The role of policy instruments for a sustainable and competitive pulp and paper industry: Sweden in a comparative perspective

A literature review

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Preface

This report is a literature review on the role of policy instruments for a sustainable and competitive pulp and paper industry. The report was commissioned by Tillväxtanalys in Sweden.

The project was conducted by researchers at NIFU, Norway (Lisa Scordato and Antje Klitkou) and Circle, Sweden (Lars Coenen). The project was co-ordinated by Antje Klitkou.

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Executive summary

The aim of the literature review was to analyse the role of policy instruments with regard to increased environmental sustainability and competitiveness in the pulp and paper industry. The review also addressed other important factors and driving forces behind this development during the last two decades. The pulp and paper industry is an energy and pollution intensive industry and energy and emission changes in this industry have therefore large environmental and climate effects. A main finding of the study is that a combination of external pressures (broad societal changes, government regulations, policy instruments and environmental demands of consumers) and internal, firm specific considerations (strategic focus on environmental management and training of employees, financial resources and evaluation and control mechanisms) have been at the core of the changes affecting the PPI. The PPI is subject to several energy and environmental policies and regulations. Policy instruments have a key role in facilitating sustainability and competitiveness in the industry. The review showed that national instruments in Sweden were designed in a more industry-friendly way and shaped to function more like “carrots” compared to more costly policies stemming from supranational levels such as the EU. In a Swedish context, the renewable electricity certificate system (ECS) had a significant effect on the increase of renewable energy production of pulp and paper industry. The scheme was decisive for facilitating investments in new turbines in chemical pulp mills and an important economic driver for some large firms’ investment plans for wind power. On the other hand, the ECS has not been a driver for technology development or innovation, which was one of the main policy expectations of the measure. It appears that a large proportion of the renewable production increase occurred in plants that were already in operation prior to the establishment of the scheme. Another important policy instrument that has facilitated energy efficiency investments was the programme for energy efficiency (PFE). An important effect of the PFE has been to trigger process innovations at mills and to strengthen the environmental management system of firms. The carbon dioxide tax and to some extent the environmental code are other policy instruments that have contributed to reduce emissions from the industry. Important to mention is also the significant (though unintended) effect that energy policy (mainly substitution from oil to other fuels) of the 70s and 80s had on the carbon emissions in the Swedish pulp and paper industry.

Compared to international instruments, national policy measures were more successful in terms of bringing down emissions from industry. The European Emissions Trading scheme (EU ETS) has shown to have a limited direct impact on the climate and environment strategies of the pulp and paper industry in Sweden and in other European countries. The scheme has in particular not succeeded in affecting firms’ investments in innovation and development of low-carbon technologies.

Energy prices are an essential driver for industrial change within the sector and rises in electricity prices in the aftermath of the electricity reform in Sweden in the mid-1990s heavily influenced the PPI. The later introduction of the EU ETS further increased wholesale electricity prices. Hence, the

historical competitive advantage of the Swedish PPI based on cheap hydroelectric power and the expansion of nuclear energy was steadily eroded. The rises in electricity prices may explain the renewed interest and increased investment in power production assets during the last decade. This phenomenon has been described as a complete overhaul or transition of the sector's strategic orientation.

The review also addressed the responses of firms to policy instruments and global market pressures. Policy instruments that aim at stimulating a transition need to consider the diverse nature of firms and take into account that they respond differently depending on the characteristics of individual firms. Notable differences in this regard were observed between types of industries within the same sector and especially between chemical and mechanical pulp and paper industries. Recent trends in the sector indicate that traditionally strong paper industries are struggling with competitiveness and profitability. In light of these trends, the chemical pulp mills have managed to achieve higher revenues and have increased their demand and capacity to pay for pulpwood. A further effect of these investment changes led to increased production of green electricity of the new chemical pulp mills. On the other hand, the situation for several mechanical pulp mills has deteriorated in recent years. This has increasingly led to a shift of firms' investments that in some cases were transferred from mechanical to chemical pulp production. The reviewed literature did not directly address the issue of the establishment of new actors in the pulp and paper sector. However, considering the capital and energy intensive nature of the industry it can be argued that new entrants have difficulties to establish themselves on the market. A further possible barrier for newcomers is as well the strong political power of incumbent actors on the market.

Investments in new pulp and paper mills have a considerable impact on environmental performance and on the competitive advantage of firms in the sector. The age of pulp and paper mills varies substantially between countries and firms within the sector and the upgrade to more modern mills is an essential element for firms' ability to compete with upcoming market actors, notably in Asia and in South America. While the Finnish PPI is world leading in terms of investments in new pulp and paper mills Sweden has relatively older capital stock, especially with regard to paper mills. Swedish PPI's reactions to the external changes have been modest until now and the reactions have mostly been to incrementally change production methods. Nevertheless, the Swedish PPI has developed into one of the major renewable energy producers in the country and ranks amongst the most sustainable in terms of carbon emissions per tonne of product in the world. Promising technologies are available for the industry and if adopted they could significantly increase competitiveness and reduce carbon emissions. For Swedish firms the biorefinery concept may offer promising new business opportunities if adopted and open up involvements in new value chains.

