1988; Hart, 1995; Russo and Fouts, 1997; Salama, 2003; and others) that found significant positive abnormal returns associated with good environmental performance and *vice versa*. Again further investigation may be required to determine the explanation behind these unexpected results.

The implication for companies would be to continue to prioritize all their commitments in order to maintain viability and meet the expectations of their stakeholders. Like individuals though, companies may be more likely to choose an investment that does good to society, rather than harm, if equally profitable. It follows that if a company perceives environmental innovation

as profitable and important to its stakeholders, then it is likely to become a priority for investment.

7.2 Limitations

The primary limitation of this study was the lack of statistical significance of the results for determination of the CARs for all but one of the announcement scenarios. It is possible that a larger sample could provide a better result; however this did not seem to reduce the variability in the externally recognized environmental performance data set. A larger sample would however provide the opportunity to subdivide the data set in various ways, perhaps by industry, in an attempt to reduce the variance. This was in fact attempted in the early stages or the analysis by adding a dummy variable to separate industries into two categories based on history of environmental issues. This did not however produce the desired effect and finer division of the data may be required.

The event study methodology can of course only be used to analyze events that are date specific and cannot show the effect of gradual changes in a firm, an industry or regulatory regime. That being said, it is possible that the changes related to growing awareness of the importance of environmental performance within organization, among stakeholders and society at large do not lend themselves to be captured by an event study. The same might be said for environmental innovation, or innovation in general, in that it normally goes through a gradual process of diffusion in the market rather than through 'big bang' dispersal. In fact the full impact of any particular innovation might not be realized at its inception, but may occur later through technology adoption and adaptation, strategic alliances, or market development.

7.3 Future Research

The contradictory results for reports of, or awards for, good environmental performance indicate a need for further investigation in the form of a large sample event study using recent data. Although it would seem to be intuitive that announcements of what would appear to be good news for both the company and the environment, the market appears to be indifferent.

In addition, future studies in this area may be required to address issues of internal validity of the event study methodology, perhaps through experimental methods. By controlling for firm, industry and market variables it would be possible to find a causal relationship between announcement related to environmental innovation and performance and simulated returns in the market.

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Appendix A. Data Analysis

7.4 Data Definition

The sample consisted of 91 announcements from which a unique company identifier and date were recorded to create the 'elist' event data file. A left join was done from 'elist' to the CRSP 'dsfnames' and 'dsi' tables to get company header and market information respectively. Finally the Compustat 'compann' table, containing company details, was joined via the CRSP 'dsf' table. This resulted in the regression dataset consisting of 82 rows for which joining keys were available. A number of columns were selected for analysis, but only the following were used in the event study and final regression models (excluding joining tables and keys):

Table	Column	Description
elist	permno	CRSP Permanent Number or Company Identifier
elist	edate	Event Date
elist	tdcount	Trading Days Relative to Event Date
elist	atype	Announcement Type (EI=0 or EP=1)
elist	modif	Announcement Type Modifier or Sub-type (EI: 0=process,1=product; EP:0=self-report,1=ext. recognized)
crsp.dsf	ret	Holding Period Security Return
crsp.dsi	vwretd	Value-weighted Market Return (incl. all dist.)
comp.compann	data117	Sales (MM$)
comp.compann	data172	Net Income (Loss) (MM$)
comp.compann	data6	Assets - Total (MM$)
comp.compann	data4	Current Assets - Total (MM$)
comp.compann	data5	Current Liabilities - Total (MM$)
comp.compann	data15	Interest Expense (MM$)
comp.compann	data3	Inventories - Total (MM$)

7.5 Variable Definitions

The selected data elements were combined to produce financial ratios for the companies in the event study. Numerous ratios were tested in the regression analysis, however the following provided the most significant results:

Name	Description	Formula
retxmkt	Return in Excess of Market	security return - value-weighted market return
roa	Return on Assets	(net income + interest expense) / assets
ros	Return on Sales	net income / sales
current	Current Ratio	(current assets + inventory) / current liability
acidtest	Acid Test or Quick Ratio	current assets / current liability

