TOWARDS A SUSTAINABLE

Paper Cycle

Sub-Study Series

11 Cost Analysis of the Pulp and Paper Industry

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COST ANALYSIS OF THE PULP AND PAPER INDUSTRY

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COST ANALYSIS OF PULP AND PAPER INDUSTRIES

Preface

IFC, in collaboration with the World Business Council for Sustainable Development (WBCSD) and International Institute for Environment and Development (IIED), has commissioned Jaakko Pöyry Consulting to conduct a cost analysis of pulp and paper industries.

The objective of the study is to assess the unit costs of pulp and paper production, per for produced, in the key regions of the world. The production costs are broken down into the cost components with particular attention to those cost components that have an impact on the environment.

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The most important pulp and paper producing regions as regards to their environmental impact are focused in this study.

The most common pulp and paper product groups are covered, representing nearly two thirds of the total global tonnage.

The heterogenous structure of the pulp and paper industry as well as the large variety of different end products makes the estimation of average costs very difficult.

The average costs being in practise impossible to find out, the methodology applied in this study is to select, based on the consultant's pulp and paper mill data bank information and on the experience from the analyses of the international cost competitiveness of pulp and paper industry, typical pulp and paper grades in each product group and typical mills in each producing region. The consumption of raw materials, energy and other production inputs at these typical mills are then estimated based on the actual data of the mills of similar characteristics. The average regional prices of production inputs are then used for calculating the production costs per ton.

The cost estimates are based on the second quarter 1995 cost level and on average exchange rates of June 1995.

The results of the cost calculations are summarised in the following table:

Total Delivered Costs by Product and Region

	USA	Canada	Western Europe	Scandinavia	South America	Russia	China
				- USD/ton -			
Bleached market pulp:							
- softwood pulp		554		575	450		
- hardwood pulp		440		538	426		
Newsprint:							
- virgin fibre		427		531		408	
- waste based	531		780				
Printing/writing	825		1 179	893		713	634
White-l. chipboard			968				567
Linerboard:							
- virgin fibre	439			549		390	
- waste based	472		591				423
Fluting:							
- virgin fibre	416			519			
- waste based			520				277

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BASIS FOR COST ESTIMATES

1.1
Geographical Coverage

The most important pulp and paper producing regions as regards to their environmental impact are focused in this study. Therefore the following countries and regions are represented:

- Regions with large production volumes (North America, Western Europe, Scandinavia and Latin America in market pulp)

- Regions with relatively large pulp and paper production volumes and with a high level of environmental impact (Russia, China)

- Other regions/countries whose production volumes and environmental impact is seen small in the global context are not included in this study

1.2
Products Scope

For the purposes of the IIED research the production costs are estimated for the following grades:

Pulp

- bleached chemical market pulp
  - softwood pulp
  - hardwood pulp

Paper

The paper grades with the best representation of the industries as a whole are selected:

- Newsprint; with separate calculations for
  - recycled fibre based newsprint
  - virgin fibre based newsprint

- Uncoated woodfree printing and writing papers

- White lined chipboard

- Corrugating raw materials:
  - linerboard with separate calculations for recycled fibre based and virgin fibre based board

- fluting with separate calculations for recycled fibre based and virgin fibre based materials.

Together these paper and paperboard grades account for nearly two thirds of the total global tonnage.

1.3 Cost Break-down

The costs are estimated using the following break-down:

	Unit	Consumption per unit	Unit price USD/unit	Cost, USD/t produced
Fibrous raw materials				
- fibre 1				
- fibre 2				
Total fibre				
Other raw materials				
Purchased energy				
- power				
- fuel				
Total purchased energy				
Other production costs				
Capital charges				
Delivery cost to				
TOTAL DELIVERED COSTS				

Fibrous raw materials include wood, recycled fibre and purchased pulp.

Other raw materials include pulping and pulp bleaching chemicals, water treatment chemicals, papermaking chemicals and additives, such as fillers and coating colour.

Purchased energy includes purchased electric power and purchased fuels. The costs of own back-pressure power production are included in the other cost items. Possible other power production at the mill, such as hydropower, is calculated as purchased power.

Other production costs include operating, packing and maintenance materials and supplies, effluent charges and effluent sludge disposal costs, personnel costs and general overhead costs, such as insurances, office supplies, travelling, fees and other various administrative costs.

Capital charges include depreciation, interests and dividends.

Delivery costs include sales costs and transport costs, in market pulp to CIF import harbour and in paper to buyers storage. The delivery point is selected to represent the most common deliveries, which in most cases is the domestic market.

1.4 Cost Estimation Method

The heterogenous structure of the pulp and paper industry as well as the large variety of different end products makes the estimation of average costs very difficult.

In the markets there are very limited number of truly standard bulk products with clear specifications. Even market pulp, which is widely considered as standard bulk grade, actually has several grades depending on the raw material basis, cooking and bleaching process, etc., each having different cost structures and specific market price. In paper, the variations e.g. in raw material basis (recycled vs. virgin fibre), grammages, surface treatment and sheeting have high impact on the costs and selling prices of the product.

Further, the structure of the industry is also very heterogenous. On one hand, there are large, efficient and new production units typically having fairly low production costs but high capital charges. On the other hand, in certain countries and in certain grades the industry consists mainly of a large number of small and old mills with relatively high production costs but low capital charges. The share of old capacity is, however, decreasing in most regions through shut-downs of oldest mills and investments in new, big units.