1 Introduction

The purpose of this literature review is to give an account of the scholarly literature on the role of policy instruments for creating a sustainable and competitive pulp and paper industry (PPI). The review focuses its attention primarily on public policy instruments but also addresses the interplay with other factors that have been important for the pulp and paper industry to transform into an environmentally sustainable and innovative industry. It is interesting and relevant to study the pulp and paper industry in this context for a number of reasons. Firstly, the pulp and paper industry is an energy and pollution intensive industry with a legacy that spans over several centuries. In Sweden, it plays a significant role in the economy as it accounts for about 6 per cent of the country's gross domestic product (IEA, 2007). Globally, the pulp, paper and printing industry is the fourth largest industrial consumer of energy[1]. A characteristic of the pulp and paper industry is that it also produces energy as a by-product and already generates about 50 per cent of its own energy needs from biomass residues.

In the context of climate change the PPI can play an important role in the long term as it could develop into a clean energy supplier (IEA, 2009; Patari, Kylaheiko, & Sandstrom, 2011; Rametsteiner, Weiss, Ollonqvist, & Slee, 2009). To reduce the industrial use of energy is an important mean to reducing the threat of increased global warming. A major concern facing the PPI in Western European Countries in recent years is a possible decline of international competitiveness, resulting in declining market shares and job losses. Main factors driving these changes are globalisation, the emergence of new actors and markets and competing technologies. Rising market competition from Asia and South America have posed challenges on the strategic reorientation of the industry.

In the following part of the review, we discuss the role of policy instruments in this transformative process and in what way the industry has responded to policies and to other factors which affect the competitiveness of the sector such as consumer demands. The review covers the conditions within the Swedish PPI primarily but makes an international comparison with the situation in other countries which have a significant PPI's such as Finland, Norway, Canada and the U.S.

The search for the scientific literature was carried out by using a key word approach in the recognised article database ISI Web of Science. The search has led us to the most relevant articles investigating the main questions described above. These articles are published in recognised international scientific journals during the period 2000-2013. The review also includes a selection of reports published by international organisations. An overview of the articles and reports is available in the reference list.

[1] According to the IEA the industry consumed 6.45 exajoules (EJ) of final energy in 2004 (5.7% of total industrial energy use) (IEA, 2007).

The literature review is organised as follows. Chapter 2 presents the literature describing the most important country specific and international policy instruments for a “greening” of the PPI in the last two decades. Chapter 3 addresses other factors and driving forces that have been important for the development of a sustainable and competitive PPI since the 1990’s. Chapter 4 describes the strategic responses of the industry to the policy measures. The impacts of measures on competitiveness and on the environmental performance of firms are discussed in chapter 5. The last chapter 6 discusses some of the main conclusions of the report. Each chapter illustrates conditions in the Swedish PPI and makes comparisons to the situation in an international context where relevant comparative aspects have been found in the literature.

2 The role of policy instruments

Important policy instruments which affected the environmental performance of energy intensive industries were foremost the carbon dioxide tax, the industrial energy efficiency programme (PFE), the Electricity Certificate System (ECS) and the Swedish environmental code. The European Emission Trading Scheme (EU ETS) has also become an important instrument since its introduction in 2005.

A study by Thollander et al, on barriers to and driving forces for the implementation of cost-effective energy efficient measures in the Swedish pulp and paper industry, concluded that the most important public policy instruments for energy efficiency have been the ECS and the PFE. The study was based on a questionnaire developed in cooperation with the Swedish Forest Industries and the Swedish Energy Agency. It was sent to the energy managers of 59 pulp and paper mills in Sweden and achieved a response rate of 69 per cent. The study concluded that largest *barriers* to the implementation of cost-effective energy efficient measures were technical risks and costs of production disruption, while cost reduction resulting from lower energy used was assessed as the main *driver* for such implementation. The study ranked also the role of public policy instruments in this implementation process, highlighting especially the role of ECS and PFE. These policy instruments have supported industries' energy efficiency investments (Thollander & Ottosson, 2008). In addition to the ECS and the PFE, the study also briefly mentions the effects of the Swedish environmental code. The code was introduced in 1988 and has amongst other objectives to foster energy efficiency in the sense that the best available technology should be used by industry taking cost in relation to benefits into account. The authors however indicate that the instruments has proved to be rather slow in implementation and not widely practiced (Thollander & Ottosson, 2008).[2]

The policy aim of the ECS was initially to increase electricity production from renewable energy sources (RES) by 10 TWh by 2010 compared to 2002. In 2009, the growth target was increased to 25TWh by 2020. According to the scheme producers of electricity receive tradable renewable energy certificates (so called TRECs). Electricity producers receive one electricity certificate for each MWh of renewable electricity they produce. Electricity intensive industries are excluded from the quota system, which makes the pulp and paper industry exempt from buying TRECs. An important outcome of the ECS has been an increased investment in new turbines in chemical pulp mills.[3] Investments in new turbines has been important to enable the production of biomass-generated electricity through backpressure. Ericsson et al. argue that the PPI has benefitted significantly from

[2] For a further discussion on this issue see also: Johansson, B., Modig, G., & Nilsson, L. J (2007) Policy instruments and industrial responses- Experiences from Sweden. 8Paper presented at the 2007 European Council for an Energy-Efficient Economy (ECEEE) summer study "Saving energy- just do it", Panel 7, 1413-1421).

