Competitive Implications of Environmental Regulation in the Paper De-inking Industry

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EXECUTIVE SUMMARY

Since 1990, the pulp and paper industry made a significant transition toward the use of recovered fiber, or "waste-paper," and by 1995, one-third of North American mills had some recycling capacity, for a broad range of products. World markets, particularly in Asia, were also growing at a rate roughly twice those of virgin fiber. The use of recovered fiber represented a key shift in technology and strategy for the pulp and paper industry; not only did it demand specific changes in process technology, but it required a shift in focus for companies whose strategic expertise had been in forest management and virgin fiber. Recovered fiber use demanded knowledge of a rapidly changing supply infrastructure and a fiber supply of highly variable quality and price.

Recovered fiber had traditionally been used in low-cost commodity products, but most mills had found the cleaning processes needed for higher grade products too arduous and costly. Key drivers in the shift toward recovered fiber included advances in cleaning technology, changes in market demand, shifts in the cost and availability of virgin fiber, and environmental regulation. All of these forces were apparent in the U.S. Pacific Northwest, and combined to undermine the region's traditional sources of competitive advantage.

The pulp and paper industry invested heavily in recovered fiber capacity and supply infrastructure, and the competitive advantages of doing this made it a necessity for others to follow suit. As products improved, "green markets" emerged and consumers bought the recycled product. At the same time, the collection and supply industries matured, giving a more consistent supply of fiber to those who had the industry experience to secure it. In the absence of regulation requiring specific technologies for processing recovered fiber, companies invented a wide variety of individual solutions to the problem of producing a high quality product with a lower cost fiber source. Capital equipment costs and operating costs such as energy and chemicals tended to be lower than in virgin fiber processing, but transportation costs were unpredictable and the disposal of large amounts of waste from de-inking mills could be very costly.

The role of regulation in the shift toward recovered fiber was not central. Regulations specific to recovered fiber usually targeted solid waste, and took four basic forms: landfill and packaging restrictions, content requirements, flow control rules, and restrictions on the use of recovered fiber in certain products. Europe and the U.S., the largest producers of waste, had the largest amount of regulation, but U.S. activity existed primarily at the state level. U.S. forest management and pollution control regulations also affected the industry as a whole, but even in the Northwest, where forest management regulation and strict state content requirements had a measurable impact, regulation did not fully explain the magnitude of the shift to recovered fiber. It was clear that recycled content requirements, and the threat of content requirements, had encouraged the rapid development of a collection and supply infrastructure for post-consumer fiber. As the supply industry became established, however, content requirements were less significant.

International trade was affected by adoption of recovered fiber as well. On both a regional and a global scale, virgin fiber availability was a key driver in the increase in demand for recovered fiber. Emerging nations and regions without large virgin fiber supplies took advantage of developing recovered fiber markets and fostered a growing international trade.

INTRODUCTION

In 1995, “recycling” had become an international preoccupation. In the pulp and paper industry, a confluence of public pressure, regulation, and market economics brought the use of recovered wood fiber to an unprecedented level, even as the process technology, industry supply structure, and regulatory framework were still developing. This report examines the forces that affected the use of recovered fiber, and looks at the implications for future policy decisions.

INDUSTRY STRUCTURE

Product Description

Recovered fiber could be used as a raw material in most pulp and paper products, which included wallboard, printing and writing paper, newsprint, packaging and converting paper, and tissue. Bales of recovered fiber (old boxes, newspapers, and other papers) were pulped with water in a basic solution, cleaned in several stages, and sometimes de-inked. The resulting stock consisted of fiber and water, and was either dried and sold as pulp or fed onto a paper machine which pressed the fibers into paper. Virgin fiber was processed from wood chips, which were digested in a chemical pulping facility or ground in a mechanical pulper until the unwanted lignin (wood content) was removed. The result was also fiber and water, and the paper-making process from this point was identical (Figure 1). Mills varied the amount of recovered fiber in paper products by changing the "mix" of the recovered and virgin slurries according to product specifications. Recovered fiber use had been limited by two characteristics: high levels of contaminants, and shorter, weaker fibers resulting from damage during use and re-pulping. Fibers could be recycled at most about seven times before damage would render them useless; some virgin fiber would thus always be required to infuse the industry with fiber sources of consistent quality.

Recovered fiber had been used for decades, principally in paperboard and corrugating medium, where fiber appearance and strength was less critical. The American Forest and Paper Association's (AF&PA) Statistical Summary of Recovered Paper Utilization shows that 1994 recovered fiber use was still weighted toward paperboard, which represented 19 of the 31 million short tons used in the United States. This was a recovered fiber utilization rate of 41.4% in the paperboard sector, compared with a 24% utilization rate in paper production.

Improvements in de-inking and de-contamination increased and diversified the use of recovered fiber and improved its image. Printing and writing papers, newsprint and containerboard with up to 100% "recycled" content were available, and many grades were virtually indistinguishable from virgin products. Pulping and cleaning process improvements preserved fiber strength and value while cleaning better. While some end products demanded certain fiber types (e.g. packaging materials demanded longer fibers, such as those found in old corrugated cardboard (OCC) for strength), mills were challenged to make "more from less," by moving deeper into the waste stream and extracting high quality fiber from cheaper, more contaminated sources.

Pre-consumer recovered fiber had been used for decades and was usually purchased directly from the generator. Since the 1980s, the industry focused increasingly on post-consumer fiber, which was purchased through brokers or directly from collectors/haulers; some companies integrated into brokering and even collection as post-consumer recovery programs developed. The five grade categories of recovered fiber contained 51 regular and 31 specialty grades. Price varied according to fiber quality and length and contaminant levels, with unsorted ("mixed") paper the least expensive and sorted office and computer printout paper the most expensive of the post-consumer grades (Table 1). Comparable virgin market pulp prices were close to $900/ton, though a ton of market pulp was effectively "more" since no

processing was required before making paper, and therefore no fiber would be lost.