The average costs being in practise impossible to find out, the methodology applied in this study is to select, based on the consultant's pulp and paper mill data bank information and on the experience from the analyses of the international cost competitiveness of pulp and paper industry, typical pulp and paper grades in each product group and typical mills in each producing

region. The consumption of raw materials, energy and other production inputs at these typical mills are then estimated based on the actual data of the mills of similar characteristics. The average regional prices of production inputs are then used for calculating the production costs per ton.

The cost estimates are based on the second quarter 1995 cost level and on average exchange rates of June 1995.

2 AVERAGE MILLS

For the production cost estimation the capacity weighted average mills were estimated. First the average size of pulp mills and paper machines were calculated as capacity weighted average sizes assuming that each production line is producing only the grade studied. Similarly, the capacity weighted technical age of the pulp mills and paper machines were calculated. The technical age can be used as an indicator of the technical condition of the mill. The technical age is calculated by taking into account the original start-up year and all small, medium and large-scale rebuilds after the start-up. The weight factors for the rebuilds are:

Small rebuild	0.25
Medium rebuild	0.75
Large rebuild	0.90

Thus for instance a paper machine started-up ten years ago and having had a medium scale rebuild two years ago, has the technical age:

$8 \times (1-0.75) + 2 = 4$ years

All the required information for calculating the average sizes and technical ages are found in the JAAKKO PÖYRY pulp and paper machine data banks for practically all countries except P.R. of China. Also, the data bank information about the Russian mills is for the purpose of this study less relevant. Therefore, instead of trying to use average cases in China and Russia, typical leading producers are selected for the analysis.

As already stated in Chapter 1.4 the cost calculations are done by selecting mill cases having their size and technical age characteristics close to the capacity weighted averages, and by estimating typical production inputs for the mills. The capacity weighted average size and technical age is presented in the following table by product and region.

TABLE 2-1
Capacity Weighted Mill/Machine Sizes and Technical Ages

	Machine size 1000 t/a	Technical age years
Bleached softwood kraft pulp		
- Canada	340	16.1
- Scandinavia	375	12.2
- Latin America	369	7.8
Bleached hardwood kraft pulp		
- Canada	351	13.0
- Scandinavia	449	10.8
- Latin America	634	7.1
Newsprint		
- USA	174	12.3
- Canada	143	10.9
- Scandinavia	185	8.9
- Western Europe	183	7.9
Uncoated woodfree paper		
- USA	127	16.1
- Scandinavia	180	7.1
- Western Europe	94	13.4
White lined chipboard		
- Western Europe	104	10.4
Linerboard, recycled fibre based		
- USA	203	5.5
- Western Europe	108	12.9
Linerboard, virgin fibre based		
- USA	324	12.1
- Scandinavia	278	7.8
Fluting, recycled fibre based		
- Western Europe	101	13.6
Fluting, virgin fibre based		
- USA	183	17.1
- Scandinavia	206	14.6

3
AVERAGE UNIT PRICES

The average regional unit prices used in the cost calculations are presented in the Table 3-1 on the following page.

The price level refers to the second quarter of 1995 and the local prices are converted to USD at exchange rates of June 1995.

Because of the strong market situation, certain prices can be considered to be relatively high, especially regarding market pulp and recycled fibre. Also, as a result of strong demand, the wood costs (at mill) in certain regions, such as Scandinavia and Canada are relatively high. As a result, the cost comparisons at second quarter 1995 cost level between virgin fibre and recycled fibre based products may to some degree favour virgin fibre based products, e.g. in the USA.

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AVERAGE REGIONAL UNIT PRICES

Exchange rates June -95 Price level 1995/II	Scandinavia	Germany	USA average	Canada average	Brazil	Russia	China
Exchange rates --> USD	FIM 4,30 SEK 7,26	1,40	1,00	1,38	1,00	1,00	1,00
Wood costs, USD/m3sub							
Softwood roundwood, mechanical	57	61	34	36			
Softwood roundwood, chemical	53	54	34	34	21	42	
Hardwood roundwood	55	50	28	25	25	35	
Softwood chips	54	43	34	32	21	42	
Hardwood chips	55	50	30	25	25	35	
Straw, USD/ADt							35
Purchased pulp, USD/ADt							
BSKP, market price	802	861	772			790	840
BHKP, market price	802	861	732				
Recycled fibre, USD/t							
Mixed waste		175	138				80
News/deinking waste		218	165				
Box waste, OCC		243	233				235
White waste		698	510				600
Purchased power, USD/MWh	40	79	50	26	46	30	60
Purchased fuel, USD/toe	168	217	66	75	130	65	80
Personnel costs, USD/man/year including fringe benefits							
Operating and maintenance	50000	61000	58000	49000	17000	4400*)	1300*)
Administration	58000	71000	67000	59000	30000	4400*)	1300*)
Interest rate, %	9,5	8,0	7,5	8,7	12,0	10,0	9,0