[3] In 2002, approximately 70% of the pulp produced in Sweden was chemical pulp while approximately 30% was mechanical pulp (Ottosson and Magnusson 2013, page 358).

the ECS and that the scheme was actually “decisive for investments and investment plans in biomass-based electricity production” and “was an important economic driver behind investment plans for wind power” (Ericsson, Nilsson, & Nilsson, 2011, p. 1445). On the other hand, studies have shown that the actual expectation of the ECS to be a driver of technical change has not so far been met (Bergek & Jacobsson, 2010). On the contrary the system has to a large extent benefitted incumbent and mature industries and turned into a “rent-generating machine” for these industries (Bergek & Jacobsson, 2010, p. 1263). Electricity prices have been raised based on the implementation of mature technology. Based on figures from the Swedish Energy Agency (SEA) the PPI’s revenues from the ECS amounted to 100MEUR/yr in 2004-2007 (Ericsson et al., 2011). That means that the PPI gained heavily from ECS. The industry has been able to take out large profit due to the fact that they are excluded from the quota system while at the same time having the possibility to sell TRECs (Ericsson et al., 2011).

The PFE, introduced in 2005 has led to increased investments in energy efficiency measures in the pulp and paper industry (Thollander & Ottosson, 2008). It is a voluntary scheme designed to give energy intensive firms a guaranteed tax exemption if they join the programme and follows its mandatory requirements. All Swedish pulp and paper companies participate in the programme. According to SEA figures for 2009 investment in energy efficiency measures in the PPI were significant and amounted to 36MEUR within the PFE programme period. It is however not clear to what extent all these investments can actually be attributed entirely to the PFE (Ericsson et al., 2011). Process innovations at the mills were fostered by the introduction of the Swedish Standard for Energy Management Systems (EMS), which is an important part of the PFE. Firms participating in the programme commit to work continuously on energy related improvements, such as energy efficiency increase, use of renewable energy carriers and increase renewable energy production and/or sales (Ottosson & Magnusson, 2013).

The ECS and the PFE are national policy instruments but designed to meet the requirements of the EU policies such as the EU Renewable energy directive and the European Union’s energy tax directive. With the energy tax directive, the Swedish government was compelled to introduce a tax on industrial process-related electricity use (Ottosson & Magnusson, 2013). The PFE was as a consequence introduced with the expectation of increasing energy efficiency in energy intensive industries.

In addition to country specific measures the industry is affected by instruments initiated a the EU level such as the European Emission Trading Scheme (EU ETS). Compared with national instruments the European scheme had a minor effect on industries in terms of energy and environmental impacts. The generous or even excessive amount of trading permits of the scheme may explain the limited impact that it has had on reducing energy intensity of the Swedish industry. Authors have argued that the ETS has so far not been a successful instrument in terms of implementation of cost-effective energy efficiency investments (Gulbrandsen & Stenqvist, 2013; Thollander & Ottosson, 2008).

In terms of impacts, it appears that a combination of national and EU policies have been affecting the energy and climate strategies of the pulp and paper industry. Using the words of Ericsson et al. “both EU and national energy and climate policies have played a role in the complex new reality facing the PPI” (Ericsson et al., 2011, p. 1447). At the same time, the literature suggests that the processes by which companies are ultimately shaped and the combination of influences from different governance levels are not well understood and require further investigation. It is commonly agreed that energy and climate policies put pressure on the industry to reorient strategies and to invest in new ways. From the viewpoint of industry, public policies are often perceived as a threat to industrial competitiveness (according to Gulbrandsen et al 2013, page 523 the PPI initially opposed the ETS, arguing that it would entail competitive disadvantages for the European industry) but they are also seen as providing potential opportunities to develop innovative ideas. New business opportunities for

the PPI are increasingly been seen in the development of chemical pulp mills into biorefineries (Ericsson et al., 2011; Patari et al., 2011).

When introduced in 2005 the EU ETS was the first EU wide regulation to target the PPI's CO_2 emissions. While the effect of country specific instruments have had a positive effect on the PPI, the effects of the scheme (ETS) appears to have been limited especially with regard to the development of innovation activities, especially low carbon solutions (Gulbrandsen & Stenqvist, 2013). The conclusion is drawn in Gulbrandsen et al. who have investigated the role of the ETS for pulp and paper companies in Norway and Sweden. Results from similar studies of German paper producers and technology providers point in the same direction (Gulbrandsen & Stenqvist, 2013). On the other hand, procedures such as monitoring of CO_2 emissions and accounting for CO_2 prices have become more significant since the introduction of the scheme. During the first trading period of the ETS (2005-2007), the PPI had no expenditures for EU Allowances (EUAs)[4]. It appears however that the trading system still had a certain impact on the PPI in terms of increased wholesale electricity prices on the European market (Ericsson et al., 2011).

During recent decades, the tools at hand for policymakers regulating environmental pollution have been evolving. Since the late nineties and beginning of the twenty first century voluntary measures have replaced command and control regulations and incentive based mechanisms. The international norm ISO 14001 relating to the implementation of Environmental Management Systems (EMSs) is an example of a voluntary measure that has been growing in popularity during the last decade (Barla, 2007). In short, an ISO-14001 EMS may improve environmental performance of a firm through the following actions: "respecting all applicable environmental regulations; documenting and analysing the plant's environmental impacts; and systematic, written and standardized checklist-type procedures towards reducing and preventing pollution" (Barla, 2007, p. 293). The norm ISO 14001 appears to be a popular instrument among industry managers but has proven to have scarce effect on actual environmental performance of firms. The finding is based on a study of the impact of the ISO 14001 certification on environmental performance of pulp and paper industry in Quebec (Barla, 2007).