7.6 Variable Means by Announcement Type

Environmental Innovation

Variable	N	Mean	Std Dev	Minimum	Maximum
retxmkt	31	0.0049429	0.0648010	-0.0914632	0.3286207
roa	31	0.0865593	0.0592193	-0.0652957	0.2019934
ros	31	-0.0256022	0.6129902	-3.2232683	0.3214664
acidtest	31	37.7420702	193.0602224	0.1010666	1077.64

Environmental Performance

Variable	N	Mean	Std Dev	Minimum	Maximum
retxmkt	51	0.000116692	0.0146936	-0.0375401	0.0451853
roa	51	0.0966282	0.0490560	0.0147229	0.2223744
ros	51	0.0918879	0.0825073	-0.2189497	0.3103340
acidtest	51	1.4470158	0.7295092	0.4534923	3.8022788

7.7 Outlier Analysis: Combined Cook's D & DFITS results

Obs	smbl	edate	retxmkt
25	FCEL	28MAR2006	0.05834
27	MMA	08JUN2006	-0.01217
30	BCON	01MAR2006	0.32862
31	QTWW	01FEB2006	-0.09146

7.8 Regression Procedures (SAS)

Market Model

```
proc reg data=dsfx2;

    where tdcount = 0; * event window set to day of announcement only;

    by atype modif;  * output grouped by announcement type;

    Market_Model: model retxmkt = ;
```

Cross-sectional Regression Model

```
proc reg data=dsfx2;

    where tdcount = 0;

    by atype;

    Fundamentals_Model: model retxmkt = modif roa ros acidtest;
```

Appendix B. Sample Announcements

Example 1. Environmental Innovation, Process

PR Newswire US

August 10, 2006 Thursday 2:00 PM GMT

DuPont Breaks Ground on Newest Air Emission Reduction Project; Agreement with Western Refining will be the environmental equivalent of taking 50,000 cars off the road

LENGTH: 571 words

DATELINE: EL PASO, Texas Aug. 10

EL PASO, Texas, Aug. 10 /PRNewswire-FirstCall/ -- Responding to global demands for cleaner air and increasingly sophisticated methods of air pollution control, DuPont has broken ground on its newest Air Emission Reduction Project that promises the environmental equivalent of taking 50,000 cars (one in 10 cars) off El Paso roads and setting a standard for healthier refinery emissions.

For decades, DuPont has offered Sulfuric Acid Regeneration (SAR) services to refiners who use sulfuric acid as a catalyst in alkylation. With this latest project, a combined effort with El Paso's Western Refining, DuPont is offering an integrated approach. An on-site sulfuric acid unit, which receives spent acid from the refinery's alkylation unit and sulfur gases from the refinery's process units, recycles the spent acid and converts the sulfur gases to sulfuric acid. It then returns fresh sulfuric acid to the refinery's alkylation unit. The resulting benefit is a 74 percent reduction in the refinery's sulfur dioxide emissions from processing sulfur gases -- making it one of the cleanest operating, sulfuric acid-using refineries in the world.

The new unit will be owned and operated by DuPont under a commercial agreement. It is the first sulfuric acid regeneration facility of its kind in the southwestern United States. The project will allow more efficient management of sulfur processing at the refinery, and enables the plant's two processing lines to recycle and reuse sulfur gases and spent sulfuric acid from the petroleum refining process. The project will improve the competitiveness of Western Refining by allowing the refinery to use more "sour crude" oil.

Today, petroleum refiners are handling crude oil with higher sulfur content than ever. At the same time, they are required to produce low-sulfur products, and to reduce the sulfur emissions generated in the process. DuPont's Environmental Solutions business offers science-based services and solutions to help petroleum refiners respond to these challenges in a way that reduces their environmental footprint.

