JAAKKO PÖYRY CONSULTING

Global Competitiveness of the Indian Paper Industry

Prepared for

Central Pulp & Paper Research Institute

Final Report Draft

September 9, 2002

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Preface

Vantaa September 9, 2002

Global Competitiveness of Indian Paper Industry

India has undergone a large process of economic reforms aiming at liberalization and attracting investments. That process, which began already in the early 1990s, continues to have an important impact on the whole economy, including the pulp and paper industry. India will also join World Trade Organisation, which will increase international competition in the Indian market.

For this reason the Ministry of Industry and CPPRI (Central Pulp and Paper Research Institute) commissioned Jaakko Pöyry Consulting to carry out a survey on the global competitiveness of the Indian pulp and paper industry.

We trust that this report will give a good base for planning the future operations of Indian pulp and paper industry. We thank Ministry of Commerce and Industry, CPPRI and representatives of the Indian pulp and paper industry for the valuable help and good cooperation in this survey.

JP Management Consulting (Europe) Oy JP Development Oy

Pekka Niku Pekka Komulainen Harri Ahveninen

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Introduction

India has undergone a large process of economic reforms aiming at liberalization and attracting investments. That process, which began already in the early 1990s, continues to have an important impact on the whole economy, including the pulp and paper industry.

The country has experienced important GDP growth during the last years and the perspectives are positive for the future as well. Home to a billion inhabitants, the growing needs for job creation and increased living standards will require even faster development.

The paper industry has an important role to play on the Indian economy. The overall paper consumption in India reached 4.2 million tons in 2000, making India a large market from any perspective. The potential for per capita consumption increase, originated on economic growth, increasing purchasing power and emerging export-led industries, attracts companies to invest and modernise.The increasing demand for paper puts pressure into supply of papermaking fibres, including efficient recovery of recycled paper, use of non-wood raw materials and the need to develop and expand sustainable use of wood.

At the same time competition in global pulp and paper markets is intensifying. This is likely to have an increasing impact on the Indian market. Indian pulp and paper industry consists of some 400 paper mills, mainly of small and medium size companies. There is a growing need to invest - capital is needed for mill modernization, productivity improvements and building of new capacity. If adequate measures are taken, India’s competitiveness could substantially be improved and the industry be prepared for global competition

Looking at the future, the Indian Pulp and Paper Research Institute is carrying out a survey of the global competitiveness of the Indian pulp and paper industry. The key objective is to analyse and give recommendations for the Government and the paper companies on how to improve international competitiveness.

Key drivers affecting

The Indian Paper Industry

External driving forces

- GDP growth and increased standard of living
- Development of export-led industry
- Growth potential in India and South-East Asia
- Development of human capital
- Legislation and government regulations
- Access to capital
- Technology and process innovations driving efficiency and scale of production equipment

Change in industry structure

- Industry size, consolidation and investment capacity
- access to raw material, recycled fibre, non-wood fibre and wood resources
- Minimum efficient scale and asset quality
- Quality improvements and standards
- Environmental considerations and standards
- Trade of fibre, pulp and paper products

Change in competitive conduct

- Foreign investments and the attractiveness of Indian markets
- Modernization of existing assets and capital needs
- Development of pulp and paper industry in South East Asia
- Consolidation and acquisitions as growth vehicle
- Partnerships and alliances
- Management of scale and scope through networked production

Change in industry performance

- Global competitiveness
- Improvement of profitability
- Increased capital intensity
- Tax incentives
- Shareholder returns
- Job creation opportunities
- Improvement of paper and related products trade balance

Current situation and goals

For Indian pulp and paper industry

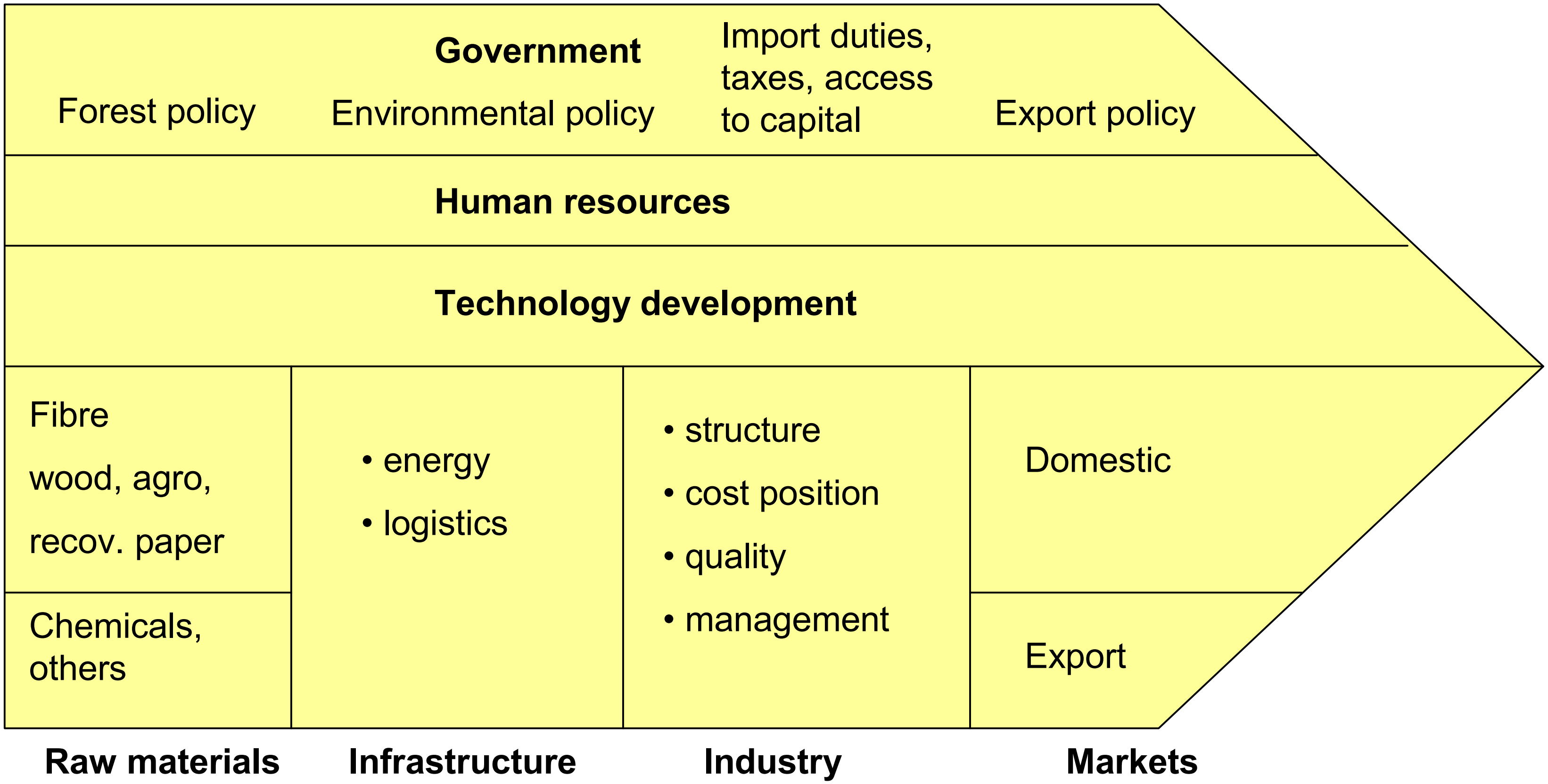
CURRENT SITUATION

- Enormous growth potential of Indian market
- Industry structure - with small and medium size mills
- Type and availability of fibre raw materials
- Infrastructural problems
- High costs of financing the projects
- Productivity and efficiency of the mills need to be improved

FUTURE GOALS

- Ensure profitability and competitiveness of the industry in years to come by focusing on
  - Market potential in India and potential export markets
  - Raw materials available for paper industry in India
  - Competitiveness of the industry
  - Utilisation of global and proprietary technologies
  - Management practices
  - Government regulations and guidance

Study framework



Objectives of the study

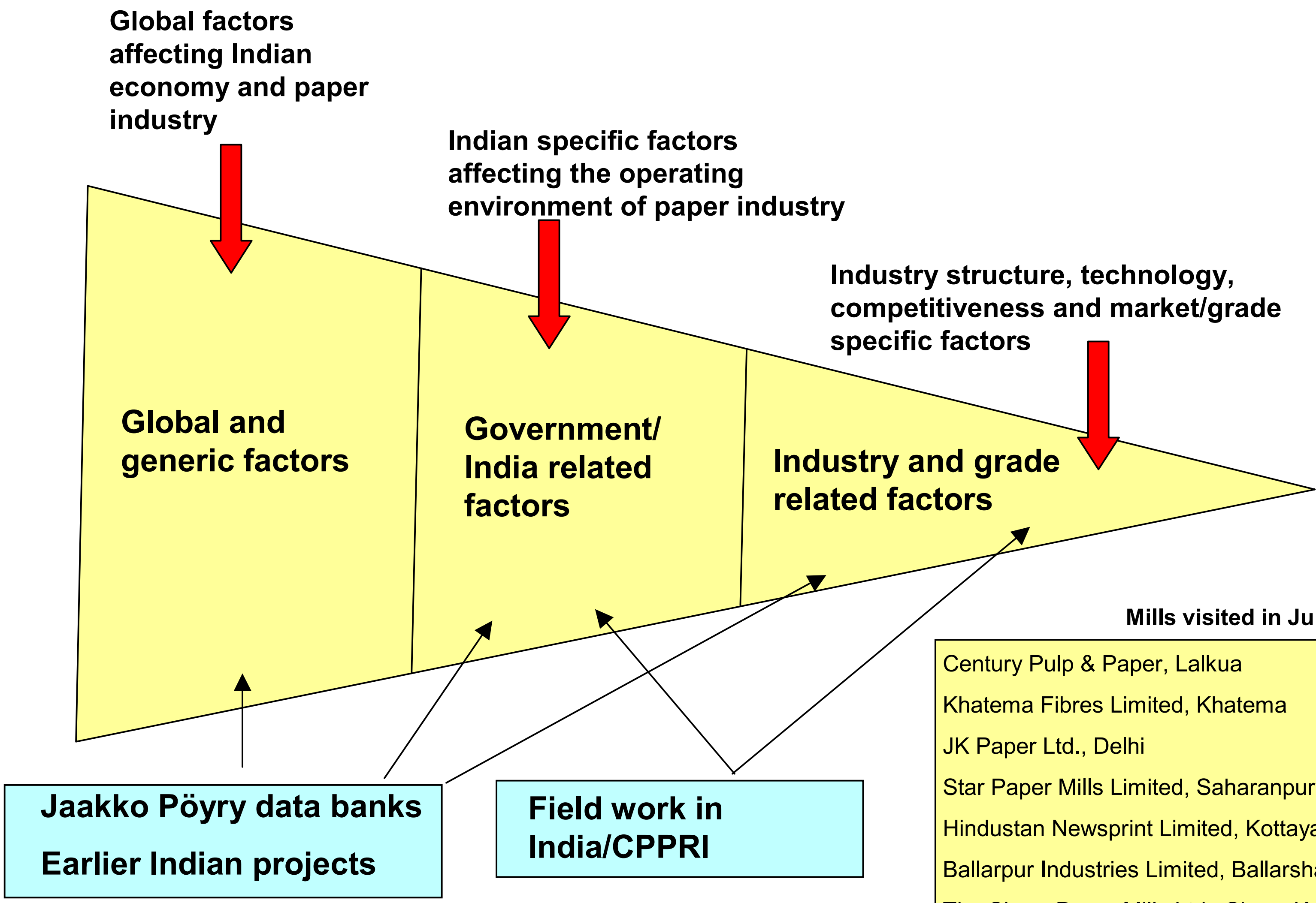
OBJECTIVE

To evaluate the global competitiveness of Indian pulp and paper industry, and to prepare recommendations and action plans for Government and industry, which would improve the competitiveness of the pulp and paper industry