In sum, it appears that national policy measures are more successful in terms of bringing down emissions from industry. National instruments were designed in a more industry-friendly way and are shaped to function more like "carrots" compared to the more costly policies stemming from the EU. A possible explanation to this may be that industry has been more successful at influencing policy design at the national level compared to influencing policy processes in Brussels (Ericsson et al., 2011). It is however difficult to draw a clear line between the degree of importance of national versus European or international policies. Policies at different levels of governance influence each other in both directions. As an illustrative example we may mention the Swedish electricity market reform that had a significant impact on the PPI investment patterns over the last decade (Ericsson et al., 2011). The reform came into force prior to the wider energy market liberalisation in Europe but Swedish policymakers were undoubtedly inspired by ongoing international debates on energy markets.

[4] The EU ETS was launched in 2005 and sets a cap on total greenhouse gas emissions by issuing and allocating a certain number of EU Allowances to industries. Industries need to have such allowances in order to emit greenhouse gas emissions.

3 Additional key factors and drivers for sustainability and competitiveness

A substantial part of the literature addresses factors other than policy instruments which have had an important role in shaping both strategies and investment choices of the pulp and paper industry during the last decades. Numerous factors and conditions have made the Swedish pulp and paper industry take a leading position in terms of sustainability and competitiveness. The PPI is a highly energy and (traditionally) pollution intensive industry that has been subject to energy and environmental policy instruments and regulations over several decades. While the attention of this literature review focuses on developments occurring after 1990, we start this section by describing events in earlier years that significantly shaped the environmental performance of the PPI.

An important historical event is the oil crisis in the 1970s and 1980s. The event contributed to a reduction in oil dependency and a search for alternative fuels at the government level and within industry. An empirical study (see Lindmark et al, 2011) has shown that the largest share of reduction of carbon dioxide (CO_2) emissions in the Swedish pulp and paper industry took place over the period 1973-1990 despite an increase in the shares of output growth. The substitution of oil by other more environmentally friendly fuels required investments in new technology and energy efficiency. According to Lindmark et al 2011, 9 per cent of the improved CO_2 intensity over the period 1973-1985 can be explained by the introduction of improved energy efficiency methods and 62 per cent by substitution of oil by other energy carriers. This indicates how energy policy and the change in the overall energy mix at the national level had a significant impact on the CO_2 emissions in the PPI in this period (Lindmark, Bergquist, & Andersson, 2011). According to these findings, most of the reduction of emissions within the PPI took place before the introduction of active climate policy instruments such as the introduction of the CO_2 tax in 1991, the ratification of the Kyoto protocol in 2002 and the introduction of the European Emissions Trading Scheme (EU ETS) in 2005. A combination of national energy policies (such as the development of hydroelectricity and nuclear power) triggered by rises in oil prices in the 70' and 80' and the gradual environmental adaptation of the PPI are hence key determinants for understanding the increased sustainability of the Swedish PPI during the last three decades.

A further event that appears to have affected both policymakers and the environmental adaptation of industry in Sweden and elsewhere is the renowned announcement of the U.S Environmental protection Agency (EPA) in 1987 that dioxins had been detected in pulp mill effluents and in various paper products. The dioxin discovery became the starting point that put the issue of pulp mill pollution on the agendas of many governments worldwide. The announcement also triggered a dramatic surge in public attention to the environment and to the pollution of pulp mills in particular (Harrison, 2002).

These historical dynamics are important to understand the transformation and reorientation of the industry in the years after 1990. The Swedish PPI is currently one of the major renewable energy producers in the country and, as mentioned earlier, energy and climate policies initiated at the European and national levels have facilitated the transformation (Ericsson et al., 2011; Ottosson & Magnusson, 2013). Important to mention are moreover the underlying economic conditions in the sector, in particular the increase in electricity prices following the electricity market reform 1996. This has been a key factor driving the PPI towards new strategic pathways and sustainability (Ericsson et al., 2011).

Moreover, environmental costumer demand grew in importance since the mid 1990's. According to Doonan et al. 2005 (Doonan, Lanoie, & Laplante, 2005) costumer demands became the most important type of external pressure for Norwegian pulp and paper firms after the mid 1990's (see also article by Sæter[5]). They also found customer demands to be important factor for the Canadian pulp and paper industry but that "the government remains the most important source of pressure" "to improve their environmental performance". Notably the authors found that the most important determinant of environmental performance in the Canadian pulp and paper industry was found to be the combination of external pressures on firms (such as government regulations, environmental demands from consumers) and intra firm aspects (such as an active environmental involvement of higher level of management, a strategic focus on the environmental training of employees, integration of environmental considerations in day-to-day decisions financial resources and evaluation and control mechanisms) (ibid.).

Many of the barriers and driving forces to energy efficiency investments appear not to be solely market-related but firm-specific, related to values, culture and power (Thollander & Ottosson, 2008). Policy instruments not only have an economic impact on the PPI, but they also create "normative ideals and influence perceptions of the future" (Ericsson et al., 2011). Ericsson et al mention the importance of cognitive factors (knowledge, expectations and perceptions) which they argue played a significant role in the strategic reorientation and investment behaviour of the Swedish pulp and paper industry during the last decade, such as the renewed interest in electricity-related investments described earlier in this report.