*) Average personnel cost

4
COST ESTIMATES

4.1
Market Pulp

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Cost Breakdown for a Typical Pulp Mill				
Grade	**Bleached softwood kraft pulp**			**Exrate of**
Region	**Canada**			**CAD to USD**
Cost Level	**2. Quarter 1995**			**1,38**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	3,116	41	127
- Softwood, chips	m3sub	2,074	33	68
Total wood		5,189		195
Other raw materials				56
Purchased energy				
- Power	MWh	0,346	30	11
- Fuel	toe	0,367	73	27
Total purchased energy				37
Other production costs				125
Capital charges				75
Delivery costs to Rotterdam				65
Total delivered costs				**554**

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Cost Breakdown for a Typical Pulp Mill				
Grade	**Bleached softwood kraft pulp**			**Exrate of**
Region	**Scandinavia**			**FIM to USD**
Cost Level	**2. Quarter 1995**			**4,30**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	4,476	53	239
- Softwood, chips	m3sub	0,497	56	28
Total wood		4,972		267
Other raw materials				53
Purchased energy				
- Power	MWh	-0,085	47	-4
- Fuel	toe	0,012	168	2
Total purchased energy				-2
Other production costs				94
Capital charges				108
Delivery costs to Rotterdam				55
Total delivered costs				**575**

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Cost Breakdown for a Typical Pulp Mill				
Grade	**Bleached softwood kraft pulp**			**Exrate of**
Region	**Latin America**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	3,414	21	72
- Softwood, chips	m3sub	1,461	23	34
Total wood		4,875		105
Other raw materials				45
Purchased energy				
- Power	MWh	-0,085	45	-4
- Fuel	toe	-0,032	150	-5
Total purchased energy				-9
Other production costs				59
Capital charges				179
Delivery costs to Rotterdam				70
Total delivered costs				**450**

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Cost Breakdown for a Typical Pulp Mill				
Grade	**Bleached hardwood kraft pulp**			**Exrate of**
Region	**Canada**			**CAD to USD**
Cost Level	**2. Quarter 1995**			**1,38**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Hardwood, round	m3sub	3,537	31	108
- Hardwood, chips	m3sub	0,624	30	19
Total wood		4,161		127
Other raw materials				18
Purchased energy				
- Power	MWh	0,740	18	14
- Fuel	toe	0,183	83	15
Total purchased energy				29
Other production costs				131
Capital charges				71
Delivery costs to Rotterdam				65
Total delivered costs				**440**

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Cost Breakdown for a Typical Pulp Mill				
Grade	**Bleached hardwood kraft pulp**			**Exrate of**
Region	**Scandinavia**			**FIM to USD**
Cost Level	**2. Quarter 1995**			**4,30**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Hardwood, round	m3sub	3,974	56	222
- Hardwood, chips	m3sub	0,000	56	0
Total wood		3,974		222
Other raw materials				55
Purchased energy				
- Power	MWh	-0,120	47	-6
- Fuel	toe	0,020	168	3
Total purchased energy				-2
Other production costs				92
Capital charges				116
Delivery costs to Rotterdam				55
Total delivered costs				**538**

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Cost Breakdown for a Typical Pulp Mill				
Grade	**Bleached hardwood kraft pulp**			**Exrate of**
Region	**Latin America**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Hardwood, round	m3sub	3,972	25	99
- Hardwood, chips	m3sub	0,000	25	0
Total wood		3,972		99
Other raw materials				20
Purchased energy				
- Power	MWh	0,057	46	3
- Fuel	toe	-0,010	130	-1
Total purchased energy				1
Other production costs				108
Capital charges				127
Delivery costs to Rotterdam				70
Total delivered costs				**426**

4.2
Newsprint

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Cost Breakdown for a Typical Paper Machine				
Grade	**Newsprint, virgin fibre based**			**Exrate of**
Region	**Canada**			**CAD to USD**
Cost Level	**2. Quarter 1995**			**1,38**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	1,540	30	47
- Softwood, chips	m3sub	0,975	26	25
Total fibre		*2,515*		*72*
Other raw materials				10
Purchased energy				
- Power	MWh	2,300	18	41
- Fuel	toe	0,000	90	0
Total purchased energy				41
Other production costs				169
Capital charges				79
Delivery costs to USA				57
Total delivered costs				**427**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Newsprint, recycled fibre based**			**Exrate of**
Region	**USA**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Recycled fibre, ONP	ADt	1,234	168	207
Total fibre		1,234		207
Other raw materials				27
Purchased energy				
- Power	MWh	0,004	49	0
- Fuel	toe	0,312	64	20
Total purchased energy				20
Other production costs				159
Capital charges				78
Delivery costs to domestic markets				40
Total delivered costs				**531**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Newsprint, virgin fibre based**			**Exrate of**
Region	**Scandinavia**			**SEK to USD**
Cost Level	**2. Quarter 1995**			**7,26**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	1,634	55	90
- Softwood, chips	m3sub	0,589	52	31
Total wood		2,223		121
- BSKP	ADt	0,072	806	58
Total fibre				179
Other raw materials				8
Purchased energy				
- Power	MWh	2,463	34	85
- Fuel	toe	0,015	169	3
Total purchased energy				87
Other production costs				88
Capital charges				71
Delivery costs to Western Europe				98
Total delivered costs				**531**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Newsprint, recycled fibre based**			**Exrate of**
Region	**Western Europe**			**DEM to USD**
Cost Level	**2. Quarter 1995**			**1,40**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- BSKP	ADt	0,021	861	18
- Recycled fibre, ONP	ADt	1,192	218	260
Total fibre		1,213		277
Other raw materials				40
Purchased energy				
- Power	MWh	0,622	79	49
- Fuel	toe	0,193	217	42
Total purchased energy				91
Other production costs				173
Capital charges				152
Delivery costs to domestic markets				55
Total delivered costs				**789**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Newsprint, virgin fibre based**			**Exrate of**
Region	**Russia**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood	m3sub	3,000	42	126
- BSKP	ADt	0,030	790	24
Total fibre				150
Other raw materials				21
Purchased energy				
- Power	MWh	2,115	30	63
- Fuel	toe	0,330	65	21
Total purchased energy				85
Other production costs				77
Capital charges				40
Delivery costs to domestic markets				35
Total delivered costs				**408**