Table 1. Major Grades of Recovered Fiber and Current Prices:

Grade	Definition	Price Range ($/short ton)
Mixed Paper	varied quality paper, often office waste	100/140
OCC	old corrugated containers	170/180
ONP (all grades)	old newspapers, from homes/newsstands	180/240
De-inking	sorted office paper and computer printout (CPO)	260/430
Pulp Substitutes	uncontaminated sheets, cuttings and kraft	145/560 *

(source: Paper Stock Report, July 3, 1995)

* grades range from boxboard cuttings to unprinted bleached sulfate, all prices baled per short ton at sellers dock

Market Size

The market for recovered fiber included all de-inked pulp, paper and paperboard mills, which in turn responded to customer demand, price, and technological capability in choosing a fiber source. As recovered fiber capacity grew, the market expanded into the existing virgin fiber market. Current industry growth was sufficient to allow growth in both virgin and recovered fiber markets, but recovered fiber was gaining ground. After a severe economic downturn in the early 1990s, total world paper and board production in 1993 was 251.6 million tons, a 1.6% increase from 1992, while total pulp production fell to 163 million tons from 165.6 million tons in 1992 (1995 North...). Worldwide, 98.5 million tons of wastepaper were used in 1993; this was a 4 million ton increase over 1992. The emphasis on the use of recovered fiber directly in paper production contributed to a simultaneous rise in paper production and drop in pulp production worldwide (*Pulp and Paper*). In both virgin and recovered fiber capacity, Asia had the highest growth rate, with a 1988-1993 annual average growth of 9.6%, compared to the world average of 3.7%. Growth in the next five years was expected to slow to 1.9% overall, though Asian production grew at roughly 4%. North America's mature industry was expected to grow at a slower 1.1%.

From 1970 - 1991 use of wastepaper grew from 37 to 87 million tons, an annual growth of 5%, compared to 2.5% for virgin pulp (Collins,1992). This trend was expected to continue as new capacity came on line; U.S. recovered fiber capacity at paper mills was expected to grow at 6.8% over the next three years, while woodpulp capacity was only expected to increase at a rate of .6% (1995 North...). In 1995, one third of all U.S. paper mills had recycling capacity. Since early in 1994, dramatic price increases for recovered fiber kept pace with new capacity, while suppliers struggled to meet demand (Figure 2). This was a profound change: as recently as 1993 there was widespread report of collected old newspapers being landfilled for lack of a market (Capps,1993). Reasons given for the rapid price increases included growing world demand for recovered fiber, new recycling capacity, reduced virgin production in some regions and increasing virgin fiber prices, and concern about future regulation that would either require recovered fiber content or restrict virgin supply. While none of these factors independently would have driven price increases of over 500% in less than two years, it was increasingly accepted throughout the industry that competitive advantage required a diverse fiber base to defend against price fluctuations and

shortages. The combination of strategic and immediate concerns had resulted in this increase, which was showing signs of leveling off in the summer of 1995.

Collection infrastructure was a limit to market size. In the U.S., the infrastructure had only recently developed enough to provide paper producers with a somewhat consistent supply of recovered fiber. Some recovered fiber collection had been undertaken by interested companies for up to 50 years; as a result, the paperboard and corrugated container industry were relatively mature in their production. Collection industries developed in the last 20 years focused on solid waste, particularly newsprint; recycled newsprint production was then reaching maturity. As office recycling programs began to see success in the 1990s, printing and writing paper markets and production developed (Collins,1992). Collection also varied according to region and population density; urban areas of the Pacific Northwest had the highest rates of fiber recovery due in part to a strong "green ethic," followed by urban areas in the Midwest and Northeast which were facing severe landfill shortages, and finally the Southeast, where low population density meant that collection less practical and landfill problems were less severe.

Threat of New Entrants

Fiber-poor nations in Asia such as Korea, Taiwan, and Japan, would provide the greatest competition with the U.S. in the demand for recovered fiber in the coming decade. Korean newsprint capacity was set to double to over 1.6 million tons by 1997. Large capacity mills and decades of recycling experience and technology made Asian countries significant threats to the American markets. The primary barrier in the use of recovered fiber was the availability of the fiber itself. As the supply infrastructure for post-consumer fiber developed, fiber procurement was becoming a strategic focus globally, as supplier power increased and companies responded with integration.

Within the U.S., the capital intensive process of papermaking kept the threat of new entrants low, but recovered fiber had implications for the industry configuration. Recovered fiber was less capital intensive than virgin, since it did not require digesting, and conversion to recovered fiber at existing mills could be inexpensive. Forty percent of new U.S. capacity was recycled, of which 75% was greenfield. Costs were still high enough to ensure that only two small greenfield projects were by new companies, however. Geography was also an issue: paper mills located strategically close to virgin sources may have been at a disadvantage, since they were often far from sources of recovered fiber. Urban mini-mills, including older paperboard mills, successfully used proximity to markets and supply to offset disadvantages of scale.

Leading Supplying Nations

The U.S. produced and consumed more than twice the pulp and paper of the next top producing country, Japan, with a 1993 production of 76,557 thousand metric tons of paper and 57,069 thousand metric tons of pulp, and consumption of 81,856 thousand metric tons, or 700 pounds per capita/year (Table 2). Asian countries, however, represented the fastest-growing markets.