Another key factor is the age of pulp and paper mills. Authors have argued that for the pulp and paper industry in general "an increase in the capital turnover such as investments in new mills is the most important factors in permanently changing carbon emissions profiles in the pulp and paper industry" (Davidsdottir & Ruth, 2005, p. 208; Nyström & Cornland, 2003). The statement is particularly relevant concerning the U.S. pulp and paper industry where investments in more energy efficient equipment are often a "side bonus to enhanced production capacity" (Davidsdottir & Ruth, 2005, p. 208). The "capital vintage" or age of the capital stock has a significant impact on the rate of technological change and hence on environmental performance (Davidsdottir & Ruth, 2004). We may also mention that in the context of the U.S. pulp and paper industry key drivers behind reduced energy efficiency and the carbon intensity appear to be linked to a range of factors such as better insulation and a shift to recycled fibres and to some extent investments in new and more efficient capital stock. Similarly to the situation in other countries, important drivers for U.S firms have been the fuel switch from residual fuel oil towards natural gas and self-generated energy (Davidsdottir & Ruth, 2004). Further attention on fuel switching, especially in the USA (and China) offers significant potential for CO_2 reductions in the sector (IEA, 2009). The age of pulp mills varies substantially between countries. In an international comparison U.S. and Canadian firms have in general a large proportion of old pulp and paper mills. The most modern mills are currently located in Brazil and Finland. Approximately 10 per cent of Swedish pulp mills are new (aged 0-14 years), whereas the corresponding figure for Finland is around 40 per cent. The age of paper mills is in general relatively younger than pulp mills. Finland ranks high also on this context with the second largest share (approximately 55 per cent) of new paper mills in the world after Korea. The corresponding

[5] See Sæter, B. (2000) Continuity and convergence: reduction of water pollution in the Norwegian paper industry. Business Strategy and the Environment 9, 390-400.

proportion of mills in the age group 0-14 years for Swedish paper mills is approximately 48 per cent (IEA, 2009).

4 Strategic responses of the pulp and paper industry

In this section, we describe the strategic responses of the industry to policy instruments and on challenges stemming from a shift in orientation of the global market for pulp and paper producers. The responses are largely dependent of the type of industry (chemical or mechanical) and on country and sector specific characteristic.

Technology may play an important role in increasing energy efficiency and reducing CO_2 emissions in the pulp and paper industry. Examples of promising energy savings technologies in the industry are gasification, advanced drying technologies and high temperature and high pressure black-liquor recovery boilers (IEA, 2007).[6] The technological profile and energy efficiency potentials of the PPI varies between firms and countries. In the IEA report on *Tracking Industrial Energy Efficiency and CO_2 Emissions*, the energy efficiency profiles of the PPI in various countries is described in the following way:

> "Finland and Sweden's pulp production is dominated by chemical pulp, while in Norway pulp production leans more towards mechanical pulping. Although no statistics are available for integrated mills, it is likely that the greater energy efficiency of the Nordic countries could be attributed to a higher degree of integrated plants together with a lower average technical age compared with Canada and the United States. The industry in the Nordic countries appear to have a better match in terms of absolute pulp and paper production which would allow for greater opportunities for integrated mills and hence higher energy efficiency. Finland appears to have the highest energy intensity in the industry of the three Nordic countries. Paper production in the Finnish industry is dominated by high grades of paper which are more energy intensive to produce." (IEA, 2007, p. 202).

Given these differences in technological specialisation, we may expect that also the strategic responses of the industry differ. A trend in the strategic reorientation of the Swedish PPI since the late 1990s indicate a renewed interest in electricity-related investments (Ericsson et al., 2011). A common business model for the PPI in the 1990s was to focus on core activities. Many companies therefore divested and outsourced activities related to power production. Since the mid-2000s, large Swedish PPI have returned to invest in power production assets. Some companies have invested in hydropower but several pulp and paper companies have presented investment plans for wind power. The liberalisation of the electricity market in 1998 and the introduction of the Kyoto protocol in 1997

[6] See also Worrell, et al. (2001), Opportunities to Improve Energy Efficiency in the US Pulp and Paper Industry, Lawrence Berkeley National Laboratory, Berkeley, California, United States.

are important factors that explain the way industry responded and the type of processes they adopted. Concerning strategic investments, the Swedish PPI steadily increased their process-integrated electricity production. The total on-site capacity for electricity generation increased from 851 MW to 1060 MW between 2000 and 2007 (Ericsson et al., 2011). In the same time, there were no changes in technologies used; steam turbine technology was still dominating. The picture differs however between firms with some firms investing in new turbines (mainly backpressure turbines). Large investments were also made by important actors, such as SCA, Södra and StoraEnso, which invested heavily in new high pressure recovery boilers and turbines (Ericsson et al., 2011). Moreover, efforts to improve energy efficiency have also steadily continued leading to reduced electricity consumption, especially for mechanical pulping and paper production. On the other hand there have been smaller reductions in electricity consumption for chemical pulping (Ericsson et al., 2011).

According to Ottosson and Magnusson 2013, while chemical pulp mills have managed to achieve higher revenues and have increased their demand and capacity to pay for pulpwood the situation for mechanical pulp mills have deteriorated in recent years. This has increasingly led to a shift of firms' investments that in some cases have been transferred from mechanical to chemical pulp production. A consequence of these investment changes have led to increased production of green electricity of the new chemical pulp mills. Hence, the effects of pressures from policy instruments have differed significantly at the level of individual firms (Ottosson & Magnusson, 2013). A quote from Ottosson and Magnusson illustrates this picture:

> "Even though factors other than the ECS and PFE may be important explanations of Rottneros' difficulties and Södra's success, these public policy instruments served to reinforce the current trends in the industry. The industry today is increasingly divided into two distinctive parts with different profitability criteria: mechanical pulping and chemical pulping […] The Södra and Rottneros cases demonstrate that the changing energy policy in Sweden- moving from a regime built upon low electricity prices to a regime which focus upon energy efficiency and renewable electricity production- changed the profitability criteria for the whole pulp and paper industry. Still, on a firm level, the effects of the pressure from policy instruments differed greatly, depending on heterogeneous production processes, facilities and technologies" (Ottosson & Magnusson, 2013, p. 364).