Sub-objectives	Main deliverables	Benefits to Indian industry
▪ External drivers affecting the markets and industry ▪ Market outlook ▪ Raw material availability ▪ Competitiveness ▪ Technology ▪ Management Practices ▪ Government regulations ▪ Monitoring mechanism ▪ Sustainable industry development	▪ Long-term market forecast for India ▪ Availability of fibre raw material and possibilities to increase the availability in the long term ▪ Competitive assessment of the industry as regards to scale of operation, quality benchmark and production costs ▪ Review of current technological state of the industry and recommendations for its improvement ▪ Recommendations to improve management practices ▪ Review of government regulations and their impact on the industry ▪ Recommendations and action plan for the government and industry ▪ Development of monitoring mechanism at the Government and industry level	▪ Provides insight and a range of options for the long-term development of the industry ▪ Understanding of key drivers affecting the future development of the industry ▪ Understanding the current global competitive position of the industry and ways to improve the competitive position ▪ Enhancement of organizational, product quality and technological capabilities ▪ Understanding of requirements for Government policy as well as benefits for the Indian economy

Methodology

The study approach and sources can be illustrated as follows



Mills visited in July 2002

Century Pulp & Paper, Lalkua
Khatema Fibres Limited, Khatema
JK Paper Ltd., Delhi
Star Paper Mills Limited, Saharanpur
Hindustan Newsprint Limited, Kottayam
Ballarpur Industries Limited, Ballarshah, Delhi
The Sirpur Paper Mills Ltd., Sirpur-Kaghaznagar

Work plan and time schedule

Project Number 52A0087

	Weeks													
Activities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**15**
Project confirmation														
Field work/data collection														
Demand forecasts														
Raw materials														
Competitiveness														
- scale of operations														
- quality benchmark														
- manufacturing costs														
Technology														
Management practices														
Recommendations and														
action plan														
Monitoring mechanism														
Interim meeting														
Presentation														
Delivery of draft report														
Delivery of final report														

August 12-14

By Sept 15

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List of common abbreviations

BHKP	Bleached hardwood kraft pulp
Bl.	Bleached
BSKP	Bleached softwood kraft pulp
CWC	Coated woodcontaining printing paper
CWF	Coated woodfree printing and writing paper
DIP	Deinked pulp
FBB	Folding boxboard, manilla back board, mechanical pulp based
OCC	Old corrugated containers, waste paper
RCP	Recovered paper, waste paper
SBS	Solid bleached board, chemical pulp based board
SI	Sulphite pulp
UCW	Uncoated woodcontaining printing paper
UHKP	Unbleached hardwood kraft pulp
UKP	Unbleached kraft pulp
UWF	Uncoated woodfree printing and writing paper
WC	Woodcontaining printing paper, mechanical printing paper
WF	Woodfree printing and writing papers
WLC	White lined chipboard, duplex board, recycled fibre based

Executive Summary

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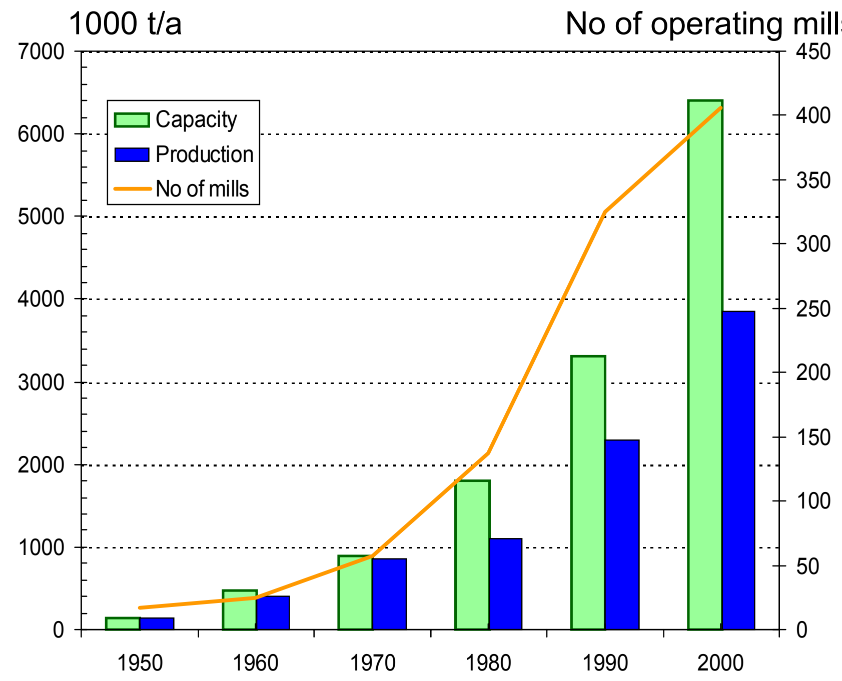
Development of Indian paper industry

Indian paper industry is highly fragmented, and domestic market oriented which is largely due to industry policy in the 1970s

- In the 1970s excise concessions were given to small agro based mills, which resulted in a rapid increase of small mills and capacity.
- In the late 1980s the industry was in a severe oversupply situation, capacity utilisation rates being around 60 %.
- In early 1990s the government reversed the policy making large units more competitive (e.g. by removing excise concessions from agro based mills).
- Today the installed capacity is over 6 million tons, of which about 1.1 million tons is idle.
- Indian paper consumption is 4.2 million tons. The per capita consumption is still only 4 kg, and thus the country has much potential to grow.
- The industry employees more than 0.3 million people directly and about 1 million people indirectly.

Paper capacity and production in India 1950-2000



Foreign direct investments in India

Allowing 100 % FDI to paper industry will increase foreign participation to the industry's development. Presently FDI level is still low.

India has opened its market since early 1990s by lowering tariff and non-tariff barriers, and liberalising investment policy. This policy is likely to attract export oriented FDI.

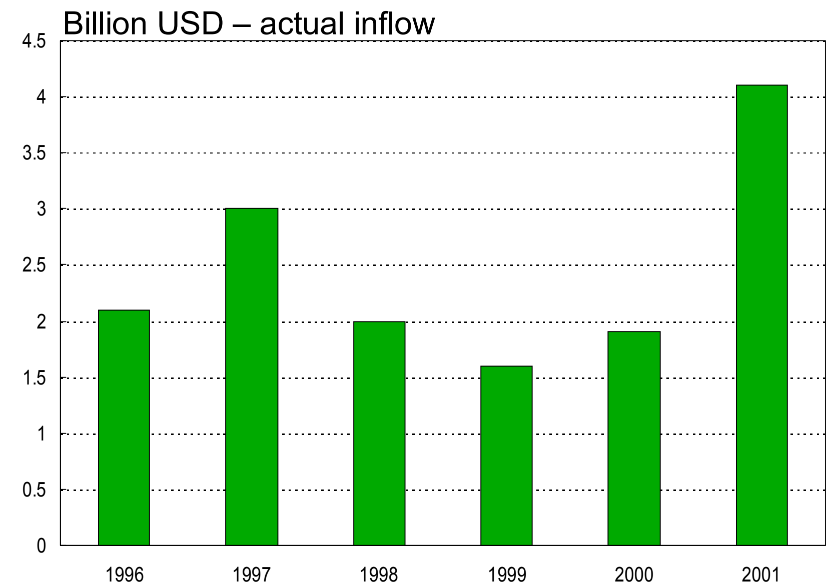
In 2001 FDI accounted for over 4 billion USD, coming mainly from the UK and the USA. For comparison, the FDI to China have been over 40 billion USD in recent years, i.e. ten times FDI in India.

Telecommunication and power/oil refining were the main targets for FDI in India.

FDIs are likely to play an important role for India's paper industry's future development:

- **100 % FDI to paper industry is possible**
- **Recently 26 % FDI in print media is allowed, which is the main end use sector for paper industry**

Foreign direct investments in India



Paper supply/demand scenario for India

Project Number 52A0087

Total demand growth in 2000-2015 is expected to be 6.8 million tons. Supply is estimated to increase by about 6 million tons during the same period (depends on investments)

GDP growth: base scenario 6 %/a, conservative scenario 5 %/a

		2000	2005	2010	2015	Growth 2000-2015	2020
				1000 tons			
Newsprint	Demand	844	1177	1552	1937	1093	2380
	Supply	456	700	1040	1390	934	1800
	Net trade	-388	-477	-512	-547		-580
WC printing/writing	Demand	40	61	80	99	59	110
	Supply					0	
	Net trade	-40	-61	-80	-99		-110
WF printing/writing	Demand	1490	2125	2870	3880	2390	5215
	Supply	1530	2000	2580	3600	2070	4600
	Net trade	40	-125	-290	-280		-615
Tissue	Demand	38	75	130	185	147	235
	Supply	30	55	100	170	140	225
	Net trade	-8	-20	-30	-15		-10
Containerboard	Demand	814	1276	1942	2773	1959	3900
	Supply	806	1155	1840	2650	1844	3600
	Net trade	-8	-121	-102	-123		-300
Cartonboards	Demand	798	1070	1468	1895	1097	2430
	Supply	828	1100	1300	1800	972	2200
	Net trade	30	30	-168	-95		-230
Others	Demand	191	222	249	276	85	315
	Supply	200	225	245	265	65	300
	Net trade	9	3	-4	-11		-15
Total Base scenario	**Demand**	**4215**	**6006**	**8291**	**11045**	**6830**	**14585**
	Supply	**3850**	**5235**	**7105**	**9875**	**6025**	**12725**
	Net trade	**-365**	**-771**	**-1186**	**-1170**		**-1860**
Total Conservative	**Demand**	**4215**	**5660**	**7430**	**9435**	**5220**	**11870**