The top consumers of waste paper were the U.S. and Japan; in 1991 the U.S. consumed 24% of the world total of this commodity. In 1993 the U.S. consumed almost 30 million tons of recovered fiber and exported 5.8 million tons, principally to Canada, Korea, Taiwan and Mexico (Table 3). This export figure was significantly lower than 1990-1992 figures, which were close to 6.5 million export tons. Growth in domestic demand and a drop in offshore demand from Asia contributed to this change. Asian countries recovered fiber for well over 50% of production, and had traditionally imported fiber from the U.S., but recent efforts at recycling in South Korea, Japan, and Taiwan were yielding recovery rates in excess of 50%, temporarily relieving some pressure on the American market. Recovered fiber still

tended to move toward markets with fiber shortages, and to countries such as Canada which supplied markets with recycled content laws. In the European Community (EC) there was "local" export because virgin fiber and paper markets were located in different countries, each with its own domestic industry. For example, Scandinavian mills produced far more pulp for export than paper, while Germany and the Netherlands had large numbers of non-integrated paper mills.

Table 2. Top Producers and Consumers of Pulp and Paper, 1993

Top Paper Producers	**Production** (1000 metric tons)	**Top Pulp Producers**	**Production** (1000 mt)	**Top Paper Consumers**	**Consumption** (1000 mt)
U.S.	76,557	**U.S.**	57,069	**U.S.**	81,856
Japan	27,762	**Canada**	22,897	**Japan**	28,059
China	18,200	**China**	15,290	**China**	20,426
Canada	17,534	**Japan**	10,593	**Germany**	15,380
Germany	13,034	**Sweden**	9,953	**UK**	9,779
Finland	9,990	**Finland**	9,338	**France**	8,924

Table 3. U.S. Wastepaper Exports to Major Consuming Countries, 1993

Receiving Country	Exports (tons)	Percent of Market
Rep. of Korea	1,212,360	20.59%
Canada	1,182,448	20.08
Taiwan	888,290	15.09
Mexico	699,258	11.88
Japan	416, 987	7.08
Indonesia	305,904	5.20
Philippines	127,241	2.16
Spain	84,647	1.44
Italy	33,826	.57

Competing Technologies

Recovered fiber demanded extensive cleaning; mills incorporated a variety of technologies, including screens, detergents, and centrifugal pumps. Post-consumer fiber was particularly contaminated; mills received everything from TV remote controls to dead animals, engine blocks, and handguns in "sorted" recovered fiber shipments. While large contaminants were removed with initial screening, the most difficult contaminants to remove were ink particles, wax, and "stickies," glues and other contaminants small enough to get through cleaning systems and stick to the paper machines, damaging the final product. Ink particles became "dirt" in recycled paper products; laser printers created large plastic flakes, and flexographic and other water-soluble inks dissolved in the pulper. Depending on the ink, mills used one of three technologies: washing, flotation, and/or agglomeration de-inking.

Washing, traditionally a European technology, used detergent to dissolve and remove ink particles; it worked well on water soluble inks. Flotation, emphasized in Japan, was successful with oil-based inks and laser print; as the name implies, it lifted the larger particles to the surface and removed them. Agglomeration was a newer technology using an agent (often a clay) to "clump" the smallest ink particles into heavier masses which could be removed in a centrifugal cleaner. These technologies competed with one another, but mills started to use a combination of two processes for some fiber supplies, reducing rivalry among suppliers. Competitive dynamics were expected to evolve as the use of recovered office paper increased, since only in the office and newsprint segments was the issue of de-inking processes critical.

Overall, cleaning and de-inking technology varied according to mill and end product. Due to the wide variety of fiber stocks and product requirements, no industry standard existed. Technologies were evolving as mills reached deeper into the waste stream and as offices adopted laser printing and water-soluble inks. The greatest competitor to recovered fiber technology was, of course, the virgin fiber papermaking process.

Existing Firms and Competitive Strategies

The pulp and paper industry was dominated by large, vertically integrated companies, most of which were North American. Large domestic markets and plentiful fiber in the U.S. resulted in more vertical integration than in Japan or Europe, where markets and raw material bases were smaller. The U.S. recovered fiber market was becoming more concentrated; the top five recycled paperboard producers

controlled 40% of that market, up from 27% in 1982. Market leaders in virgin papermaking and recycled paperboard production were different, reflecting traditional patterns of fiber use in certain products (Table 4).

Table 4. Top North American Paper Products Companies, 1993

Total Paper and Pulp Production		**Recycled Paperboard Production**	
Company	Sales ($m)	Company	Sales ($m)
International Paper	$7,000	Jefferson Smurfit	$2948
Kimberly Clark	6,637	Newark Group	300
Georgia - Pacific	5,231	Sonoco Products	1,947
Stone Container	4,775	Caraustar Industries	NA
Scott Paper	4,749	RockTenn	NA

Recent expansion and backward integration into recycling among the largest companies was changing the industry, as new players competed with the non-integrated mills which had long counted on wastepaper as a cheap fiber supply. Examples of three companies with very different approaches to recycling were Weyerhaeuser, International Paper, and JSC, an American affiliate of Dublin-based Jefferson Smurfit.

Jefferson Smurfit Corporation

Jefferson Smurfit, with annual sales approaching $3 billion even in the recession year of 1993, was the world's largest recycler, with operations around the globe, including a brand new 1995 venture in China, and nearly 20 mills in the U.S. processing recovered fiber. JSC had traditionally recycled, and had integrated into brokering fiber and into collection systems with a secondary fiber procurement division named Smurfit Recycling; as well as sorting and brokering, the company actively assisted municipalities and businesses in establishing recycling. Smurfit Recycling was facing competition in the Northwest from Weyerhaeuser, which had entered into recycling in the 1970s, but in matters of environmental regulation, JSC mills were well positioned, and JSC was a member of the Recycled Paperboard Alliance, an industry group dedicated to raising public awareness of recycled products. JSC mills did feel the pinch of rising raw materials costs, but well-established supply relationships and technical experience ensured profitability even as recovered fiber hit record prices.