Notable differences can therefore be observed between chemical and mechanical pulp and paper industries with regard to how they have responded or have been affected by policy measures and other types of external pressures.

Due to the capital and energy intensive nature of the pulp and paper industry, new entrants have difficulties in establishing themselves on the market. A further barrier for newcomers is also the strong political power of incumbent actors on the market (Ottosson & Magnusson, 2013). Recent trends in the sector indicate that traditionally strong paper industries are struggling with competitiveness and profitability. This has been the case for the Finnish paper industries where profitability in the sector declined sharply in the period from 2002-2005. During the last decade, there has therefore been a reorientation of both policies and reorganisation of the paper industry. An important factor contributing to these challenges is the threat of declining wood imports from Russia. In 2006, Russian authorities announced that they would substantially increase export duties of roundwood, which would have a significant impact on the import of this type of timber to Finland. The response of government policies on these challenges have been a stronger emphasis on instruments such as increased R&D investments on new products and energy efficiency. The response from the industry has been to establish a new Finnish Forest Cluster owned by major forest cluster companies together with private and public research organisations, and Universities. The Swedish pulp and paper industries have been facing similar challenges and have responded by putting a higher emphasis on R&D and intensified firm collaboration (Rametsteiner et al., 2009) . The

industry has also increased its attention towards further value- added production, new products, efficient transportation systems, and taking active part in including renewable energy sources to the energy system. The response of policymakers have been to create new strategies for increasing competitiveness of the industry by emphasising the need to stimulate R&D and increased cooperation between actors (Rametsteiner et al., 2009, p. 187).

As suggested by Karltorp & Sandén 2012 " a more radical response to increasing pressure caused by landscape [or broad societal] changes would be to enter new value chains" (Karltorp & Sandén, 2012, p. 74) and stress that biorefinery concepts may offer new business opportunities for firms in the Swedish pulp and paper industry. The authors note that the Swedish PPI's reactions to the external changes have been modest until now and the reactions have mostly been to incrementally change production methods. However, developments along two trajectories have been noted: the first concentrates on gasification for fuel production, the second on separation and refining of high value products. At this stage, the response is mostly visible at the level of research and development projects (Karltorp & Sandén, 2012).

5 Effects on competitiveness and on the environment

Followers of the innovation systems theory largely agree that moving towards sustainable industrial transformation requires that new green technologies are developed and widely adopted. There is a widespread agreement on the importance of technological innovations. It is furthermore a common belief that policy instruments are necessary to help advance technological development. There is however little consensus amongst scholars on the relationship between different types of policies and technological development (Mickwitz, Hyvattinen, & Kivimaa, 2008).

The pulp and paper industry is a highly capital-intensive industry characterised by a high degree of path dependency (Davidsdottir & Ruth, 2005). Research has shown that the PPI is often "reluctant to embrace major technological change" and that it is essentially a conservative and mature industry which competitive advantage has traditionally been based on the use of existing technological capabilities (Ottosson & Magnusson, 2013, p. 359)[7]. As we have described earlier in the report, the price of energy plays a central role in decision making in the pulp and paper industry and energy prices have hence a significant effect on industrial change in the sector (Davidsdottir & Ruth, 2005).

During recent years the global market situation for the sector has changed and companies that have continued on traditional technological trajectories have faced difficulties and even faced the option of closing several mills (Patari et al., 2011). The literature emphasises that during the decade 1996-2005 there has been a shift in innovation dynamics in global PPI (Patari et al., 2011). By measuring the value creation capability of large international PPI the study concludes that apart from a few exceptions, North American and Nordic companies have shifted from being value creators in 1996 to value destroyers in 2005. (If a company has lower return on invested capital (ROIC) than weighted average cost of capital (WACC) then the company is classified as value destroyer)[8]. The fact that several of these companies have struggled to compete globally is explained by two factors: the emergence of new actors in South America (especially in Brazil) and in Asia and the lack of focused value chain strategies (upstream vs. downstream strategies). The companies in the Nordic countries such as StoraEnso, Smurfit, Sappi, Holmen and SCA were all value destroyers in 2005. North American companies have followed the same trend, with the notable exception of the US firm

[7] Similar conclusions are drawn by Laestadius, S.(2000) Biotechnology and the potential for a radical shift of technology in forest industry. *Technology Analysis & Strategic Management* 12: 193-212 and by Bergek A. (2002) Responses to technological opportunity: The case of black liquor gasification in Sweden. In *Shaping and exploiting technological opportunities: The case of renewable energy technology in Sweden*. Göteborg: Chalmers University of Technology.

[8] The study uses two economic indicators: ROIC which is calculated by dividing earnings before income taxes by total capital. The total capital is a sum of total common equity and total debt. The second indicator is WACC which is the cost of equity calculated according to the capital asset pricing model.

Kimberly Clark which success is explained by focused strategy on branding and consumer products (Patari et al., 2011). By focusing on economies of scope instead of economies of scale, successful companies have managed to survive in the increased global competition. Technology could play an important role in reducing CO_2 emissions and improve competitiveness in the pulp and paper industry. According to the IEA the most promising energy saving technologies in the industry are black liquor gasification, advanced drying technologies and biorefineries (IEA, 2009). Turning towards biorefining is mentioned as a promising solution for companies currently struggling with value creation (Karltorp & Sandén, 2012; Patari et al., 2011).