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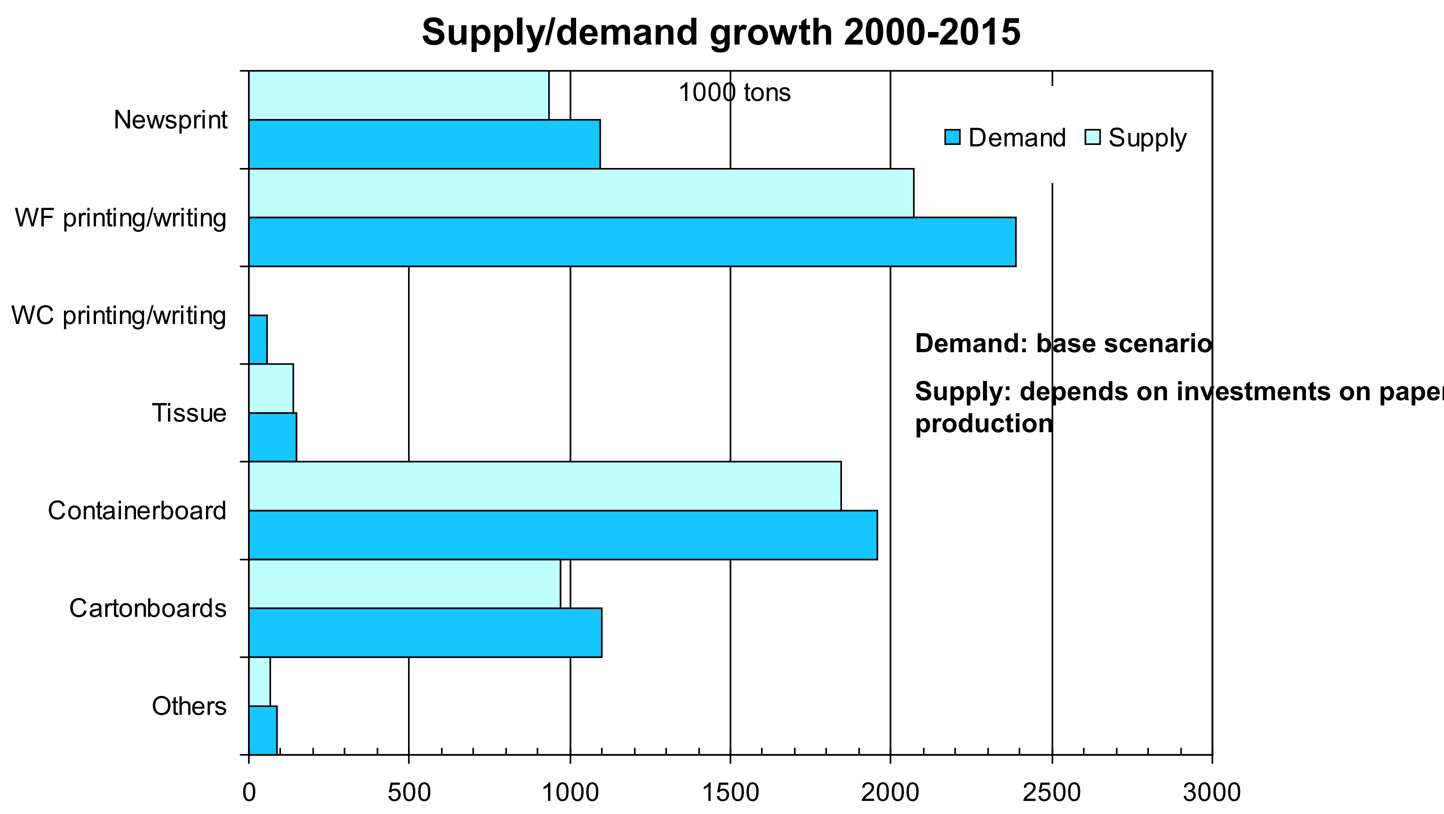
Growth of paper supply/demand in India

Printing and writing papers and containerboard are expected to grow most. There are less than 0.2 million tons of decided projects and about 0.4 million tons of planned project, ie. the planning gap during the next 15 years would be well over 5 million tons.



Fibre resources

Fibre deficit is the main problem of the Indian paper industry

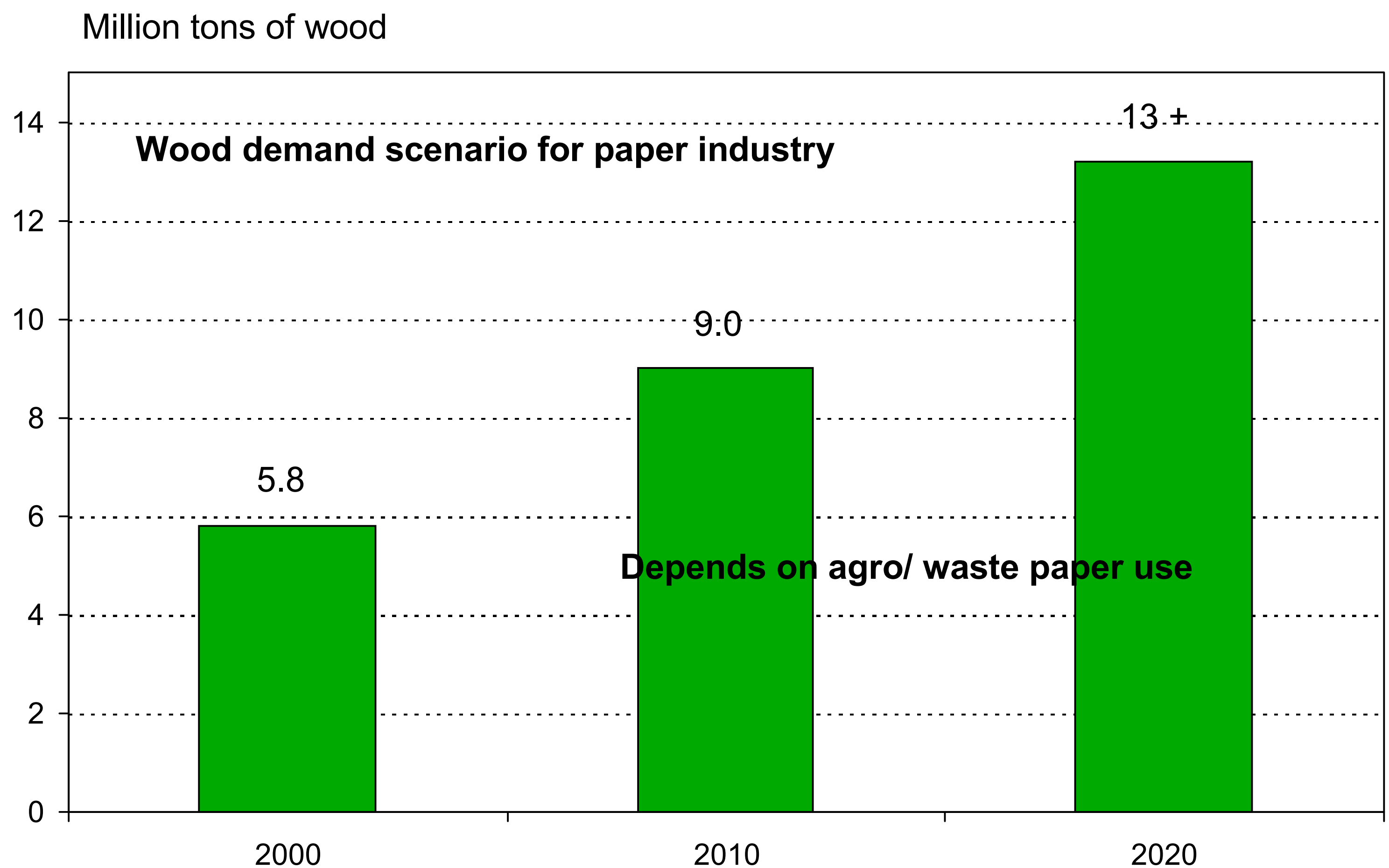
The fibre resources used by the Indian pulp and paper industry come from three sources:

- **Forests**
  - including bamboos and mixed hardwoods from forest fellings, and Eucalyptus wood from plantations (both organized plantations and farmers' fields/agroforestry plots)
  - In India all forests are Government owned and largely not accessible to pulp and paper industry. Plantation is being done by farmers on private lands and the produce is sold to pulp and paper industry. However, the effort is still small and meets some 10-15 % of wood needs of the industry.
- **Agricultural residues**
  - such as bagasse, rice and wheat straws and cotton stalks.
- **Waste paper**
  - including both domestic and imported waste paper.

Currently the proportions of each category in the total production of pulp and paper are 36, 29 and 35 %, respectively. Over the past years, the share of forest based industries has declined.

Industrial wood demand scenario for India

The paper industry's wood demand is expected to grow from 5.8 million tons to 9 million tons by 2010, and to over 13 million tons by 2020.

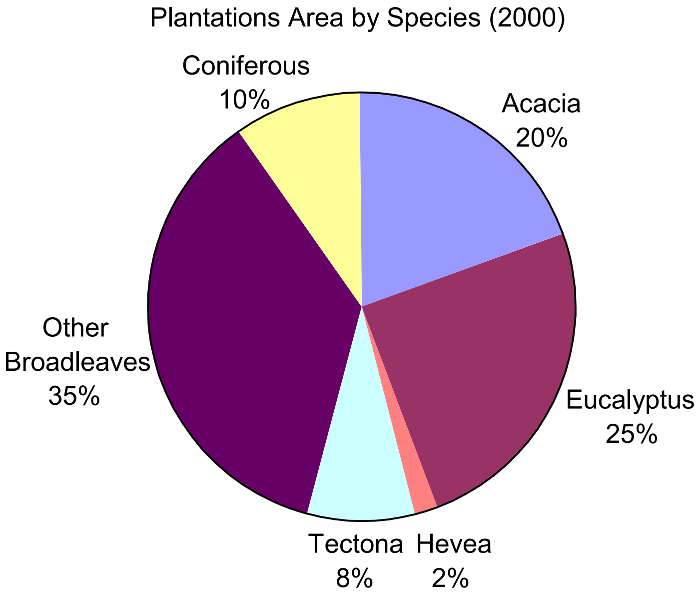


Securing future wood supply

Serious attention should be paid on the development of forest plantations

- Current forest plantations in India are estimated at 32.5 million ha, of which 90 % is based on hardwood, mainly eucalyptus and acacia.
- The paper industry's needs for wood is expected to grow from 5.2 million tons in 2000 to 13.2 million tons by 2020 (assuming that part of fibre needs are covered by increasing use of waste paper and agro residues).
- <u>The state of current plantations and their potential/accessibility for pulp and paper industry should be evaluated</u>
- <u>About 0.6 million ha land for plantations would be required to meet the paper industry's wood demand</u>. India has about 100 million ha of waste land and 32 million ha of degraded forest land, small part of which could be allocated for plantations.

Forest plantations in India



Total 32.5 million ha

Agricultural residues

Availability of agricultural residues is good, but there are many limitations to their use

Agricultural residues are emerging as a significant alternative raw material resource for the pulp and paper industry in India. Their share of total fibre use of the paper industry is 29 % (1.3 million tons). The use of agricultural residues has grown since the early 1970s partly due to the dwindling bamboo resources, and partly due to the government's industrial policy encouraging investments in agro-based paper production. Major incentives for investors included tax holidays, excise duty remissions and liberalized imports of machinery.

The main agricultural residues utilized by the paper industry include bagasse, cereal straws (wheat and rice), kenaf/mesta, jute sticks, grasses and cotton stalks.

Annual potential of agro based fibres in India 2001 (IAPMA estimate)

Agro residue	Availability Mill. tons	Tons needed for 1 ton of pulp	Pulp potential (theorethical)
Wheat straw	22	2.5-3.5	7
Rice straw	15	2.5-3.5	5
Bagasse	10	5.0-6.0	2
Jute, mesta, kenaf	2		
Total	**49**		**14+**

Today the agro-based paper mills use mainly bagasse and straw as raw material. Even if the theorethical availability of bagasse and straw is high there are limitations in their use – seasonal availability, high silica content of rice straw, transportation costs for long distances, investments in pollution control equipment, and quality of end products.

Waste paper

Domestic recovery rate for paper industry's use is increasing slowly -imports of waste paper need to be increased substantially

Waste paper based industry accounts for about one third of Indian paper capacity. The recovery of waste paper has increased from 650 00 tons in 1995 to 850 000 tons in 2000. Most of paper is recovered, but due to alternative uses the recovery rate for paper industry is still only about 20 %. This is low by international standards: Thailand (42%), China (33%), Germany (71%).

Waste paper recovery and trading are still unorganised in India. The collection is being carried out by individual wheelers, and the system of sorting is unsophisticated. The Indian recovery is not keeping pace with recycled paper utilization, resulting in increase in Imports (700 000 tons in 2000). Multiple use of paper products (as wrapping papers, packaging applications, etc.) is common in India, and often these end uses pay better price for waste paper than paper industry.