4.3
Uncoated Woodfree Printing and Writing Papers

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Cost Breakdown for a Typical Paper Machine				
Grade	**Uncoated woodfree paper, sheets**			**Exrate of**
Region	**USA**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	1,008	32	32
- Hardwood, round	m3sub	1,656	32	52
- Softwood, chips	m3sub	0,421	29	12
- Hardwood, chips	m3sub	0,416	31	13
Total wood		3,501		109
Other raw materials				121
Purchased energy				
- Power	MWh	0,029	40	1
- Fuel	toe	0,580	53	31
Total purchased energy				32
Other production costs				322
Capital charges				145
Delivery costs to domestic markets				95
Total delivered costs				**825**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Uncoated woodfree paper, sheets**			**Exrate of**
Region	**Scandinavia**			**FIM to USD**
Cost Level	**2. Quarter 1995**			**4,30**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	1,016	53	54
- Hardwood, round	m3sub	1,835	56	102
- Softwood, chips	m3sub	0,428	56	24
- Hardwood, chips	m3sub	0,097	56	5
Total wood		3,376		186
Other raw materials				128
Purchased energy				
- Power	MWh	0,387	47	18
- Fuel	toe	0,153	168	26
Total purchased energy				44
Other production costs				265
Capital charges				136
Delivery costs to Western Europe				135
Total delivered costs				**893**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Uncoated woodfree paper, sheets**			**Exrate of**
Region	**Western Europe**			**ITL to USD**
Cost Level	**2. Quarter 1995**			**1641,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- BSKP	ADt	0,237	854	202
- BHKP	ADt	0,553	854	472
Total fibre		0,790		675
Other raw materials				80
Purchased energy				
- Power	MWh	0,668	55	37
- Fuel	toe	0,186	177	33
Total purchased energy				70
Other production costs				188
Capital charges				76
Delivery costs to domestic markets				90
Total delivered costs				**1179**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Uncoated woodfree paper, sheets**			**Exrate of**
Region	**Russia**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Hardwood, round	m3sub	2,247	35	79
- Hardwood, chips	m3sub	0,119	35	4
Total wood		2,365		83
- BSKP	ADt	0,253	790	200
Total fibre				282
Other raw materials				55
Purchased energy				
- Power	MWh	0,424	30	13
- Fuel	toe	0,232	65	15
Total purchased energy				28
Other production costs				149
Capital charges				114
Delivery costs to domestic markets				85
Total delivered costs				**713**

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Cost Breakdown for a Typical Paper Machine				
Grade	**Uncoated woodfree paper, sheets**			**Exrate of**
Region	**China**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Straw	ADt	1,650	35	58
- Recycled fibre, white	ADt	0,250	600	150
- BSKP	ADt	0,100	840	84
Total fibre		0,350		292
Other raw materials				74
Purchased energy				
- Power	MWh	0,800	60	48
- Fuel	toe	0,200	80	16
Total purchased energy				64
Other production costs				119
Capital charges				65
Delivery costs to domestic markets				20
Total delivered costs				**634**

4.4
White Lined Chipboard

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Cost Breakdown for a Typical Paper Machine				
Grade	**White lined chipboard**			**Exrate of**
Region	**Western Europe**			**DEM to USD**
Cost Level	**2. Quarter 1995**			**1,40**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Recycled fibre, white WF	ADt	0,186	723	135
- Recycled fibre, white WC	ADt	0,215	416	89
- Recycled fibre, news	ADt	0,306	198	61
- Recycled fibre, mixed	ADt	0,355	176	63
Total fibre		1,063		347
Other raw materials				99
Purchased energy				
- Power	MWh	0,423	86	36
- Fuel	toe	0,225	176	40
Total purchased energy				76
Other production costs				268
Capital charges				103
Delivery costs to domestic markets				75
Total delivered costs				**968**

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Cost Breakdown for a Typical Paper Machine				
Grade	**White lined chipboard**			**Exrate of**
Region	**China**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Recycled fibre, white	ADt	0,285	600	171
- Recycled fibre, mixed	ADt	0,750	80	60
Total fibre		1,035		231
Other raw materials				105
Purchased energy				
- Power	MWh	0,700	60	42
- Fuel	toe	0,180	80	14
Total purchased energy				56
Other production costs				85
Capital charges				70
Delivery costs to domestic markets				20
Total delivered costs				**567**