In a Swedish context, the ECS system and the PFE, discussed earlier in this report, had significant effects on the increase of renewable production of the Swedish pulp and paper industry and were important drivers for a "green" structural change. This indicates that the schemes had a limited effect on firms' technical change but had notable effects on environmental sustainability. An indication of the latter is that in an international perspective, the Swedish pulp and paper industry is among the most sustainable in terms of carbon emissions. Sweden, followed by Norway, Finland and Canada has the lowest carbon emissions per tonne of product in the world (IEA, 2007). The leading position of the Swedish PPI is largely explained by the characteristics of the Swedish energy mix, which is composed by renewable energy (hydropower and biomass) and nuclear (Lindmark et al., 2011). The United States has the highest emissions per tonne due to high fossil fuel use in energy production (IEA, 2007 page 194). Overall, the global emissions from the pulp and paper industry (per tonne of pulp exported) declined significantly in the period 1990-2003 (IEA, 2007).

A further point to emphasise in this context is the expected effect attributed to environmentally focused energy taxation on technology development in energy intensive industries (Mickwitz et al. 2001). Policymakers in several countries, claim that energy taxation has not only environmental effects but may potentially also effect the innovative performance of firms. A study on the Finnish pulp and paper industry found evidence that contradict this claim and concludes that energy taxation had in fact little impact on innovation in the sector. It was found that other factors were more important to foster process efficiency. These factors were environmental considerations, cost savings and public R&D funding (Mickwitz et al., 2008). The conclusions indicate that more than taxation instruments a combination of policy instruments and regulations, i.e. environmental standards and permit conditions have an important impact on the emergence or diffusion of new, environmentally sounder technologies. Important to note is the authors' conclusion on the difficulty in generalising the role of policy instruments for innovation and diffusion without taking into account the specific characteristics of the sector. As pointed out earlier it is also likely that policy instruments may have different effects on individual companies despite belonging to the same sector (Karltorp & Sandén, 2012; Mickwitz et al., 2008).

As discussed earlier, the reform of the Swedish electricity market had a significant effect on the PPI as the reform implied a steady increase in electricity prices. Interesting to note is that the expectations of the industry were different from the actual outcome of the reform. The industry expected a gradual lowering of electricity prices as a direct effect of increased competition of power producers. Instead, the reform led to negative effects on Sweden's competitive advantage with respect to traditionally low energy prices compared with other countries in Western Europe (Ericsson et al., 2011). Important to mention is also that in addition to low energy prices the competitiveness of the Swedish PPI has been based on a combination of factors, comprising skilled work force, high quality forest resources, transportation solutions, and efficiency in product and process development (Rametsteiner et al., 2009).

6 Conclusions and discussion

The pulp and paper industry plays a significant role in the Swedish economy as it accounts for about 6 per cent of Sweden's gross domestic product. With more than 85 per cent of its exports the Swedish PPI is the world's second largest exporter of paper, pulp and sawn timber combined. In Europe, Sweden's pulp and paper industry is the third largest after Germany and Finland (IEA, 2007).

Much of the policy debate about climate change issues have centred on the need for design and timely introduction of instruments that can contribute to significant abatements of greenhouse gas emissions from industry. The pulp and paper industry has been the target of such instruments for several decades and continues, despite significant improvements in energy saving technologies and pollution reduction, to receive the attention of policymakers preoccupied with environment and climate issues. In Sweden, the PPI accounts for approximately 50 per cent of Sweden's annual industrial energy use (SEA, 2008) and changes in this industry have large environmental and climate effects. In an international comparison Sweden's PPI remains one of the most energy efficient thanks to technical progress introduced during the last three decades (Henriksson & Lundmark, 2013, p. 175). A challenge remains to invest in newer and more efficient mills (especially for pulp production) and to explore new pathways (see the discussion on biorefineries) in order to be able to compete globally. This challenge is shared with the PPI in other countries such as in Canada and in the United States where the reliance on older technologies has made the industry less competitive on the global market (IEA, 2009).

A major concerns facing the PPI in Sweden and in other Western European countries in recent years, is a possible decline of international competitiveness. At the same time new forest based business opportunities are seen in the fields of bio-energy, bio-refineries, tourism, carbon sequestration, etc. which may counteract this decline (Rametsteiner et al., 2009). According to the IEA "there are notable differences in energy use for pulp and paper production between countries, due to a range of factors such as product mix, processes used, plant size, technology, technical age, feedstock quality, fuel prices and management attention to energy efficiency"(IEA, 2007, p. 175). The IEA explains that several factors are important to increase energy efficiency in the pulp and paper industry, where investment cost and competitiveness are key determinants. Current energy efficient technology can play an important part if retrofitted on existing mills. Main challenges for the PPI as a whole are to increase use of heat recovery and increase paper recycling and recovered paper (especially in North America and in parts of Asia). While the efficiency of heat consumption showed real gains from 1990 to 2003, little change has occurred in the overall efficiency of electricity use. The IEA sees a potential improvement for both efficiency of heat consumption and electricity use (IEA, 2007).