Weyerhaeuser

Since 1974 Weyerhaeuser, one of North America's largest integrated forest products companies (with 1994 sales of $9 billion in pulp, paper, and wood products) had been carefully building a presence in recovered fiber, and in the summer of 1995 it outpaced JSC as the largest paper broker in the Pacific Northwest, while new operations in the Southeast and Iowa extended the company's recycling production capacity. With a centralized unit dedicated to recovered fiber, Weyerhaeuser competed directly with JSC and other older players in buying and brokering paper, beginning with an interest in OCC and office paper. In the 1990s Weyerhaeuser Recycling began to broker other materials, such as aluminum cans, and the company moved into collection by providing "takeaway" service for large consumers such as K-Mart. Weyerhaeuser's emphasis on long-term agreements with customers and integrated waste services ensured a fairly stable and increasing flow of fiber even in a tight market, and an innovative joint venture with Nippon Industries introduced Japanese de-inking technology into the North American newsprint market. Weyerhaeuser's experience in recycling was an advantage as fiber became scarce and expensive; the company benefitted from its experience and flexible sourcing ability, and achieved robust profits in 1994 and 1995. Weyerhaeuser planned to double recycling capacity by year 2000.

International Paper

The largest forest products company in the world, International Paper (IP), was a latecomer into the recovered fiber markets, but was entering into recycling with dedication in 1995, as part of a strategy to modernize and "green" the company. Seven IP mills had recycling capacity and the company was pursuing plans for expansion of its recycling systems. With many of the largest mills in the country, IP had the capacity to change the dynamics of the recovered fiber market significantly as it introduced and implemented its plans to expand recycling.

DRIVERS OF INNOVATION

As recently as 1992, industry analysts doubted whether recovered fiber use in the U.S. could be cost effective, given that high collection costs, erratic supply, production difficulties, and inferior product tended to make the entire venture more costly than using known technology to produce fine virgin products. Collection systems had surprised the skeptics of the 1980s and produced large quantities of available post-consumer fiber, but market demand and production capacity lagged behind. Three years later the situation was reversed and mills sought recovered fiber from hundreds of miles away. Prices and production capacity were both increasing rapidly, ensuring that fiber procurement would continue to be an important issue.

Market Pressures

Several market forces were key drivers in the industry shift toward recovered fiber. These included: fiber price and availability (both virgin and recovered), technological capability, and changing customer and consumer pressures.

Virgin fiber availability in some regions had been reduced by heavy harvests on private land, changing forestry practices, urbanization, federal and state harvest restrictions, and growth in demand. Better milling practices had also increased the timber yield and reduced the amount of wood fiber available to the paper industry as chips[1].

Recovered fiber prices had traditionally been very low - many municipalities had even paid haulers to bring fiber to nearby mills. Low margin manufacturers had used this fiber supply for years; ironically, these small producers who had been in the recovered fiber market so long may have been at a disadvantage as recovered fiber prices were beginning to skyrocket.

Technology was improving; new technology involved both capital equipment and technical expertise; the variety of paper products and production facilities ensured wide variety of recycling technologies. Companies were able to offset the cost of technology with the savings gained from using cheaper sources of fiber.

Consumer pressure was mounting with awareness of environmental issues and support for recycling efforts. This awareness was important to producers looking to differentiate commodity products.

Since 1990, these pressures had been present in considerable force in the U.S. market. A lag between

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In the Northwest fiber is plentiful, but a high percentage of it is publicly owned timber land and subject to policy changes which have shifted from providing timber at very low prices to severe harvest restrictions. Recent legislation may increase harvest levels, but the long run outlook is difficult for Northwest mills.

collection of recovered fiber and the development of recycling capacity helped create an oversupply of post-consumer fiber, keeping prices low even as new cleaning and de-inking processes were becoming more accessible. Virgin fiber prices were skyrocketing in response to increased demand and decreased harvests; chips were becoming more expensive and less available. As the financial and strategic benefits of a more constant, less expensive fiber supply became apparent, mills began to invest in recovered fiber capacity, and consumer markets for recycled products developed as the popularity of recycling increased.

Regulatory Pressures

Regulation in the pulp and paper industry had a long and varied history, from command and control effluent regulations of the 1970s, to popular demand for mandatory recycling throughout the 1980s, to industry agreements with government to reduce packaging and solid waste. Over the last decade an increasing number of regulations in various countries had been directed at recovered fiber use and solid waste reduction. Despite its reputation for stringent environmental regulations, the U.S. had no federal regulations mandating recycling; instead individual U.S. states had developed a complex mosaic of recycling programs and initiatives.

Federal policies in the U.S. and in other countries did affect recovered fiber indirectly. The following areas of regulation were important factors in fiber sourcing decisions world-wide.

Effluent regulations existed in most paper-producing countries, and generally restricted the effluent of all mill operations. Since recovered fiber did not require digesting, it generally reduced both overall water use and chemical effluents, making it preferable to virgin fiber. Mills which de-inked, however, required careful sludge and effluent disposal.

Landfill preservation and solid waste reduction goals had driven certain countries, particularly European nations and individual states in the U.S., to develop a broad array of regulations to increase the use of recovered fiber. These had the effect of creating a supply of recovered fiber and facilitating its adoption as a fiber source.

Forest preservation and ecosystem management legislation in the U.S. and Europe had resulted in changes in harvesting practices, and sometimes in restricted harvests of virgin fiber. This contributed to price increases in the virgin fiber market. Other parts of the world had much more aggressive forestry practices and fewer restrictions, but Canada's 1995 restriction on the British Columbia harvest, the first in that province, may have indicated a growing trend in forest management in nations with historically lenient positions on conservation. In the U.S., the Forest Service's Option 9 (the spotted owl recovery plan) had greatly reduced timber harvests in the Northwest, contributing to a steep rise in virgin fiber prices and a regional shortage of wood chips.

In sum, as market forces combined to encourage recovered fiber capacity, so the environmental initiatives of the previous ten years supported this trend, with a combination of virgin fiber harvest restrictions and laws demanding that paper be removed from the waste stream.