4.5
Linerboard

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Cost Breakdown for a Typical Paper Machine				
Grade	**Linerboard, virgin fibre based**			**Exrate of**
Region	**USA**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	2,009	34	68
- Hardwood, round	m3sub	0,000	31	0
- Softwood, chips	m3sub	1,305	28	36
- Hardwood, chips	m3sub	0,000	33	0
Total wood		3,314		104
- Recycled fibre, OCC	ADt	0,097	228	22
- Recycled fibre, DLK	ADt	0,017	294	5
Total recycled fibre		0,115		27
Total fibre				131
Other raw materials				12
Purchased energy				
- Power	MWh	0,586	44	26
- Fuel	toe	0,278	61	17
Total purchased energy				43
Other production costs				98
Capital charges				99
Delivery costs to domestic markets				55
Total delivered costs				**439**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Linerboard, virgin fibre based**			**Exrate of**
Region	**Scandinavia**			**SEK to USD**
Cost Level	**2. Quarter 1995**			**7,26**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, round	m3sub	2,032	52	106
- Hardwood, round	m3sub	0,337	54	18
- Softwood, chips	m3sub	0,856	52	45
- Hardwood, chips	m3sub	0,018	54	1
Total wood		3,242		170
- Recycled fibre, OCC	ADt	0,000	109	0
- Recycled fibre, DLK	ADt	0,204	136	28
Total recycled fibre		0,204		28
Total fibre				198
Other raw materials				12
Purchased energy				
- Power	MWh	0,589	34	20
- Fuel	toe	0,209	120	25
Total purchased energy				45
Other production costs				86
Capital charges				96
Delivery costs to Western Europe				112
Total delivered costs				**549**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Linerboard, recycled fibre based**			**Exrate of**
Region	**USA**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Recycled fibre, DLK	ADt	0,199	295	59
- Recycled fibre, OCC	ADt	0,472	229	108
- Recycled fibre, mixed	ADt	0,410	96	40
Total fibre		1,081		206
Other raw materials				41
Purchased energy				
- Power	MWh	0,140	51	7
- Fuel	toe	0,194	67	13
Total purchased energy				20
Other production costs				76
Capital charges				77
Delivery costs to domestic markets				52
Total delivered costs				**472**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Linerboard, recycled fibre based**			**Exrate of**
Region	**Western Europe**			**DEM to USD**
Cost Level	**2. Quarter 1995**			**1,40**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Recycled fibre, DLK	ADt	0,199	279	56
- Recycled fibre, OCC	ADt	0,457	243	111
- Recycled fibre, mixed	ADt	0,434	175	76
Total fibre		1,091		243
Other raw materials				46
Purchased energy				
- Power	MWh	0,012	79	1
- Fuel	toe	0,219	262	57
Total purchased energy				58
Other production costs				105
Capital charges				77
Delivery costs to domestic markets				62
Total delivered costs				**591**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Linerboard, virgin fibre based**			**Exrate of**
Region	**Russia**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Softwood, chips	m3sub	2,944	42	124
- Hardwood, chips	ADt	1,142	32	37
Total fibre		4,086		160
Other raw materials				10
Purchased energy				
- Power	MWh	0,644	30	19
- Fuel	toe	0,264	65	17
Total purchased energy				36
Other production costs				58
Capital charges				80
Delivery costs to domestic markets				45
Total delivered costs				**390**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Linerboard, recycled fibre based**			**Exrate of**
Region	**China**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Recycled, imported OCC	ADt	0,570	350	200
- Recycled, domestic OCC	ADt	0,570	120	68
Total fibre		1,140		268
Other raw materials				14
Purchased energy				
- Power	MWh	0,350	60	21
- Fuel	toe	0,150	80	12
Total purchased energy				33
Other production costs				51
Capital charges				42
Delivery costs to domestic markets				15
Total delivered costs				**423**

4.6
Fluting

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Fluting, virgin fibre based**			**Exrate of**
Region	**USA**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Hardwood, round	m3sub	1,214	37	45
- Hardwood, chips	m3sub	0,424	32	13
Total wood		1,638		59
- Recycled fibre, OCC	ADt	0,327	228	75
Total fibre		3,603		133
Other raw materials				8
Purchased energy				
- Power	MWh	0,473	39	18
- Fuel	toe	0,344	88	30
Total purchased energy				49
Other production costs				118
Capital charges				65
Delivery costs to domestic markets				43
Total delivered costs				**416**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Fluting, virgin fibre based**			**Exrate of**
Region	**Scandinavia**			**FIM to USD**
Cost Level	**2. Quarter 1995**			**4,30**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Hardwood, round	m3sub	1,977	56	110
- Hardwood, chips	m3sub	0,580	56	32
Total wood		2,557		143
Other raw materials				13
Purchased energy				
- Power	MWh	0,615	47	29
- Fuel	toe	0,280	168	47
Total purchased energy				76
Other production costs				121
Capital charges				69
Delivery costs to Western Europe				98
Total delivered costs				**519**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Fluting, recycled fibre based**			**Exrate of**
Region	**Western Europe**			**ITL to USD**
Cost Level	**2. Quarter 1995**			**1641,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Recycled fibre, OCC	ADt	0,428	244	104
- Recycled fibre, mixed	ADt	0,642	220	141
Total fibre		1,070		246
Other raw materials				41
Purchased energy				
- Power	MWh	0,169	55	9
- Fuel	toe	0,233	177	41
Total purchased energy				51
Other production costs				70
Capital charges				52
Delivery costs to domestic markets				61
Total delivered costs				**520**