"Our goal is to become the single-source solution for our global customers' most difficult sulfur-related challenges," said Joseph Skurla, business development director for DuPont Chemical Solutions. "We are in discussion with a number of other refineries, both inside and outside the United States, concerning the development of similar projects. We are pleased to be able to share our expertise and clean technologies with the world."

DuPont's first on-site SAR unit at the Valero Refinery in Delaware City, Del. started operations in September 2005; another at the ConocoPhillips refinery in Linden, N.J. recently broke ground.

DuPont (NYSE:DD) is a science company. Founded in 1802, DuPont puts science to work by creating sustainable solutions essential to a better, safer, healthier life for people everywhere. With operating facilities in more than 70 countries, DuPont offers a wide range of innovative products and services for markets including agriculture, nutrition, electronics, communications, safety and protection, home and construction, transportation and apparel.

Example 2. Environmental Innovation, Product

Business Wire

March 28, 2006 Tuesday 1:30 PM GMT

Tokyo Gas Evaluating FuelCell Energy's DFC(R) Products for Introduction to Customers of Its Energy and Industrial Gas Business Units

LENGTH: 849 words

DATELINE: DANBURY, Conn. March 28, 2006

FuelCell Energy, Inc. (NasdaqNM:FCEL), a leading manufacturer of efficient, ultra-clean power generation plants for commercial and industrial customers, today announced that Tokyo Gas has initiated a program to evaluate a Direct FuelCell(R) (DFC(R)) power plant for introducing these units to customers of its energy and industrial gas divisions.

The unit is currently located at Kawasaki Heavy Industries' factory in Akashi, Japan, where Tokyo Gas will evaluate the power plant under a variety of expected operating conditions focusing particularly on grid interconnection performance. Tokyo Gas has agreed to install this DFC300A power plant at its new R&D center in Tsurumi in the second quarter of 2006.

Tokyo Gas is one of Japan's largest installers of natural gas-fueled distributed generation systems for high efficiency, combined heat and power applications. According to its Corporate Social Responsibility (CSR) Report, installation of natural gas cogeneration systems has grown to 1196 MW from 765 MW during the past five years, an increase of 44 percent. This trend is expected to continue in the years ahead (see http://www.tokyo-gas.co.jp.proxy.lib.uwaterloo.ca/csr/report_e/index.html, page 22). Tokyo Gas is considering adding DFC products to its energy generation portfolio, pending the outcome of its evaluation, to address additions to the current 2.2 GW of gas-fired cogeneration at 2000 locations throughout the country.

"Tokyo Gas is the largest gas supplier in Japan," said R. Daniel Brdar, president and CEO of FuelCell Energy. "They are actively extending their pipelines to industrial gas users and expanding the country's infrastructure. Our ability to use this strategically important fuel source in high efficiency distributed generation for firm and reliable base load power applications represent a strong potential market for our megawatt-class products."

DFC power plants address two significant energy issues in Japan -- high energy costs and reduced greenhouse gas emissions under rules established by the Kyoto Protocols. The high efficiency of DFC power plants not only results in less fuel needed per kilowatt hour of electricity and lower operating costs, but reduced amounts of carbon dioxide. In addition, DFC power plants provide greater energy reliability because they are located directly at customer sites.

About FuelCell Energy

FuelCell Energy develops and markets ultra-clean power plants that generate electricity with higher efficiency than distributed generation plants of similar size and with virtually no air pollution. Fuel cells produce base load electricity giving commercial and industrial customers greater control over their power generation economics, reliability and emissions. Emerging state, federal and international regulations to reduce harmful greenhouse gas emissions consider fuel cell power plants in the same environmentally friendly category as wind and solar energy sources -- with the added advantages of running 24 hours a day and the capacity to be installed where wind turbines or solar panels often cannot. Headquartered in Danbury, Conn., FuelCell Energy services over 40 power plant sites around the globe that have generated more than 94 million kilowatt hours, and conducts R&D on next-generation fuel cell technologies to meet the world's ever-increasing demand for ultra-clean distributed energy. For more information on the company, its products and its worldwide commercial distribution alliances, please see http://www.fuelcellenergy.com.proxy.lib.uwaterloo.ca.