Recycling Regulations

Regulations that directly affected recovered fiber tended to fall into four categories, each with different aims. The results were complicated, and at times, contradictory.

<u>Recycling Laws - Content Requirements</u>

These rules required that recovered fiber be included in products produced or sold in a given area, in order to encourage production capacity and “seed” markets for recovered fiber. California newsprint requirements mandated that all newspaper sold in California must contain 40% recovered fiber. The goal was mandated, though the means of reaching it was left to industry. As time went by, required content increased. Particularly in developed countries, content laws were effective in spurring growth of post-consumer collection networks that anticipated growth in recycling capacity.

Recycling Laws - Solid Waste Reduction

These included mandated recycling programs, "landfill bans," which prohibited certain recyclable materials from landfills, and packaging laws, which required that packaging be reduced, recycled, and/or recyclable, or taxed "virgin" packaging and products. The most comprehensive waste reduction efforts were "take-back" laws such as those in Germany, which required manufacturers to recycle or dispose of their products after they had been used.

Flow Control

Flow control dealt with ownership and transport of waste in the U.S. As collection infrastructure developed, citizens, collectors, and municipalities were in controversy over who "owned" the one-time “garbage,” and the revenues it could bring as it became a valuable commodity to various markets. The issue extended across state lines in cases where a community had a contract with an incinerator or landfill in another state. Various court cases had already addressed flow control, with varying results; legal definitions of "solid waste" and "recyclable materials" needed clarification in order to solve the problem.

Recovered Fiber Use Restrictions

The U.S. Food and Drug Administration (FDA) had a complex set of rules governing contaminants and processes in food contact products such as microwave trays. Certain chemicals could not be used in production, or must have been used in certain ways. This is the only instance where regulations actually directed the technology used to process recovered fiber. Toxic contaminants in the fiber presented a problem since mills could not control post-consumer fiber quality until purchase. Also, sludge disposal rules could be onerous for de-inking mills, which produced four times the sludge of virgin mills due to inks, fillers, and additives in the fiber stock. Although these contaminants were not produced at the mill, regulators had yet to integrate waste diversion benefits with sludge disposal costs.

By 1995, Europe had the strictest recycling provisions and packaging laws, followed by individual states in the U.S.; these tended to be regions with large solid waste concerns. Japan and other Asian countries stressed voluntary agreements, but recycling there was gaining popularity. Table 5 summarizes laws aimed at recycling in several countries; Table 6 summarizes U.S. state laws.

Table 5. National Recycling Laws Outside the U.S.

Country	Recycling Goal	Date of Goal	Status
Austria	80% of all packaging	1994	proposed
Belgium	28% all material	1995	voluntary
Canada	newsprint sold in Toronto must be 50% recycled 50% reduction of packaging Manitoba Packaging tax	1991 2000	statutory voluntary proposed
Denmark	disposable packaging taxed		
Finland	disposable packaging taxed		
France	green dot to be required		
Germany	80% packaging, 80% paper reused	1995	statutory
Japan	voluntary industry standards and goals		
Italy	some disposable packaging taxed	1993	statutory
Netherlands	60% average recycling 40% (50% office waste)	2000 1995	 voluntary
Norway	disposable packaging taxed		
Portugal	EIU Paper and Packaging regulation		
Sweden	60% paper by	2000	proposed
UK	50% of recyclable household waste Environment Protection bill, raises landfill fees	2000 1990	Gov't target statutory

Table 6. Recycling Mandates in Various U.S. States

Focus of Regulation	Number of states passing in 1994	Total Number of States
Comprehensive Recycling:	4	39
Landfill Bans:	1	39
Green Labeling	2	20
Packaging Mandates:	7	9
Purchasing Preference:	8	44
Tax Incentives	2	28
Newsprint Mandates:	1	13
Grants, loans	7	29

Of the different measures to reduce solid waste and encourage recycling, the most enforceable and effective had clear goals and few process specifications. Take-back laws were popular in Europe, disposable packaging taxes existed in Canada, and the concept of "producer responsibility" was gaining popularity in the U.S. among those who processed recovered fiber and were responsible for disposing of the various unwanted ingredients of the original production. Taxes, particularly those on virgin

materials, were enforceable and logical if the goal was to encourage recovered fiber use; these were popular at the National Recycling Congress in 1992, but the paper industry, facing high virgin and recovered fiber costs, was reticent. Content requirements and purchase preferences tended to be arbitrary and uncoordinated and were no longer necessary for seeding recovered fiber markets in the U.S., though laws such as the California newsprint requirements had, in fact, been one motivation for mills in the Northwest and Canada to invest in recovered fiber capacity. It is important to note that no regulations mandated particular technologies for recovered fiber processing.

Other Government Programs of Interaction

As regulation developed at every governmental level, a variety of goals, tax incentives, voluntary agreements, and grant programs had also emerged. While European countries had developed rules and binding agreements at national and EC levels, U.S. and Canadian activity was at the state and provincial level. States had instituted numerous content and packaging requirements and landfill restrictions, along with purchasing guidelines to encourage recycling. The U.S. Executive Order directing the government to purchase paper with recovered fiber was the only publicized federal recycling requirement; it had been mimicked by a number of states, local governments, and businesses. As regulation and the threat of regulation grew, a host of voluntary recycling goals and agreements developed among industry groups and governments.

Many state and national governments provided assistance to municipalities and companies establishing collection programs and markets. In January 1993, over half of the U.S. states had grant or loan projects, and by 1995, 29 states gave tax credits, usually for capital expenses, while 44 states had purchasing preferences to spur consumer markets. Fifteen states provided research funds, nine provided venture capital, and 22 had training programs for companies. Eco-labelling was popular in Europe and widely discussed in the U.S., but coordination among various industrial and consumer groups was necessary in order to give the labelling needed clarity and credibility. The effects of these programs were difficult to measure, but public officials and industry agreed that they, along with databases to help businesses find recycled materials and "buy recycled" challenges to business, were helping to establish markets.