Jaakko Pöyry Consulting OY

Cost Breakdown for a Typical Paper Machine				
Grade	**Fluting, straw and rec. fibre based**			**Exrate of**
Region	**China**			**USD to USD**
Cost Level	**2. Quarter 1995**			**1,00**
	Unit	**Consumption per Unit**	**Unit price USD/unit**	**Cost USD/t paper**
Fibre				
- Straw	ADt	1,600	35	56
- Recycled fibre, mixed	ADt	0,200	80	16
Total fibre		1,800		72
Other raw materials				16
Purchased energy				
- Power	MWh	0,500	60	30
- Fuel	toe	0,250	80	20
Total purchased energy				50
Other production costs				79
Capital charges				45
Delivery costs to domestic markets				15
Total delivered costs				**277**

4.7 Sensitivity Analysis

In the following tables, the total delivered costs by product and region are summarised, followed by the tables showing the share of fibre and energy costs ad percent of total costs. These cost items are the most important ones when considering the environmental impacts of pulp and paper production.

The total costs are very sensitive to the prices of fibrous raw materials as well as fibre furnishes. A 10 % change of fibre costs (e.g. in prices) will change the total costs typically by 3 to 4 %, but in the extreme cases over 6 % (testliner production in China).

The total costs are clearly less sensitive to the cost of energy; a 10 % change in the prices of purchased energy will change the total costs typically only by 1 %.

Total Delivered Costs by Product and Region							
	USA	Canada	W.Europe	Scadinavia	S. America	Russia	China
			USD/ ton				
Bleached Market Pulp:							
Softwood pulp		554		575	450		
Hardwood pulp		440		538	426		
Newsprint:							
Virgin fibre		427		531		408	
Waste based	531		789				
Printing/writing	825		1179	893		713	634
White-t. Chipboard			968				567
Linerboard:							
Virgin fibre	439			549		390	
Waste based	472		591				423
Fluting:							
Virgin fibre	416			519			
Waste based			520				277
Cost of Fibre, Per Cent of Total Delivered Costs							
	USA	Canada	W.Europe	Scadinavia	S. America	Russia	China
			Per Cent				
Bleached Market Pulp:							
Softwood pulp		35		46	23		
Hardwood pulp		29		41	23		
Newsprint:							
Virgin fibre		17		34		37	
Waste based	39		35				
Printing/writing	13		57	21		40	46
White-t. Chipboard			36				41
Linerboard:							
Virgin fibre	30			36		41	
Waste based	44		41				63
Fluting:							
Virgin fibre	32			28			
Waste based			47				26
Cost of Purchased Energy, Per Cent of Total Delivered Costs							
	USA	Canada	W.Europe	Scadinavia	S. America	Russia	China
			Per Cent				
Bleached Market Pulp:							
Softwood pulp		7		0	-2		
Hardwood pulp		7		0	0		
Newsprint:							
Virgin fibre		10		16		21	
Waste based	4		12				
Printing/writing	4		6	5		4	10
White-t. Chipboard			8				10
Linerboard:							
Virgin fibre	10			8		9	
Waste based	4		10				8
Fluting:							
Virgin fibre	12			15			
Waste based			10				18

5
KEY FACTORS AFFECTING PRODUCTION COSTS

5.1
Cost of Fibrous Raw Materials

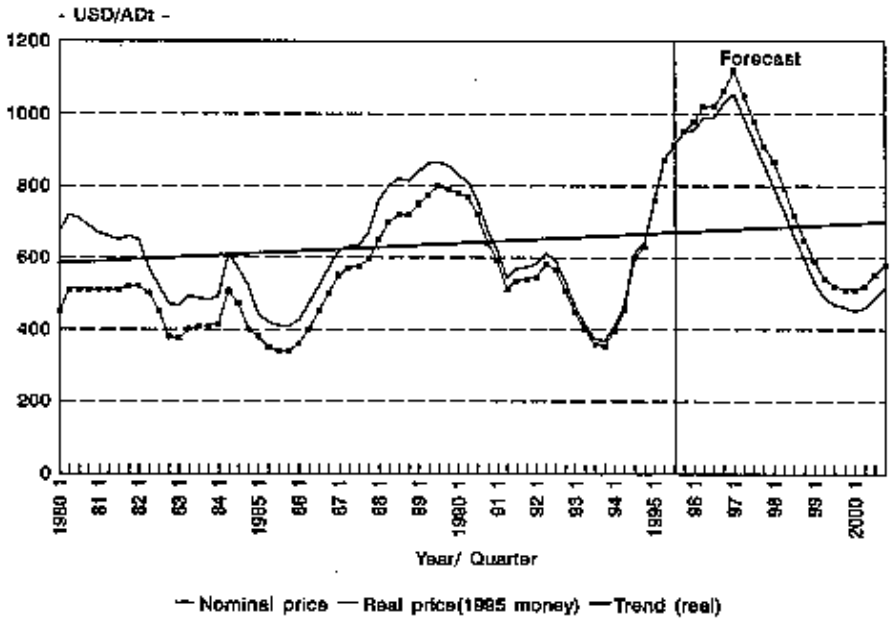
The fibre costs (wood, recycled fibre and pulp) are typically the biggest cost item in pulp and paper production. The fibre costs account for 30-40 %, sometimes over 50 % of the total delivered costs.