The total availability of waste paper is divided between geographical regions as follows:

- Northern region 30 %
- Eastern region 10 %
- Southern region 20 %
- Western region 40 %

The main waste paper grades available for recycling are:

- Old corrugated containers 40 %
- Office refuse 20 %
- Old newspapers and magazines 20 %
- Mixed paper 20 %

Pulp/waste paper supply/demand scenario

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		2000	Scenario 2005	2010	2015	Growth 2000-2015	2020
				1000 tons			
Mechanical pulp	Demand	275	347	453	586	311	760
	Supply	240	340	450	580	340	750
		-35	-7	-3	-6		-10
Semi-chemical	Demand	0	0	0	0	0	0
	Supply	0	0	0	0	0	0
	Net trade	0	0	0	0	0	0
BSKP	Demand	85	140	202	299	214	430
	Supply	0	0	0	0	0	0
	Net trade	-85	-140	-202	-299		-430
BHKP	Demand	957	1234	1568	2150	1193	2930
	Supply	850	1000	1200	1500	650	1800
	Net trade	-107	-234	-368	-650		-1130
UKP	Demand	231	222	231	252	21	270
	Supply	220	220	220	230	10	250
	Net trade	-11	-2	-11	-22		-20
Sulphite	Demand	0	0	0	0	0	0
	Supply	0	0	0	0	0	0
	Net trade	0	0	0	0		0
Non wood pulp	Demand	1267	1490	1889	2481	1214	3200
	Supply	1268	1490	1889	2481	1213	1500
	Net trade	1	0	0	0		-1700
Recovered paper	Demand	1600	2496	3652	5283	3683	7300
	Recovery	850	1400	2500	3800	2950	5500
	Net trade	-750	-1096	-1152	-1483		-1800
Dissolving	Demand	390	420	470	500	110	520
	Supply	390	420	470	500	110	520
	Net trade	0	0	0	0		0

Growth depends on investments/available plantations, BHKP growth could be higher

Growth of fibre supply/demand in India

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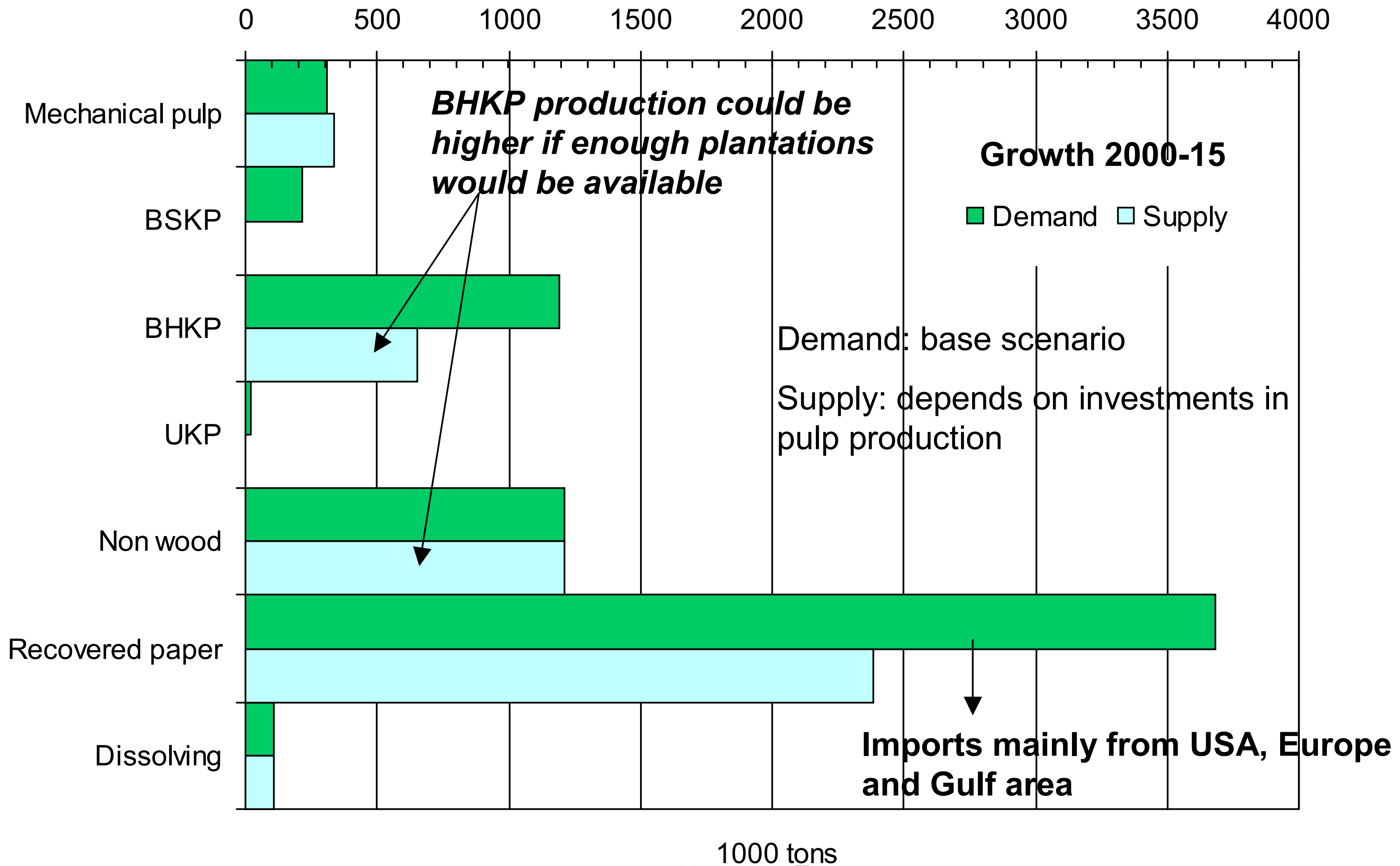
Consumption of waste paper is expected to grow most. About 0.1 million tons of pulp capacity expansions have been decided, and some 0.1 million tons are planned. The planning gap for pulp during the 15 years would be over 2 million tons (excl. waste paper)



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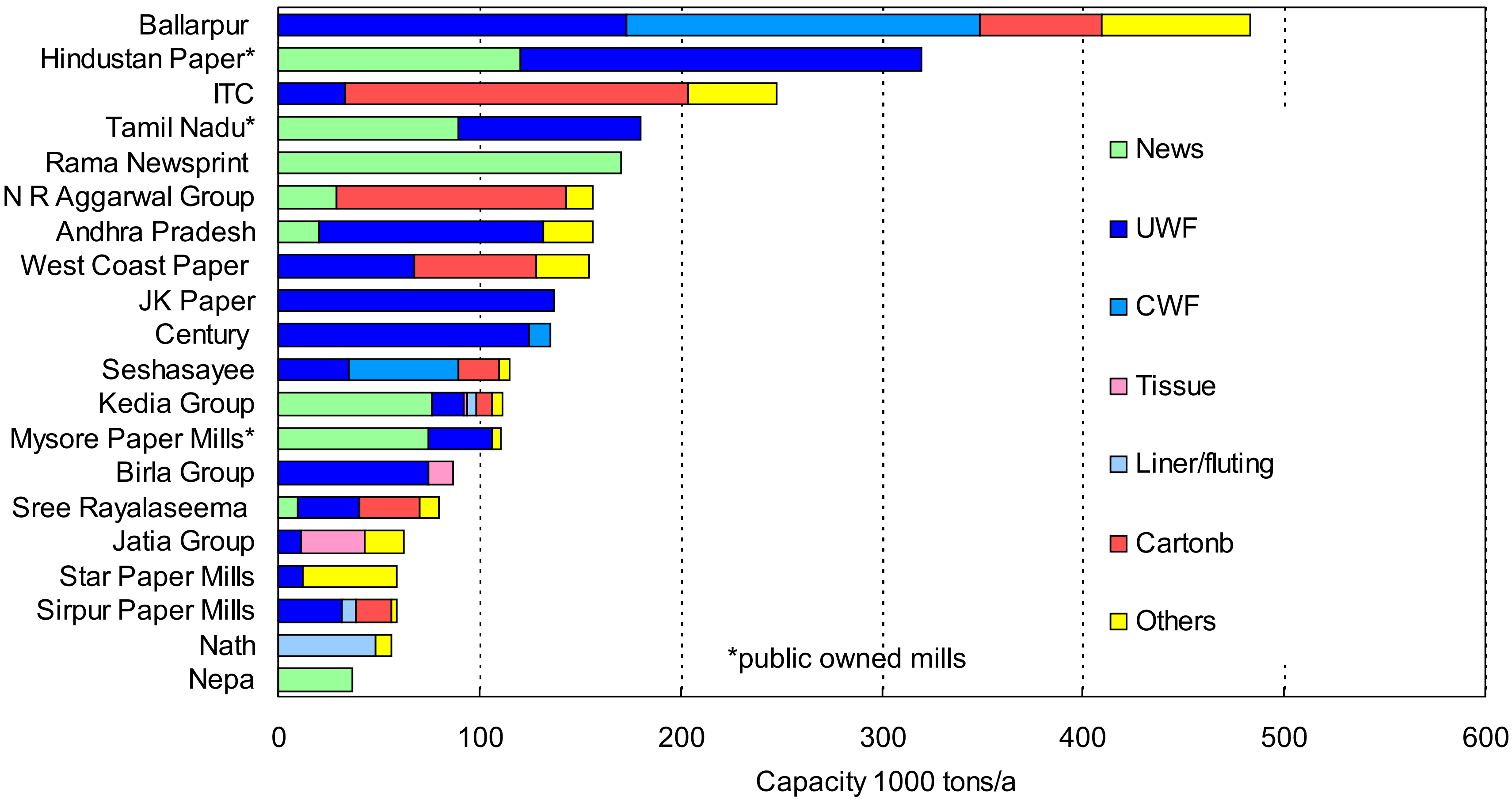
Major paper producers in India 2002

The biggest producers focus on printing and writing papers, newsprint and cartonboards



Paper mill structure in India 2001

There are over 500 paper mills in India. Most of the mills are small, only 34 mills have a capacity of over 33 000 tons. The Indian paper machines are mostly small units. In an international comparison, even the largest machines are medium-size, as large-scale machines are today in the range of 400 000-600 000 t/a, and have a trim width up to 10 metres.