Direct FuelCell, DFC and DFC/Turbine are registered trademarks of FuelCell Energy, Inc. All other trademarks are the property of their respective owners. The Company's sub-megawatt DFC fuel cell power plant is a collaborative effort combining its Direct FuelCell technology with a Hot Module(R) balance of plant design from MTU CFC Solutions, GmbH.

This news release contains forward-looking statements, including statements regarding the Company's plans and expectations regarding the development and commercialization of its fuel cell technology. All forward-looking statements are subject to risks and uncertainties that could cause actual results to differ materially from those projected. Factors that could cause such a difference include, without limitation, the risk that commercial field trials of the Company's products will not occur when anticipated, general risks associated with product development, manufacturing, changes in the utility regulatory environment, potential volatility of energy prices, rapid technological change, and competition, as well as other risks set forth in the Company's filings with the Securities and Exchange Commission. The forward-looking statements contained herein speak only as of the date of this press release. The Company expressly disclaims any obligation or undertaking to release publicly any updates or revisions to any such statement to reflect any change in the Company's expectations or any change in events, conditions or circumstances on which any such statement is based.

Example 3. Environmental Performance, Reported

PR Newswire US

September 1, 2005 Thursday 4:24 PM GMT

Alcan Sustainability Report highlights value creation

LENGTH: 534 words

DATELINE: MONTREAL Sept. 1

MONTREAL, Sept. 1 /PRNewswire-FirstCall/ -- Alcan Inc. (NYSE, TSX: AL) has published its 2005 Sustainability Report, an annual update of the Company's progress on sustainability. Available in print and on Alcan's website (http://www.alcan.com.proxy.lib.uwaterloo.ca/SR05), the report provides updated information on the economic, environmental and social performance of the Company's global operations and the leading role it has taken over the past year.

"Leading companies build sustainable businesses by embedding strong governance and corporate responsibility into their strategies and culture. At Alcan, we've recognized that business and sustainability go hand-in-hand," said Travis Engen, President and Chief Executive Officer of Alcan Inc. "It is the integration of environmental stewardship, economic performance and the well-being of our communities that drives fundamental value creation," he added.

Alcan's commitment to sustainability is translating into concrete actions through the Company-wide implementation of AIMS, the Alcan Integrated Management System, consisting of Value Based Management, Continuous Improvement, and EHS FIRST - Alcan's approach to environment, health, and safety.

Alcan's sustainability milestones include:

- Joining the United Nations Global Compact, a voluntary international initiative for businesses promoting the development of a more sustainable and inclusive global economy;

- Co-chairing the Working Group on Accountability and Reporting at the World Business Council for Sustainable Development as well as the World Economic Forum's Water Initiative;

- Participation in the G8 Climate Change Roundtable;

- Selection as a member of the Dow Jones Sustainability World Index (DJSI World) for the fourth time in five years and named leader in its sector;

- Selection as one of the top companies for Corporate Social Responsibility by the Globe and Mail annual ranking in Canada - rated number one in its sector and chosen as one of the special "World Leaders" for continued international recognition in this field.

This year, Alcan also is chairing the International Institute for Sustainable Development (IISD) and the International Business Leaders Forum (IBLF). Both organizations contribute to sustainability by promote responsible business practices internationally and advancing policy recommendations bearing on international business.

Alcan is a multinational, market-driven company and a global leader in aluminum and packaging. With world-class operations in primary aluminum, fabricated aluminum as well as flexible and specialty packaging, aerospace applications, bauxite mining and alumina processing, today's Alcan is well positioned to meet and exceed its customers' needs for innovative solutions and service. Alcan employs almost 70,000 people and has operating facilities in 55 countries and regions.