Some of the fibre costs, such as market pulp vary widely during the market cycles, as illustrated in Figure 5/1. There are several reasons to forecast wide price fluctuations of market pulp also in the future, such as:

- Market pulp can be globally regarded as marginal source of fibre, as e.g. in bleached hardwood pulp two thirds of the pulp is used in the integrated paper production and only one third is sold as market pulp

- Role of partly integrated pulp and paper mills add the market instability during market cycles, as the amount of their saleable market pulp increases during weak markets and vice versa

FIGURE 5/1
Price Development of BHKP Market Pulp in Western Europe



- Size of capacity increments of new mills is quite high (up to 700 000 t/a) and can create market disturbances during their start-up

- High share of capital charges of new mills require good operating rates to achieve competitive costs per ton, which easily leads to oversupply situations

- Rapid increase of paper demand in the fibre deficit regions of the world (Southeast Asia) may lead widening supply gap of good quality market pulp

- The future degree of substitution of market pulp by recycled fibre will be slower than during past few years because of already high recovery rates in many countries.

Based on the above points, it is more probable that the trend prices of market pulp will increase rather than remain constant in the future. The fluctuations around the trend price will, however, continue to remain high.

The recycled fibre prices vary during the market cycles much the same way as market pulp (Figure 5/2), but the price fluctuations seem to be even wider than in market pulp. The international trade of recycled fibre is dominated by the exports from the USA to the Asian countries (Figure 5/3). As the environmental awareness in the USA is forecast to progress well, both the recycled fibre recovery rates and domestic utilisation rates of waste paper can be expected to develop further. This may result decreasing export volumes and higher prices of recycled fibre, especially regarding higher quality grades, such as old corrugated containers and old newspapers and magazines.

Long-term trend price of pulpwood will much depend on local supply/ demand development as the international trade of pulpwood is forecast to remain limited (Figure 5/4). Globally, the increasing supply of pulpwood from the fast-growing plantations will compensate the slower growth of supply from the traditional pulpwood supply regions in North America and Europe. The production of pulpwood from fast-growing plantations is forecast to grow from 70 to 150 million m^3/a in the period 1992-2015, or by 80 million m^3/a. The demand growth of all pulpwood during the same period is forecast at about 180 million m^3/a. Typically the cost of fast-growing plantation pulpwood is lower than the pulpwood from traditional supply, especially when considering marginal wood supplies from traditional sources.

FIGURE 5/2
Price Development of Recycled Fibre in Germany 1982-1994 (DEM/ton)

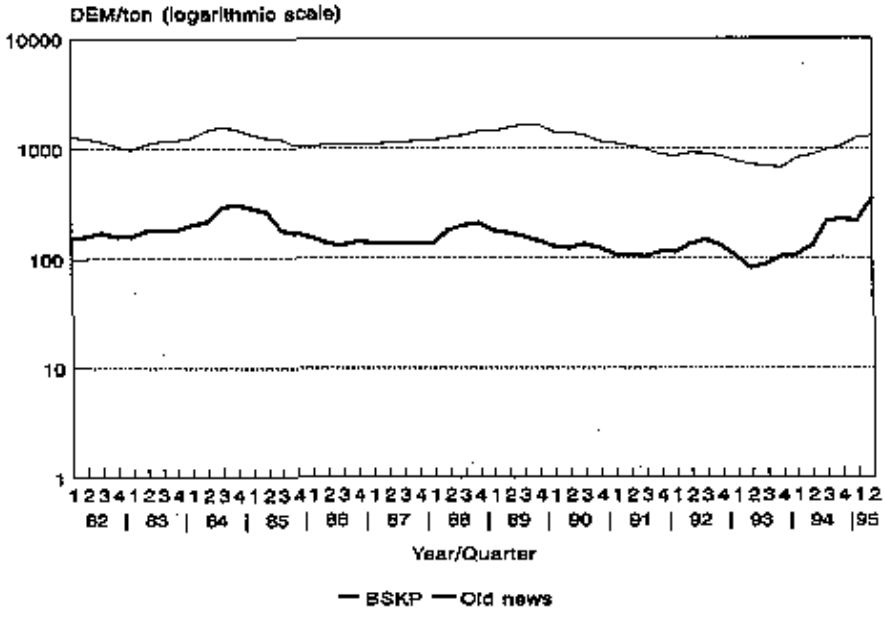


FIGURE 5/3
Net Trade Balance of Paper and Paper Fibre in the World in 1993 by Region