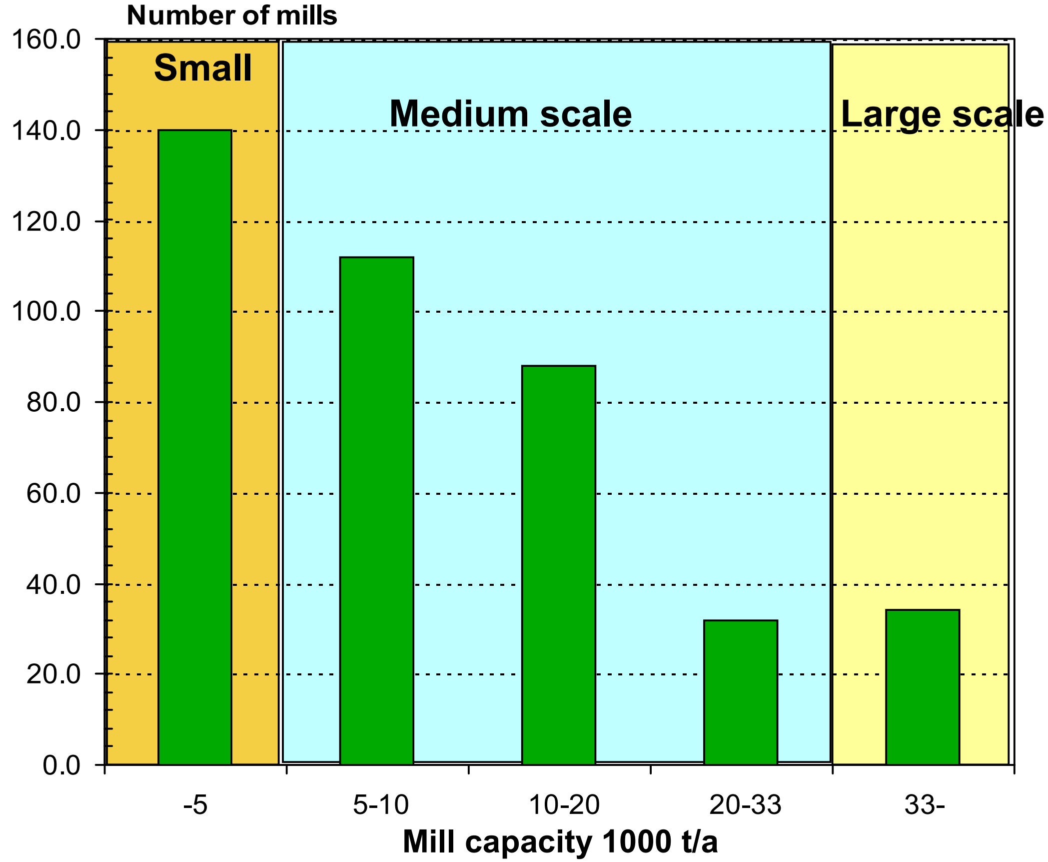
The following parameters are illustrative of the Indian paper industry:

The average capacity of paper machines is about 14 000 t/a

Most of Indian paper machines have a trim width from 1.5 to 3.5 m

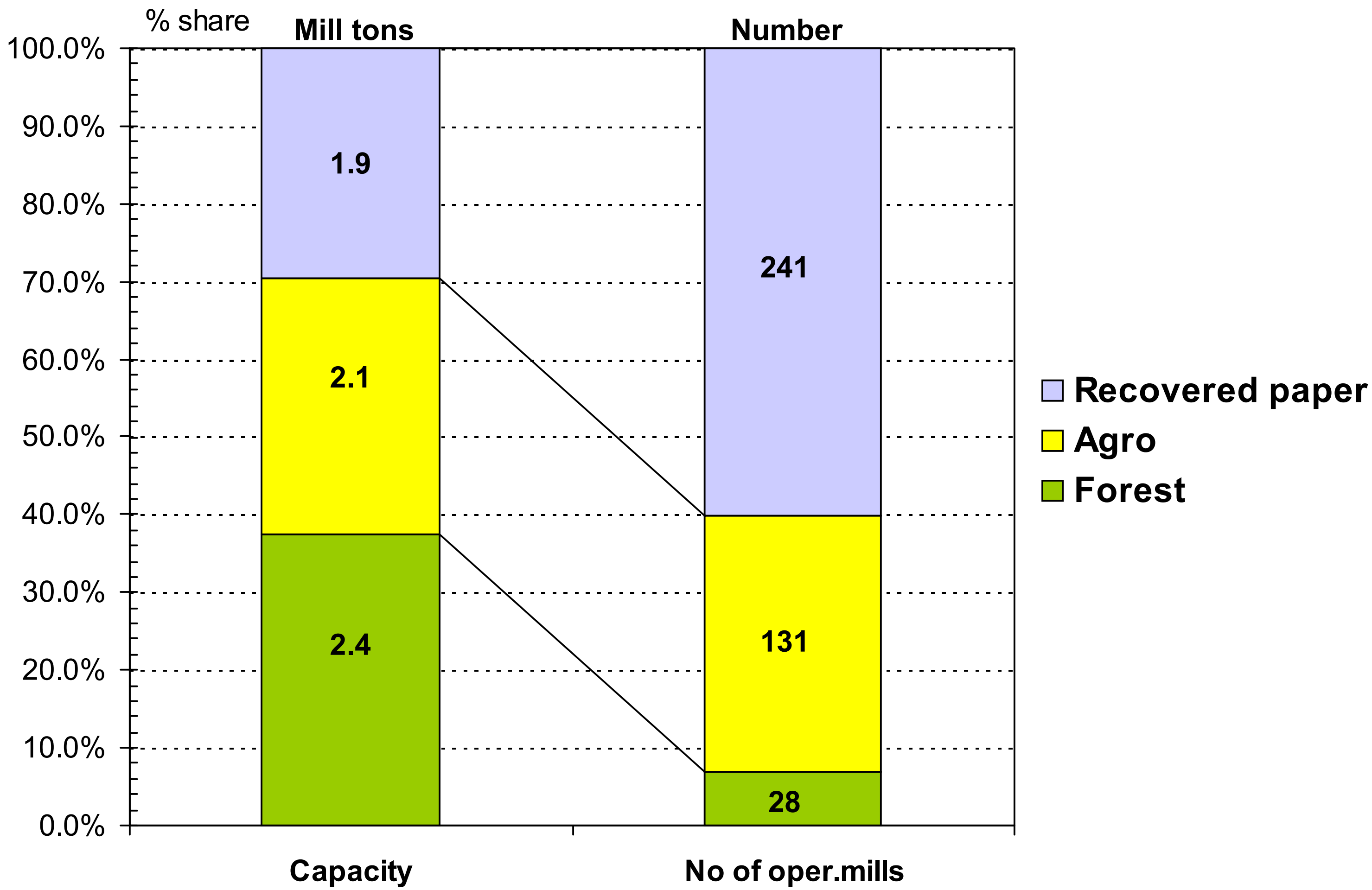
There are only 9 paper machines with trim width of 5 m or more

Only 14 machines have capacities 50 000 t/a or more



Structure of Indian Paper Industry

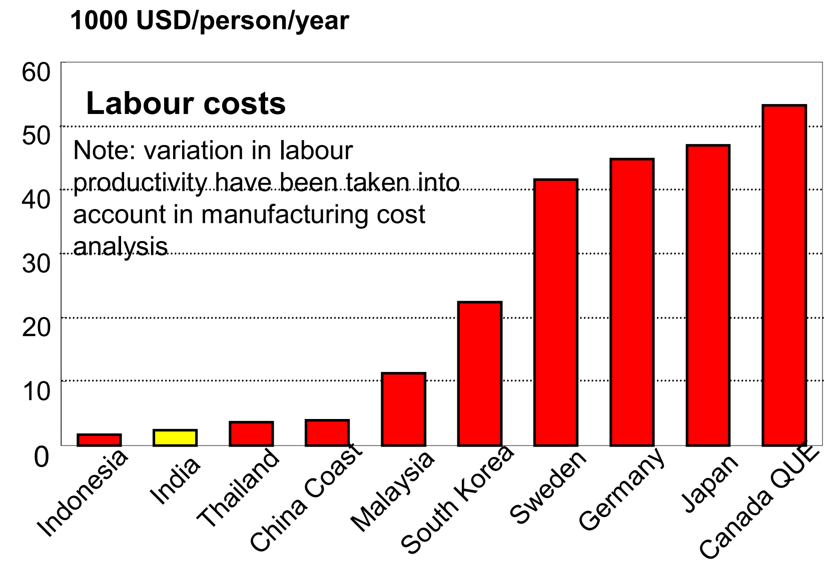
Production capacity is almost equally divided into three main fibre groups, but less than 10 % of mills are forest based



International unit cost comparison

Project Number 52A0087

India has cost advantage in labour costs and cost of fuels, altough lower labour productivity and variation in coal quality reduces the advantage.

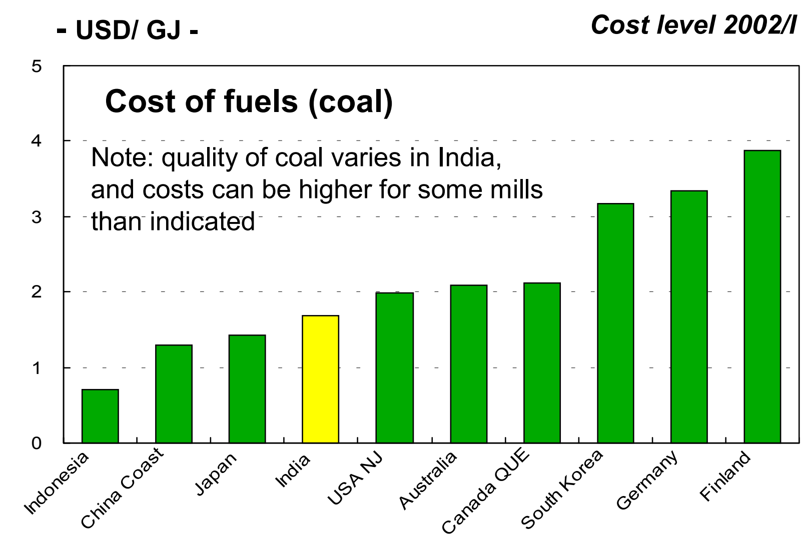


In Asian comparison, Indonesia has the lowest wood, fuel and power costs.

Unit costs in selected Asian countries 2002/I

	Hardwood USD/m3	Labour (operating) USD/person/a	Fuel (coal) USD/GJ	Purchased power USD/MWh
India	**45**	**1000**	1.69	**87**
Indonesia	**23**	1603	**0.70**	**32**
China	**45**	3870	1.29	72
Malaysia	28	**11263**	**2.50**	45
Thailand	30	3571	1.30	39

Cost level 2002/I



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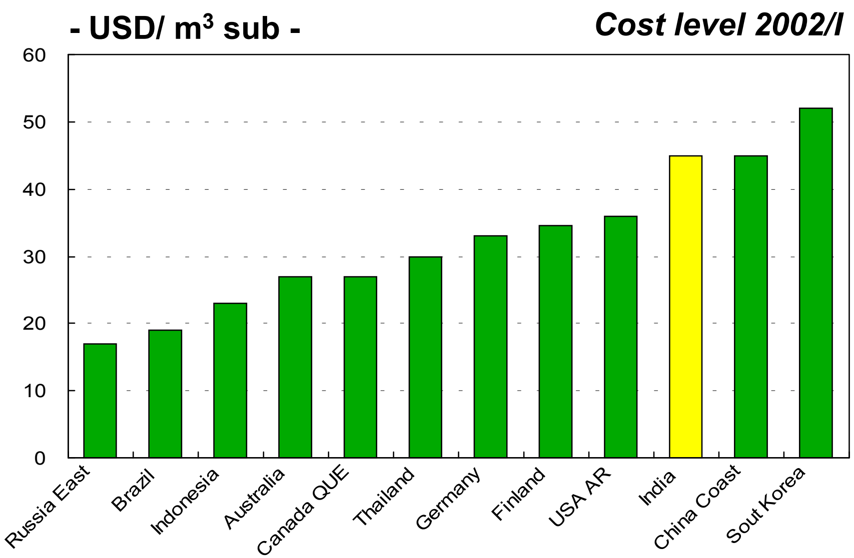
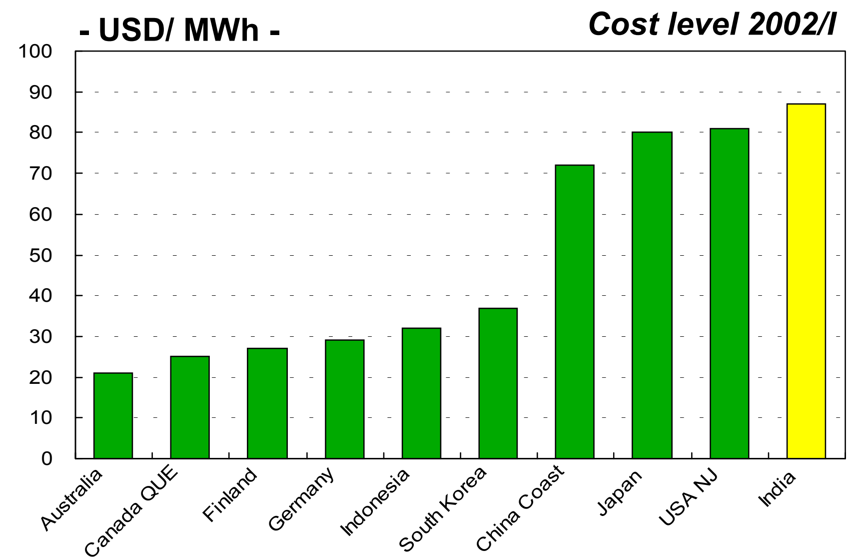
International unit cost comparison

There is a lack of wood raw material in India, and wood prices are high. Also purchased power costs are high and vary by State. Import duties and transport costs make also imported waste paper (OCC, ONP) expensive. The unit consumption of power, water, chemicals, etc. especially in the small mills is much higher than in the best practice mills mainly due to obsolete technology.