INDUSTRY INNOVATIONS IN RESPONSE TO DRIVERS

In the absence of mandated technologies, innovations in the industry had proliferated, creating endless opportunities for competitive advantage, either by reducing cost or increasing the quality of a product. An emerging realization in both the recovered and virgin markets was the need to control raw materials. Supply and collection systems varied widely according to region and even locality; fiber procurement strategies varied according to company and sometimes according to mill. Due to vertical integration, it was difficult to tell how successful various strategies had been, but fiber supply was an important emerging field of competition. Firms had also refocused geographically; a new greenfield mill in Iowa, for example, was located to take advantage of midwestern fiber supplies.

Resulting Technologies and Innovations

Despite the fact that, in the space of less than five years, an entire industry had abandoned the opinion that high-quality recycled paper products were technologically and economically infeasible, there was little “new” technology in the shift toward recovered fiber. Advances in screening and cleaning technologies were improvements on well-known systems; even de-inking technologies had been well developed in Europe and Japan since the 1960s and 1970s. Innovations such as agglomeration de-inking and drum pulping (a method of pulping which was used to clean relatively homogeneous, delicate fiber such as old phone books or magazines) were providing more cost-effective options to deal with a larger

variety of fiber sources, but were not themselves revolutionary.

It can be argued that, as a response to an environmental challenge, the use of recovered fiber could itself represent an innovation. Weyerhaeuser's North Bend, Oregon mill produced corrugating medium from 100% recovered fiber, after shutting down a batch digester that did not meet Oregon effluent requirements. Economics also played a role in the decision, since Northwest virgin fiber costs were high and adding old corrugated cardboard (OCC) capacity was much less expensive than building a new digester, but recovered fiber had become the environmental and economic response to a problem.

Innovations often involved recognizing existing opportunities to use lower quality fiber in high quality products. One recent innovation involved old magazines (OMG); traditionally OMG had been shunned as hopelessly contaminated, with short fibers and a high concentration of fillers, inks, and brighteners. Producers of printing grades, however, had discovered that much of this waste could be reused in the paper process, and that it could give the same desired properties to the new product as it did to the old, while reducing the amount of process waste and raw materials. In fact, the clay used as brightener in magazines was the principle ingredient in agglomeration de-inking, and could ensure a cleaner product without added cost. Hence the quality of recycled magazine paper had increased as the cost of producing it dropped.

Cost of Innovations

The cost of adopting recovered fiber capacity varied from literally nothing, in boxboard mills which had used OCC since World War II, to expensive de-inking systems in integrated mills which had traditionally used virgin pulp for high quality newsprint and other products. Capital costs depended on: final product, type of recovered fiber used, mill size, and existing papermaking technology. Operating costs varied with location, availability and grade of fiber, and energy and waste disposal costs.

Capital and Operating Costs

Capital and production costs for recovered fiber products were extremely variable and site specific. Much depended on facility size, age, location, intended fiber source, and end product, and there was much argument about the cost-effectiveness of recovered fiber. With this variation in mind, general costs and operating cost ranges for large mills are estimated in Tables 7 and 8. Costs are compared across two virgin processes, kraft and chemi-thermo-mechanical pulping (CTMP) and one recovered fiber process, de-inked pulp production.

Table 7: Capital Costs for Recovered Fiber Capacity, 1991

	Annual Capacity (000 metric tons)	**Capital Cost** ($ million)	**Capital Cost per ton** ($)
Bleached Kraft	400	700	1750
Bleached CTMP*	200	250	1250
De-inked Pulp	70	35	500

Table 8: Operating Costs, 1991*

	Low Cost ($/metric ton)	**High Cost** ($/metric ton)
Bleached Kraft	250	500
Bleached CTMP	250	350
De-inked Pulp	325	375

* Operating costs include labor, materials and energy; paper-making costs are constant and are excluded.

Transportation Costs

While the cost of shipping was included in the commodity price of virgin fiber and was therefore borne by the shipper, recovered fiber shipping costs were paid by the purchaser, and varied considerably according to location[2]. In 1994, shipping costs were $15 - 25 per short ton within the U.S. Midwest, but over $50/short ton for shipment from the Midwest to the West Coast (Urquhart,1994). Mills which recycled needed to obtain an economical fiber supply, and recent market conditions had hurt some mills in the Northwest, where virgin and recovered fiber prices were high, end products were low-priced commodities, and California markets demanded recovered fiber content. Mills could go to Chicago and St. Louis to guarantee furnish, and as prices for ONP peaked in late June 1995, one mill actually favored virgin fiber (also at an all-time high price) due to its "cost advantage."

Change in Materials Costs

The recent rise in recovered fiber cost had caused debate about the limits of collection and the economics of content requirements. Though some companies were re-thinking plans to add recycling capacity, recycled fiber prices seemed to be peaking, and virgin fiber was still more costly for most mills. Those most injured were low-margin paperboard producers who depend on inexpensive fiber. Recent legislation in the U.S. may lower virgin fiber costs and discourage recycling, but new harvests will likely face litigation, delaying any effect on fiber prices.

Change in Fixed Costs

Apart from capital costs, which were relatively low, there was little change in fixed costs associated with adopting recovered fiber production capacity, unless the company was involved in collection of waste. These costs must then be compared to the fixed costs of managing forests, in order to be a meaningful measure of total fiber costs.