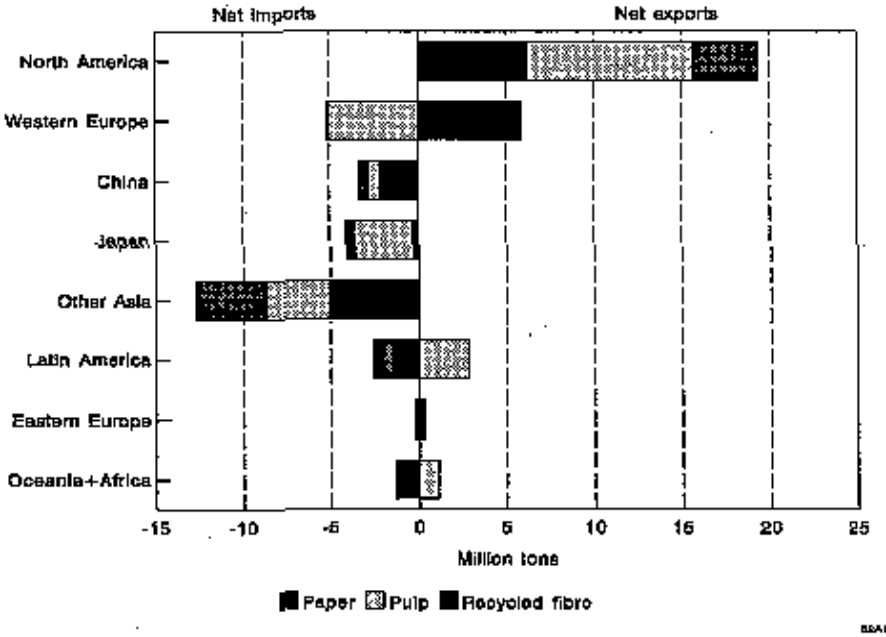
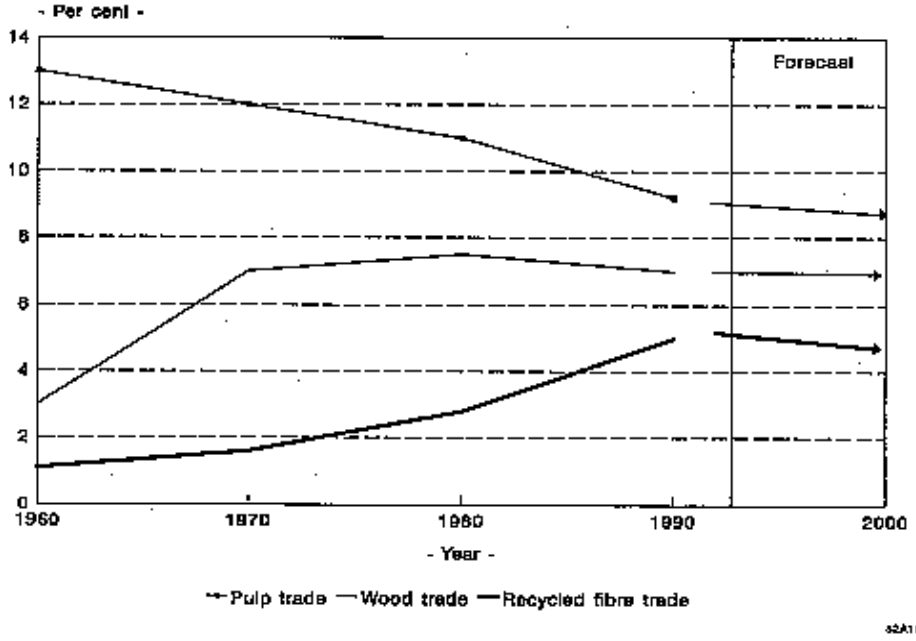


FIGURE 5/4
International Trade of Fibre as Per Cent of Total Fibre Consumption



During the past decades the quality properties of paper have changed; in many cases the quality requirements (e.g. printability) have significantly increased. At the same time the development of papermaking chemistry and technology has allowed larger utilisation of lower quality and/or cheaper raw materials, such as fillers and recycled fibre. These trends are forecast to continue also in the future, which means that the possible increases in the real prices of certain raw materials can be at least partly compensated by the development of papermaking furnishes.

5.2 Structure of the Industry

The oldest pulp and papermaking capacity will continue to be shut-down also in the future. In addition to the lack of cost and quality competitiveness, the tightening environmental regulations will be more and more difficult to follow at the older mills. Further, the increasing environmental awareness in countries like Russia and P.R. of China will force the old capacity to be shut-down. A special problem in this respect is the production of non-wood pulp in P.R. of China, India and various other countries. Because of the small size of the pulp mills and technological difficulties, a great majority of these mills operate without chemical recovery of cooking liquor. Thus the effluent load caused by the non-wood pulp industry is clearly higher than the effluent load from the woodpulp

industry even if the non-wood pulp production is less than 10 % of the global wood pulp production.

The structural change of the pulp and paper industry towards more modern and environmentally cleaner structure will change the cost structure so that the capital charges will increase, while the energy and personnel costs, and in some cases also raw material costs decrease. The overall effect will in most cases be increasing total costs, especially in countries like P.R. of China, Russia and India.

5.3 Exchange Rates and Inflation

The estimation of the future production costs in the different regions of the world in a common currency like USD, is to a great extent depending on the development of the exchange rates of local currencies to USD as well as local inflation rates.

Thus, for instance, the current production costs in Russia are almost at the Western European level, as in spite of high inflation, the exchange rate of rouble has remained several months practically at the same level. Cost calculations in the year 1993 situation showed very low production costs in USD.

The future cost level in Russia is forecast for several years more likely to resemble the 1993 cost situation rather than the current one.