Hardwood prices



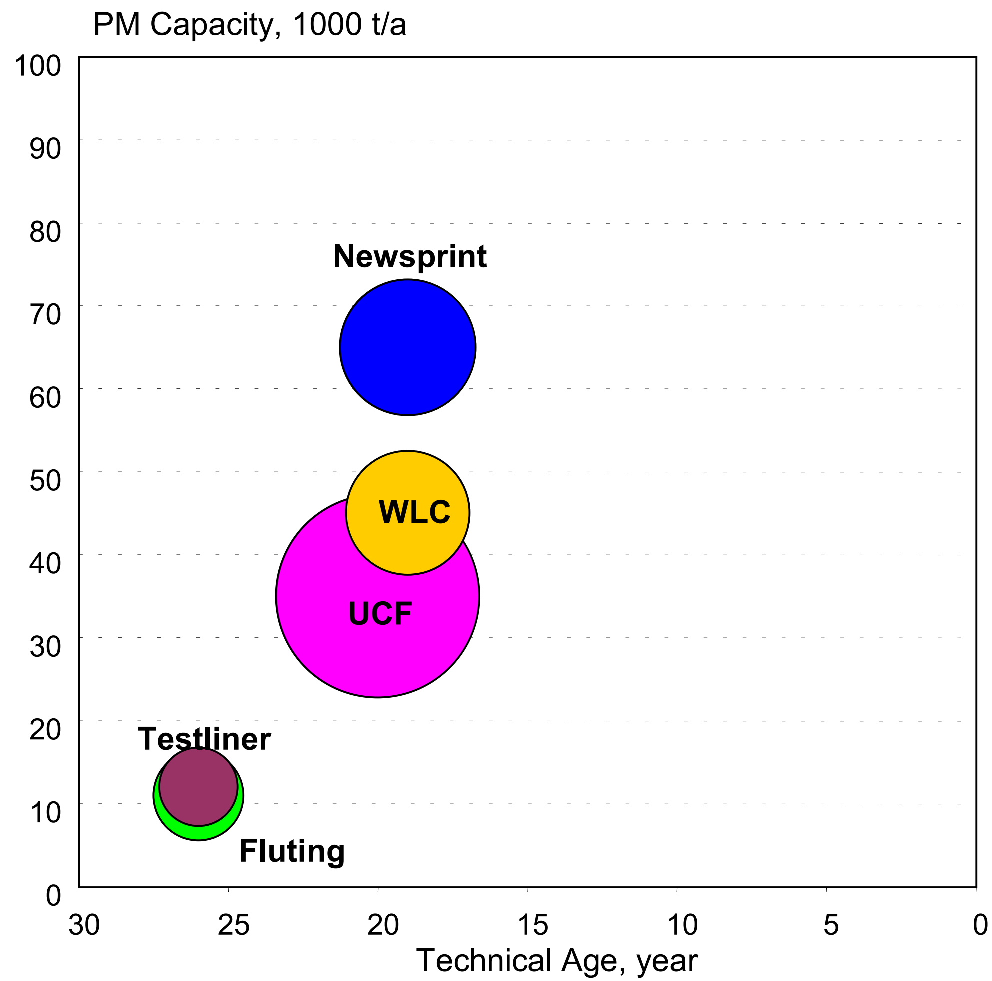
Purchased power



Asset quality by grade comparison – India

The newsprint, printing and writing sector and cartonboard have much better production structure than containerboard raw materials. Reading/education, growth of office papers, tobacco industry, pharmaceutical packaging and luxury item packaging are the key drivers of this situation.

Corrugating material sector is underdeveloped, but has good potential when retail sector develops and packaging standards rise (both for domestic market and for export oriented industries).



Delivered cost of newsprint to Mumbai

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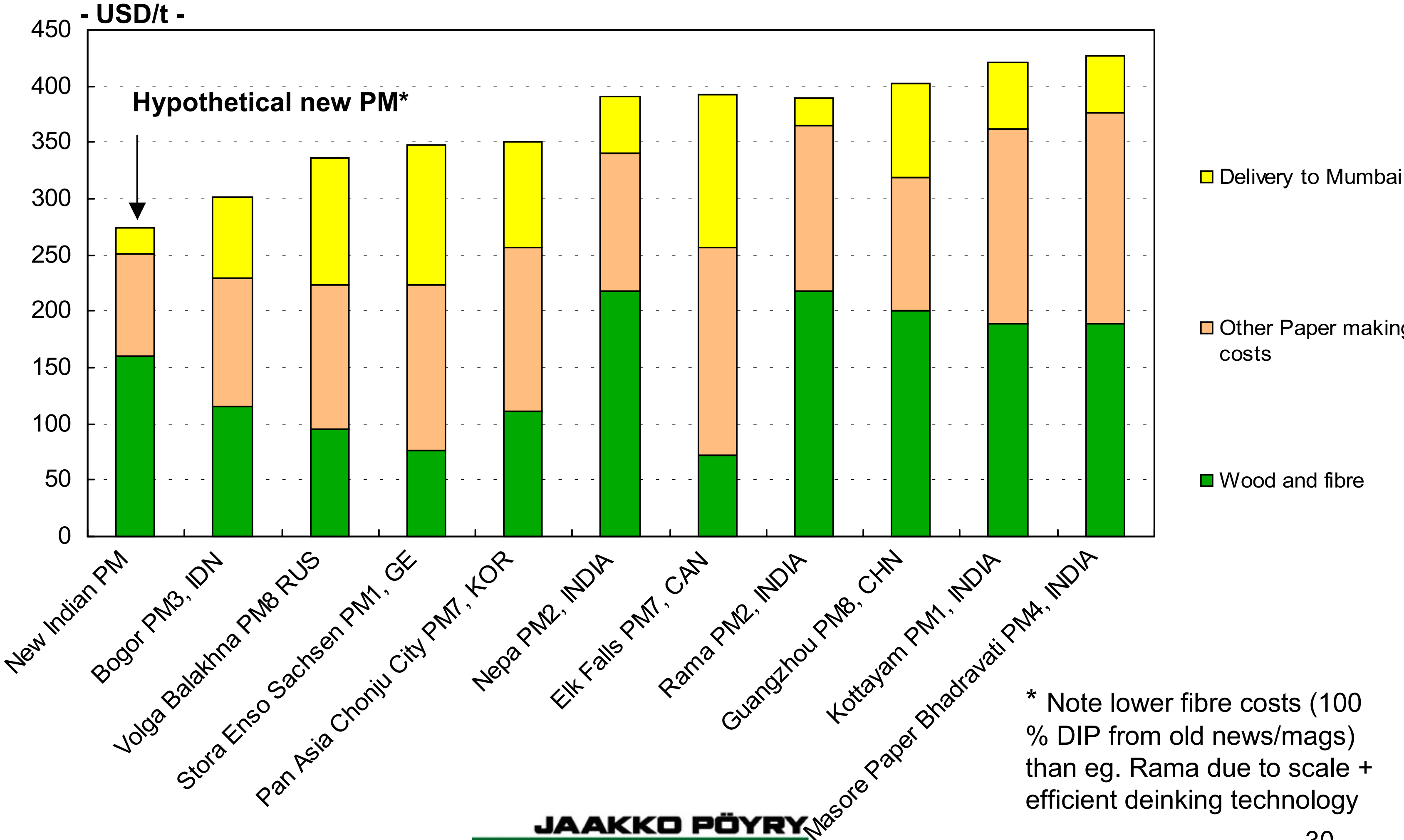
The high fibre costs weaken the cost competitiveness of Indian newsprint producers even at their home market. A new PM (about 200 000 t/a) eg. near Delhi or Mumbai would, however, be very competitive.



* Note lower fibre costs (100 % DIP from old news/mags) than eg. Rama due to scale + efficient deinking technology

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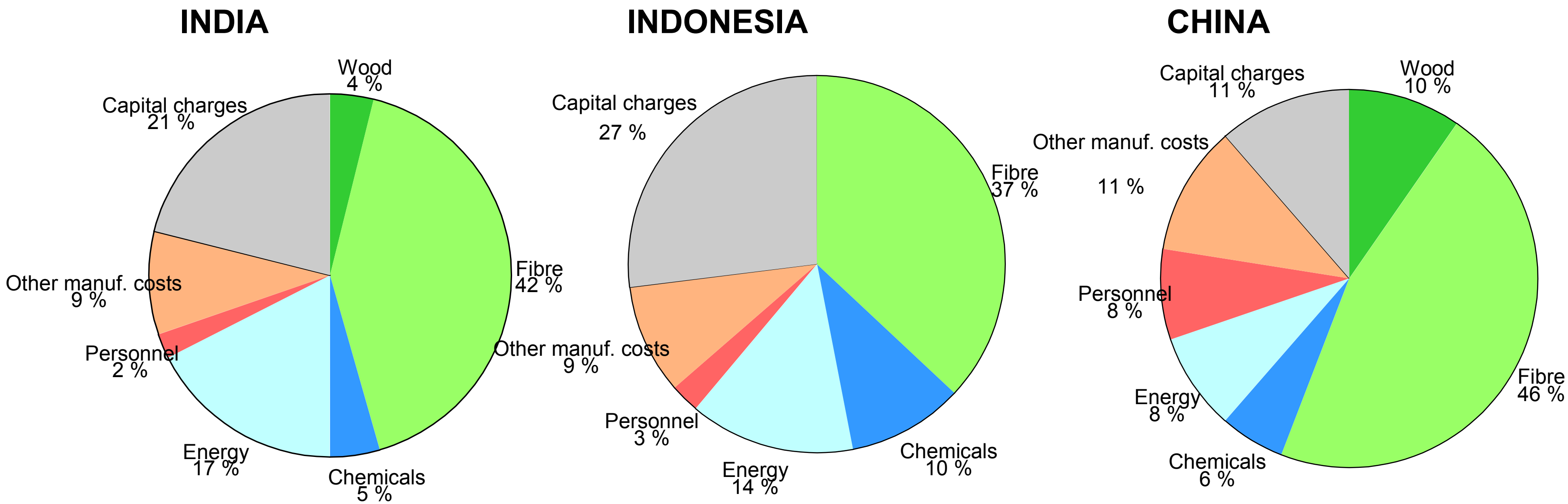
Average costs – Newsprint*