Example 4. Environmental Performance, Recognized

Business Wire

May 19, 2005 Thursday 1:45 PM GMT

Valence Technology and EnergyCS Plug-In Hybrid Vehicle Wins Awards at Tour de Sol

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A concept plug-in hybrid vehicle (PHEV) developed by EnergyCS and Valence Technology, Inc. (Nasdaq:VLNC) has won the hybrid category in the Tour de Sol's Monte Carlo-style Rally, which ended May 14. Valence is a leader in the development and commercialization of Saphion(R) technology, the only safe, large-format Lithium-ion rechargeable battery technology.

Powered by Valence Technology's U-Charge(TM) Power System, the PHEV is a fully functional concept car based on a 2004 Toyota Prius. Modifications made by EnergyCS included incorporation of Valence's Saphion Lithium-ion battery technology in order to allow more zero-emission driving and better gas mileage.

In the Tour de Sol Monte Carlo-style Rally, in which there were 41 entrants, the vehicle won first place in the modified hybrid-vehicle category for fuel-efficiency and performance. On a 150-mile run, the EnergyCS-Valence PHEV achieved 102 miles per gallon (MPG) and used only nine kilowatt-hours of electricity to charge the Saphion lithium-ion batteries, which cost less than $1.00 to recharge. (For a commute of 50-60 miles between battery charges, the PHEV averages 125 or more MPG.)

The EnergyCS-Valence PHEV also won the Innovative Technology award in the Tour de Sol Championship for demonstrating a hybrid-vehicle architecture that can enable vehicles to reduce oil consumption and climate change emissions by replacing gasoline with clean, renewably produced electricity for its motive power.

About Tour de Sol

The Tour de Sol Monte Carlo-style Rally is open to hybrid and alternative-fuel vehicle owners to compete for special prizes. The Tour de Sol Championship is for concept vehicles built by students, entrepreneurs and corporations that are working towards zero oil and carbon-emission vehicles.

The Tour de Sol event is organized by the Northeast Sustainable Energy Association (NESEA), the nation's leading regional education and advocacy association that aims to accelerate the deployment and use of renewable energy, green buildings, and energy efficiency in everyday life. NESEA produces major sustainable energy events that

inspire and motivate large numbers of people to get involved and make a difference. For more information visit online http://www.tourdesol.org.proxy.lib.uwaterloo.ca or call 413-774-6051.

About Valence Technology

Valence batteries are based on its proprietary Saphion technology, which replaces toxic heavy metals with phosphates, creating a battery that is chemically more stable and safer than traditional oxide-based batteries. Valence batteries are not only environmentally friendly, but require virtually no maintenance and offer long life and low overall ownership costs.

Valence Technology is a leader in the development and commercialization of Saphion(R) technology, the only safe, large-format Lithium-ion rechargeable battery technology. Valence holds an extensive, worldwide portfolio of issued and pending patents relating to its Saphion technology and Lithium-ion rechargeable batteries. The company has facilities in Austin, Texas, Henderson, Nevada and Suzhou and Shanghai, China. Valence is traded on the Nasdaq SmallCap Market under the symbol VLNC and can be found on the Internet at http://www.valence.com.proxy.lib.uwaterloo.ca.

About EnergyCS

Energy Control Systems Engineering (EnergyCS) is a privately held company based in Monrovia, California. It provides leading edge consulting, design and prototyping services for system integration, management and monitoring of electrochemical energy systems such as batteries and fuel cells. The company is focused on and particularly interested in applications in the areas of EV and HEV transportation and alternative energy on systems from 24 to 1000 VDC. http://www.energycs.com.proxy.lib.uwaterloo.ca

In order to make the benefits of PHEV technology more widely accessible, EnergyCS has partnered with Clean-Tech LLC to form EDrive Systems, LLC. The new company will commercialize EnergyCS' PHEV conversion kits using Valence Saphion batteries and make plug-in retrofits available to consumers in early 2006. Clean-Tech specializes in developing advanced alternate fuel retrofits for vehicles and will be the integrator for the EDrive technology. For more information, send an e-mail to info@edrivesystems.com.