Additional Learning Costs

Recycling technology adoption did result in at least a temporary decrease in productivity, especially when it involved using a less consistent supply base. Contaminated fiber supplies decreased productivity slightly, because more machine maintenance was required and product quality could have been affected. Productivity could have been increased with experience, but inconsistent supply was always a possibility. It was difficult to deal with suppliers and establish quality fiber furnish; this required experience in the

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This is not the case in virgin fiber markets, where purchase price includes shipment.

market. Nearly every mill using recovered paper has turned away fiber by the truckload when it was literally too contaminated to use.

Overall, recovered fiber capacity could be added incrementally, limited to certain product lines or geographic regions, or used only under certain economic conditions. Flexibility was key, and production costs varied with each mill. The benefits of recovered fiber use were flexible sourcing, product differentiation, and often reduced fiber costs; each mill would ultimately determine the best fiber sourcing strategy for its situation.

EFFECT OF DRIVERS AND INNOVATION ON INDUSTRY

The worldwide move toward recovered fiber was motivated by a combination of market and environmental drivers, and though it was impossible to determine the actual contribution of each to market growth, some important conclusions could be drawn about the relative importance of various drivers.

Key Drivers for Recovered Fiber Use

Despite the confluence of environmental concerns and regulatory efforts, it is difficult to conclude that the move to recovered fiber was primarily a response either to technological innovation or to environmental regulation. While cleaning technology was better and more available, it was not, strictly speaking, "new." In many cases, new mills in the U.S. were fitted with well-established Japanese or European technology, and in many other mills incremental change to existing equipment had proven effective. Ultimately, the key drivers of recovered fiber adoption were fiber price and availability, consumer demand, and the threat of regulation. While existing environmental regulation and technological change were integral forces in the economics of fiber, they were not independently strong drivers of recycling.

Existing environmental regulation had affected certain regional and national markets, often indirectly through restriction of virgin fiber supply, but it was notable that the area of most rapid growth in recovered fiber use, Asia (specifically Korea, Taiwan, and China), had enacted recycling programs only in the last five years, and only in response to a severe fiber shortage as capacity increased. The largest recovered paper projects worldwide were being driven by market economics and a scarcity of virgin fiber. So great was the market demand for fiber that recycling programs in Asia quickly achieved recovery rates of around 50%.

In the U.S., where state regulations and local recycling programs were common, decisions by paper companies to invest in recovered fiber capacity in the early 1990s could be based on fiber price alone, and Northwest mills seldom cited environmental reasons as key to adding capacity; virgin fiber costs were instead the most often cited driver of recycling. Simply put, recovered fiber represented a cost advantage as well as an "environmental" action.

Environmental regulation, and the threat of environmental regulation, did play an important role in the development of markets for recovered fiber. In fact, it was likely that the combination of the 1992 Federal Option 9 timber harvest restrictions and the strict 1990 California content requirements combined to raise prices on virgin fiber and guarantee a market for recycled newsprint that made recovered fiber an appealing option to Northwest mills. Option 9 was not the only determinant of virgin fiber price, however, and its impact was essentially regional. High harvest levels on both public and private lands in the 1980s also had driven both the fiber shortage and, indirectly, Option 9. Moreover, these two initiatives, though contemporary, were not part of a concerted effort to change the dynamics of fiber

pricing. Their result, however, was to contribute to the strategic advantage of recovered fiber use in the Northwest.

More broadly significant had been the public interest in recycling and recycled products; this had created both a demand for new products and a series of state and local recycling efforts in the 1980s, which developed a supply for the industry; here technology had provided an opportunity to produce high quality products with no increased cost. In addition, the threat of ever-more complex state or even federal regulation had spurred the industry to set its own recycling goals and develop markets for recovered fiber before they were mandated. Again, it is important to remember that even 1995 fiber prices still supported this effort without additional incentive.

Related and Supporting Industry

There are two industries supporting the production of recovered fiber pulp and paper products: waste collection and equipment production. These have developed in tandem with production, though there are "growing pains": in 1990 the collection industry out-performed production capacity, creating a raw material glut, and by 1995 capacity expansion had outstripped collection and contributed to local shortages and high prices. Though they initially moved slowly into recovered fiber, producers had adopted it with a vengeance, and technology had kept pace.

Most producers in the Northwest felt, even in a tight market, that the recovered fiber supply was "out there" - the challenge was finding it at a workable price. The collection industry was concentrating rapidly, and as issues of flow control were resolved it will undoubtedly mature. Given the range of fiber stocks and products, however, it was unlikely that the paper industry as a whole would become as vertically integrated in recovered fiber as it was in virgin fiber. Firms with experience and flexibility in fiber sourcing were in better strategic positions.

Change in Industry and Market Resulting from Innovation

<u>Regional Re-Alignment in the US</u>

As the North American paper industry incorporated recovered fiber into its production, some areas of the country were better positioned than others to take advantage of this raw material. Across the country, it was likely that those who can use recovered fiber to differentiate their products could gain a competitive advantage and avoid competition based strictly on cost.

The West and South, which emphasized commodity production and large integrated mills, were further from major sources of recovered fiber, and the South, especially, had access to cheap virgin fiber on fast growing pulpwood plantations. Waste recovery rates in the Northwest were very high, but population was relatively low, and Pacific Rim competition for fiber is strong. The Northeast and Lakes states, the earliest paper producing regions in the U.S., had the most mills, but these tended to be smaller, older, more often non-integrated, and were focused on printing and writing and specialty grades (Ohanian,1993). The shift to specialty grades had happened naturally as forests in the North and Midwest became depleted at the turn of the century and commodity production in larger mills developed in regions with more plentiful fiber. Proximity to large markets and high energy costs made recovered fiber attractive in the Midwest and Northeast, but specialty and printing and writing grades were the slowest to successfully incorporate recovered fiber. Mills throughout these regions would require technological innovation to keep costs down and product margins healthy as they competed with larger mills. Recent regional production statistics are summarized in Tables 9 and 10.