Against this background, national and international energy and environment policies may have an important role in facilitating new business opportunities and hence having an impact on the competitiveness and sustainability of the industry. It is clear that the rising market competition from Asia (mainly China) and South America (mainly Brazil) has posed challenges to the strategic reorientation of the PPI in Sweden and in other Western countries. At the global level, the United States remain the world's largest producer of paper and paperboard accounting for 23.6 per cent of production in 2004 (IEA, 2007). Together with China, Japan and Canada they account for more than half of all global production. For the production of chemical and mechanical pulp the United States, is again in the lead followed by Canada, Japan, Sweden, Finland and Brazil (IEA, 2007). However, as future growth in demand for pulp and paper products will grow stronger in Asia in parallel to per-capita income growth in the region, the share of Western countries' global production may continue to decline (IEA, 2009).

The literature review has showed that policymakers have a key role in developing instruments that contribute to sustainability and competitiveness of the industry. Instruments that aim at stimulating a transition need to consider the diverse nature of firms and that that there are a manifold of external and internal pressures affecting firms' strategic choices and responses. New technological pathways exist but it remains to be seen if they will be adopted by the industry. This nevertheless remain a critical point in the transition of the PPI.

References

Barla, P. (2007). ISO 14001 certification and environmental performance in Quebec's pulp and paper industry. *Journal of Environmental Economics and Management, 53*(3), 291-306.

Bergek, A., & Jacobsson, S. (2010). Are tradable green certificates a cost-efficient policy driving technical change or a rent-generating machine? Lessons from Sweden 2003-2008. *Energy Policy, 38*, 1255-1271.

Davidsdottir, B., & Ruth, M. (2004). Capital vintage and climate change policies: the case of US pulp and paper. *Environmental Science & Policy, 7*(3), 221-233. doi: 10.1016/j.envsci.2004.02.007

Davidsdottir, B., & Ruth, M. (2005). Pulp nonfiction - Regionalized dynamic model of the US pulp and paper industry. *Journal of Industrial Ecology, 9*(3), 191-211. doi: 10.1162/1088198054821618

Doonan, J., Lanoie, P., & Laplante, B. (2005). Determinants of environmental performance in the Canadian pulp and paper industry: An assessment from inside the industry. *Ecological Economics, 55*(1), 73-84. doi: 10.1016/j.ecolecon.2004.10.017

Ericsson, K., Nilsson, L. J., & Nilsson, M. (2011). New energy strategies in the Swedish pulp and paper industry-The role of national and EU climate and energy policies. *Energy Policy, 39*(3), 1439-1449. doi: 10.1016/j.enpol.2010.12.016

Gulbrandsen, L. H., & Stenqvist, C. (2013). The limited effect of EU emissions trading on corporate climate strategies: Comparison of a Swedish and a Norwegian pulp and paper company. *Energy Policy, 56*, 516-525. doi: 10.1016/j.enpol.2013.01.014

Harrison, K. (2002). Ideas and environmental standard-setting: A comparative study of regulation of the pulp and paper industry. *Governance-an International Journal of Policy and Administration, 15*(1), 65-96. doi: 10.1111/1468-0491.00180

Henriksson, E., & Lundmark, R. (2013). Structural changes in industrial electricity use: the case of the pulp and paper industry in Sweden. *Energy Efficiency, 6*(2), 305-314. doi: 10.1007/s12053-012-9176-4

IEA (Ed.). (2007). *Tracking Industrial Energy Efficiency and CO_2 emissions. In support of the G8 plan of action.* Paris.

IEA (Ed.). (2009). *Energy Technology Transitions for Industry. Strategies for the Next Industrial Revolution.* . Paris.

Karltorp, K., & Sandén, B. A. (2012). Explaining regime destabilisation in the pulp and paper industry. *Environmental Innovation and Societal Transitions, 2*, 66-81. doi: 10.1016/j.eist.2011.12.001

Lindmark, M., Bergquist, A. K., & Andersson, L. F. (2011). Energy transition, carbon dioxide reduction and output growth in the Swedish pulp and paper industry: 1973-2006. *Energy Policy, 39*(9), 5449-5456. doi: 10.1016/j.enpol.2011.05.018

Mickwitz, P., Hyvattinen, H., & Kivimaa, P. (2008). The role of policy instruments in the innovation and diffusion of environmentally friendlier technologies: popular claims versus case study experiences. *Journal of Cleaner Production, 16*, S162-S170. doi: 10.1016/j.jelepro.2007.10.012

Nyström, I., & Cornland, D. W. (2003). Strategic choices: Swedish climate intervention policies and the forest industry's role in reducing CO2 emissions. *Energy Policy, 31*(10), 937-950. doi: 10.1016/s0301-4215(02)00137-4

Ottosson, M., & Magnusson, T. (2013). Socio-technical regimes and heterogeneous capabilities: the Swedish pulp and paper industry's response to energy policies. *Technology Analysis & Strategic Management, 25*(4), 355-368. doi: 10.1080/09537325.2013.774349

Patari, S., Kylaheiko, K., & Sandstrom, J. (2011). Opening up new strategic options in the pulp and paper industry: Case biorefineries. *Forest Policy and Economics, 13*(6), 456-464. doi: 10.1016/j.forpol.2011.06.003

Rametsteiner, E., Weiss, G., Ollonqvist, P., & Slee, B. (2009). *Policy Integration and Coordination: the Case of Innovation and the Forest Sector in Europe*. Luxembourg: Publications Office of the European Union.

SEA. (2008). Energy in Sweden 2008. In Swedish Energy Agency (Ed.). Eskilstuna, Sweden.

Thollander, P., & Ottosson, M. (2008). An energy efficient Swedish pulp and paper industry - exploring barriers to and driving forces for cost-effective energy efficiency investments. *Energy Efficiency, 1*(1), 21-34. doi: 10.1007/s12053-007-9001-7

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