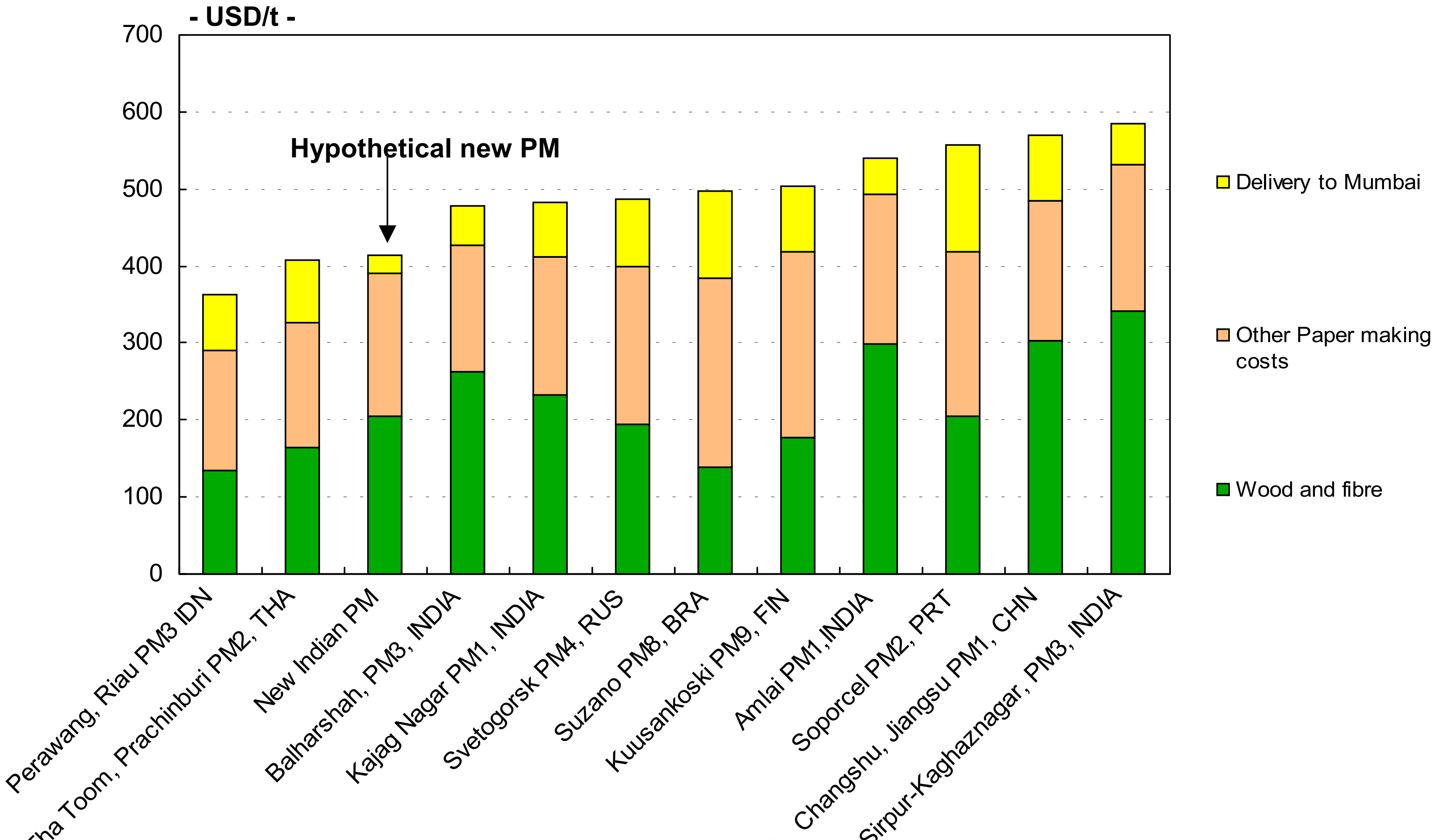
Costs USD/t

	India	Indonesia	China
Wood	17	0	35
Fibre	178	116	166
Chemicals	20	31	21
Energy	75	45	29
Personnel	10	8	28
Other manuf. costs	39	29	40
Capital charges	91	84	41

**For India the cost breakdown is based on six largest PM, but for Indonesia and China the cost are for one typical producer. The chinese mill is relatively old and thus its capital charges are low.*

Delivered cost of UCWF to Mumbai

The currently the Indian producers are cost competitive in their home markets against other than South East Asian competitors. A new modern PM in India (about 200 000 t/a) could compete also with them.



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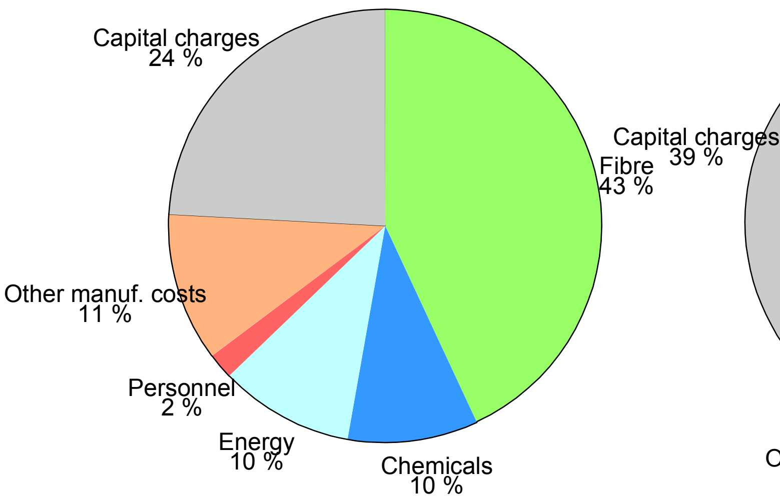
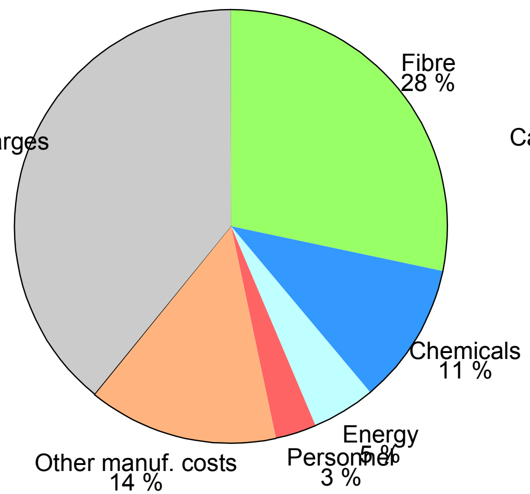
Average costs – Uncoated woodfree*

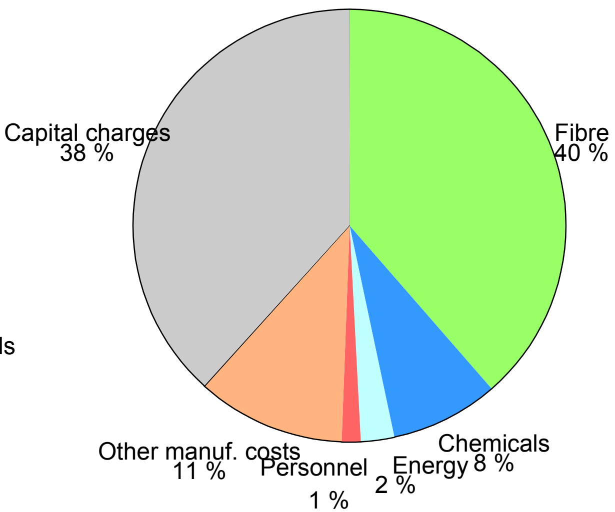
INDIA



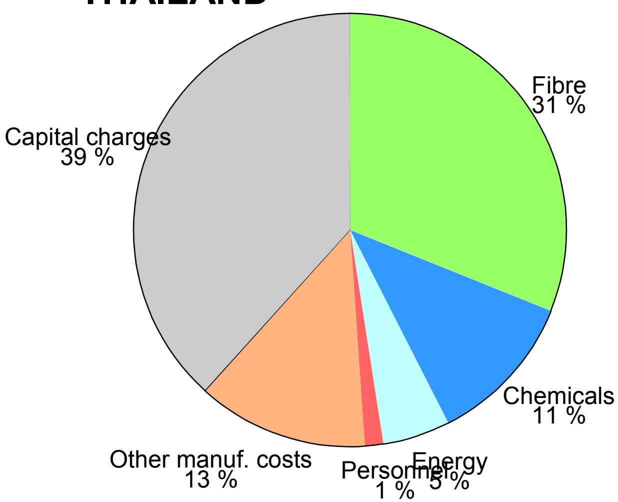
INDONESIA



CHINA



THAILAND



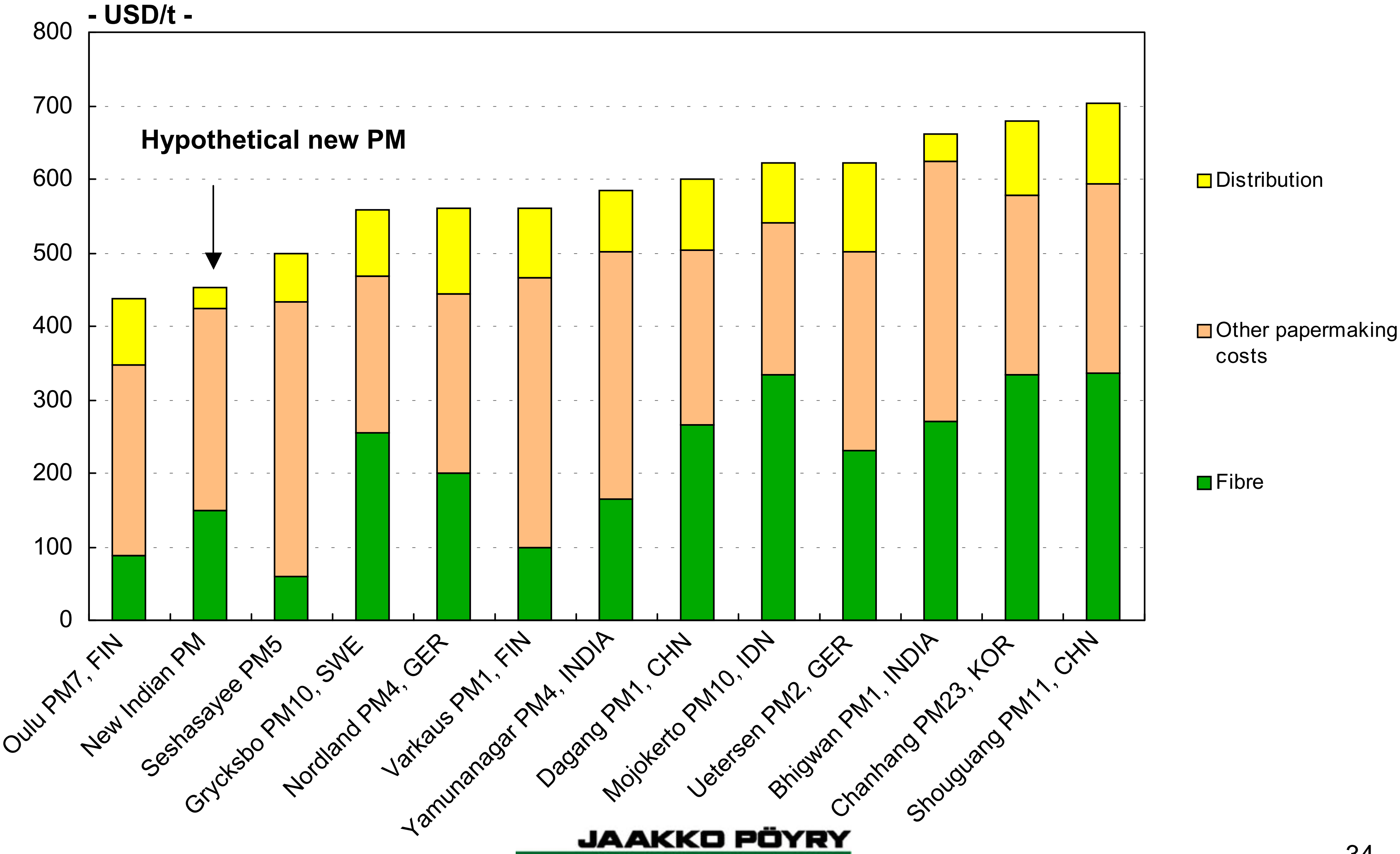
Costs USD/t

	India	Indonesia	China	Thailand
Fibre	235	134	302	165
Chemicals	52	50	64	60
Energy	54	21	19	27
Personnel	10	15	12	7
Other manuf. costs	61	66	87	68
Capital charges	131	185	300	204