Appendix C. Companies and dates of announcements

Company	Date of announcement
Abbott Laboratories	30-Nov-06
Air Products & Chemicals Inc	14-Nov-06
Alcan Inc	1-Sep-05
Alcan Inc	21-Mar-06
Alcoa Inc	18-Mar-05
Alcoa Inc	5-Dec-05
Alcoa Inc	21-Mar-06
Alliant Energy Corp	6-Sep-06
American Electric Power	21-Mar-06
Anheuser-Busch Cos Inc	27-Oct-05
Anheuser-Busch Cos Inc	5-Jun-06
Aramark Corp	24-Oct-06
Atmos Energy Corp	27-Nov-06
Autodesk Inc	13-Sep-06
Avista Corp	21-Feb-05
Avista Corp	1-Mar-06
Beacon Power Corp	1-Mar-06
Bowater Inc	29-Jun-05
Canon Inc -Adr	15-Mar-05
Canon Inc -Adr	24-Oct-05
Carnival Corp/Plc (Usa)	18-Aug-06
Chevron Corp	17-Aug-05
Cintas Corp	9-Nov-05
Coca-Cola Co	5-Oct-05
Coca-Cola Co	15-Jun-06
Compass Minerals Intl Inc	31-Aug-06
Corning Inc	2-Mar-05
Delhaize Group Sa -Adr	22-Feb-05
Delhaize Group Sa -Adr	2-Mar-06
Dell Inc	2-Jun-05
Dow Chemical	20-Feb-06
Dow Chemical	23-Mar-06
Dte Energy Co	1-Sep-05
Du Pont (E I) De Nemours	21-Mar-06
Du Pont (E I) De Nemours	10-Aug-06
Duke Energy Corp	26-Oct-05
Eaton Corp	23-Mar-06
Emcor Group Inc	11-Jul-05
Energy Conversion Dev	5-Oct-05
Fuelcell Energy Inc	28-Mar-06
General Electric Co	29-Sep-06
Green Mountain Power Corp	3-Nov-05
Hewlett-Packard Co	17-Mar-06
Hyperion Solutions Corp	4-Oct-06
Intel Corp	3-Nov-05
Intl Paper Co	1-Mar-06
Kimberly-Clark Corp	25-Apr-06
Kinder Morgan Inc	25-Oct-06
Lafarge Sa -Adr	21-Jun-05
Lennox International Inc	22-Feb-05
Lowe's Companies Inc	23-Feb-05
Marriott Intl Inc	1-Mar-05
Marriott Intl Inc	14-Mar-06
Merck & Co	14-Mar-06
Metso Corp -Adr	4-Oct-06
Municipal Mtg & Equity Llc	8-Jun-06
Nec Corp -Adr	21-Oct-06
Novelis Inc	15-Dec-06
Peabody Energy Corp	22-Sep-06
Plantronics Inc	7-Sep-05
Plug Power Inc	18-Jan-05
Puget Energy Inc	21-Mar-06
Quantum Fuel Sys Tech Worldw	1-Feb-06
Sears Holdings Corp	20-Mar-06
Servidyne Inc	14-Mar-05
Servidyne Inc	22-Mar-06
Smithfield Foods Inc	5-Apr-06
Starbucks Corp	23-Jun-05
Steelcase Inc	13-Jun-06
Steelcase Inc	30-Jun-06
Steelcase Inc	19-Sep-06
Stmicroelectronics Nv -Adr	15-Sep-05
Timberland Co -Cl A	1-Nov-05
Txu Corp	28-Jul-06
United Parcel Service Inc	22-Jun-05
United Technologies Corp	11-Apr-06
United Technologies Corp	10-Oct-06
Utd Microelectronics -Adr	3-Jun-05
Valence Technology Inc	19-May-05
Wal-Mart Stores Inc	19-Jul-05
Wal-Mart Stores Inc	3-Feb-06
Wal-Mart Stores Inc	30-Oct-06
Weyerhaeuser Co	27-Jun-05
Weyerhaeuser Co	16-Aug-05
Weyerhaeuser Co	22-Feb-06