Table 9. Regional Distribution of U.S. Pulp and Paper Production: 1990

Region	# Paper Mills	% of total	# Pulp Mills	% total
North	197	32.9	57	16.5
Lake	159	26.6	70	20.3
South	168	28.1	155	44.9
Pacific	74	12.4	63	18.3

(source: Ohanian,1993)

Table 10. Percent of U.S. Production by Region: 1987

Region	Paper and Paperboard	Woodpulp
North	13.9%	7.8%
Lake	17.8	7.5
South	53.4	68.4
Pacific	15.0	16.3

(source: Ohanian,1993)

Increased Global Competition

The U.S. market had traditionally exported wastepaper; in 1995 growing Asian markets were competing with increased U.S. capacity to create a climate of rising prices and perceived shortages (Ohanian,1993). New capacity coming on line in both Asia and the U.S. would worsen recovered fiber shortages and would present a real challenge to expanding industries in those regions. A continued weak dollar would put U.S. mills at an additional disadvantage in competition with Asian markets for recovered fiber. Asian nations with growing capacity were importing recovered fiber from Europe and North America, bringing international competition into contact, ultimately, with curbside recycling.

Improved Product Performance

Performance of recovered fiber products had improved dramatically, if incrementally, as mills around the world experimented with technologies and fiber stocks. As companies found ways to make better products with cheaper fiber sources, other companies were forced to respond to remain competitive. The range of high quality, inexpensive products made with recovered fiber was growing. Indications were that the public would "buy recycled" if quality and price were the same, and the products which could meet this challenge would have a strong competitive advantage and cost advantage.

REGULATION AND INNOVATION IN A GLOBAL CONTEXT

Export / Transfer of Technology to Foreign Markets

Worldwide, 100 new flotation de-inking facilities were established in 1989-90, for a total annual capacity of over 5 million metric tons. Most were located in major producing countries in North America, Europe, and Asia, but some were in Kenya, Costa Rica, Ecuador, and Honduras, indicating a rapid global adoption of new technology. In the U.S., both Diashowa and NorPac, a Weyerhaeuser-Nippon joint venture, were using Japanese technology to develop products for both domestic and export markets.

Market Changes

While the market for recovered fiber had grown dramatically, it was difficult to measure changes in the demand for "recycled products," although there was a general sense that a "green ethic" had driven both increased consumer demand for and increased state regulatory attention to recovered fiber. Grassroots public concern was a behind the development of recycling regulation, particularly in the United States where the federal government had remained quiet. Whether or not they were cost effective, recycling programs would continue to grow in number because they were locally popular, and markets for recycled products would improve with improving product quality. Mill managers in the Pacific Northwest reported that consumers in the U.S. were generally not willing to pay premium prices for recycled products, but 50% of the mill managers said that some industrial customers were requesting recycled materials to "improve company image" and "respond to demand." Actual consumer demand for recovered fiber was difficult to measure because it varied according to product, but the market was clearly supporting the industry move toward recovered fiber.

Implications for Environmental Regulation

While environmental regulation may not have been the primary driver in the pulp and paper industry's move toward recovered fiber, its effects in some areas were important. As markets developed, there was a need to carefully focus any future regulatory initiatives around the changing industry dynamics. In several areas, the ability of the industry to continue to innovate was in question unless existing regulatory settings were re-examined.

Content requirements were in need of re-examination. While they had effectively supported the development of recycling capacity and recovered fiber markets, rigid content requirements were reaching the end of their environmental lives. Both Scandinavia and Canada were importing waste paper in order to produce pulp and newsprint, respectively, for export markets in Europe and the U.S. with stringent content requirements. Recession and environmental pressure closed over 30 newsprint and groundwood machines in Canada since 1989, while 11 new de-inking plants had emerged to produce recycled newsprint for the same markets, changing the configuration of the industry to one which did not recognize comparative regional advantages in fiber sources.

As fiber markets became tighter and hauling distances became longer (mills in the Northwest went as far away as Chicago for recovered fiber and Chile for virgin) the environmental cost of transportation would begin to offset the gains in solid waste reduction. Likewise, smaller curbside recycling programs could be energy intensive if they were not carefully planned. The Centre for the Management of Environmental Resources created a model configuration of the European paper industry that allowed nations rich in raw materials to produce virgin products while those closer to solid waste sources recycled, reducing transportation and at the same time increasing the percentage of recovered fiber used (Weaver,1995). While models are generally somewhat optimistic, policy makers should consider efficiency of process as well as end result in solid waste reduction.

While the variety of regulations in different states could be frustrating for manufacturers, in 1995 there was no indication that a lack of regulatory coordination was having a negative impact on innovation or on business. Interstate issues of flow control and disposal, however, were in need of federal definition, as were any discussions of a "green labelling" system for recycled products.

In regions where situations prevented an economically viable recycling industry from developing, owing to underpriced virgin fiber or unfair competition for recovered fiber from landfills or incinerators, regulatory attention could continue to have a positive impact on a developing market. Experience had shown that demand and technology were adequate to support viable markets, and government support of these developments was consistent with an emphasis on supporting innovation and fiber sourcing

flexibility.

In 1995, the recovered fiber market seemed to present a case in which existing regulation had been "just enough" to support important technological and market developments; the challenge was to intervene only where coordination and continued support of innovation was necessary.

CONCLUSION

The international emergence of recovered fiber as a valuable commodity illustrates the complexity of environmental and technological developments. The change had become possible through favorable market conditions and emerging technology, but it was also linked to public concerns and government initiatives. The success of the markets and the rapidity of technological development might have been related to the fact that very few recovered fiber regulations mandated specific technologies. Some regulations were more effective than others: content requirements might have reached their effective limit as capacity grew and more market driven tools such as purchase preferences gained popularity. Despite regional fiber shortages and price volatility, recovered fiber provided the flexibility needed by companies wishing to gain a strategic advantage in pulp and paper production.

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