**For India the cost breakdown is based on six largest PM, but for Thailand, Indonesia and China the cost are for one typical producer. The capital charges for Indonerisan, Thai and Chinese machines are high due to the recent start-up.*

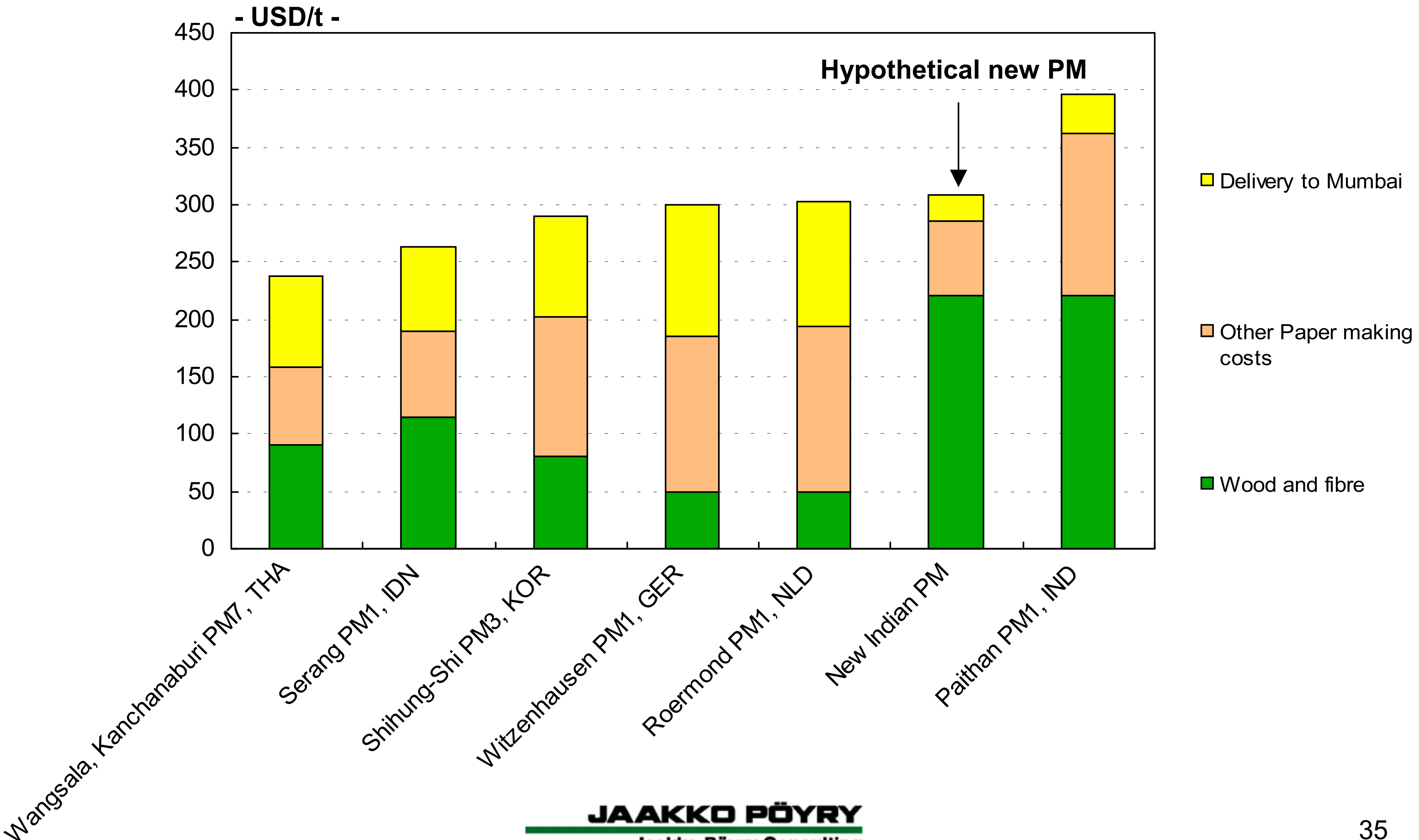
Delivered cost of CWF to Mumbai

The largest Indian CWF machine is cost competitive at home markets. A new modern PM would be very competitive.



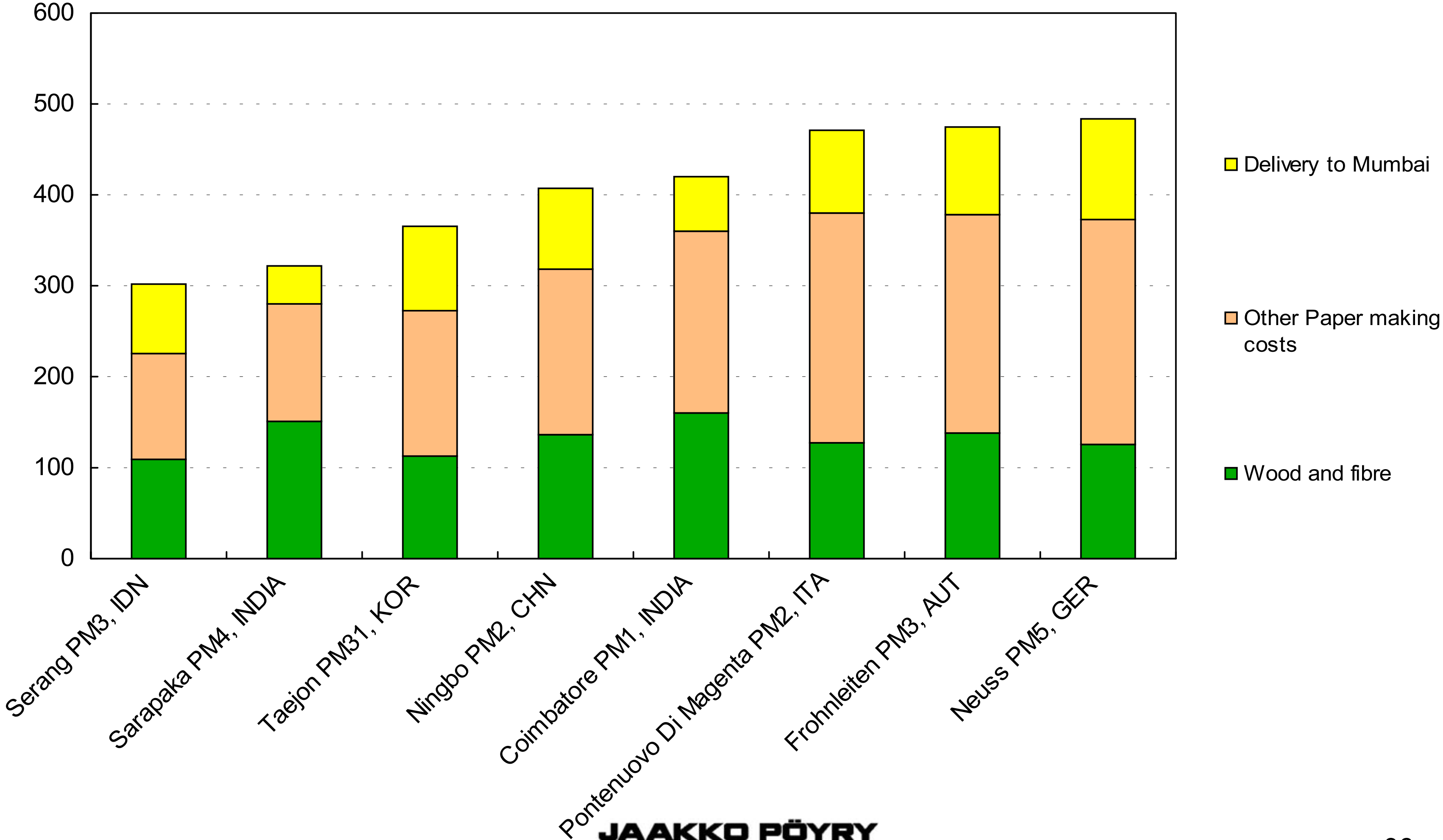
Delivered cost of Testliner to Mumbai

High cost of raw materials combined with small scale production make the estimated cost level of the selected Indian mill fairly high in spite of transport cost advantage. The size of a modern testliner PM in India should be some 270 000 t/a



Delivered cost of WLC/duplex to Mumbai

The best Indian mill reaches low cost level as a result of low processing costs. The mill is integrated, and purchases wood and waste paper, while most of the competitors buy bleached chemical pulp and waste paper.

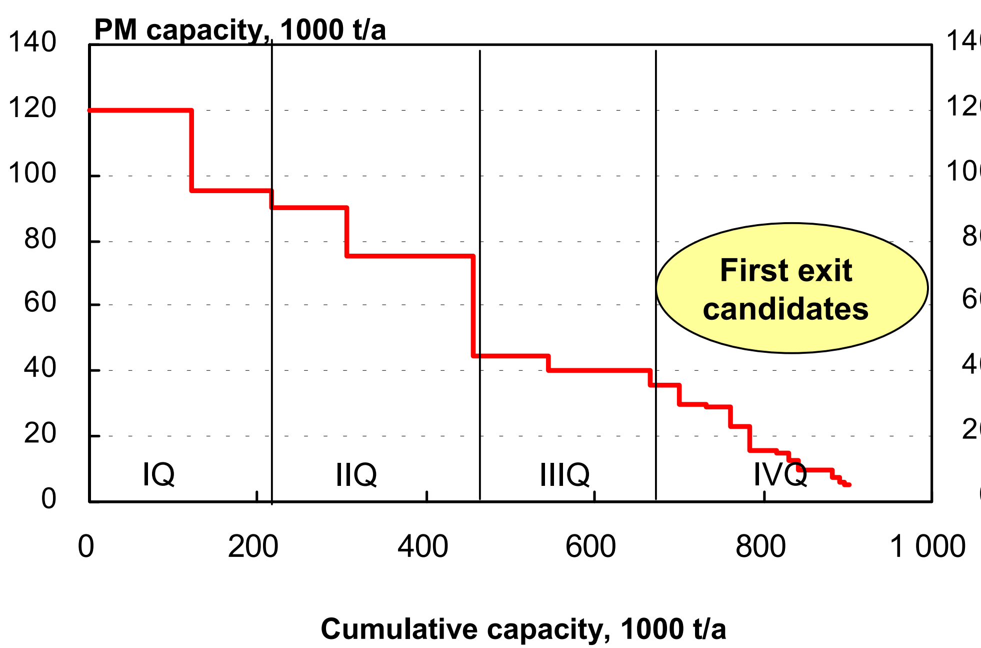


Capacity structure – Newsprint and Pr/Wr

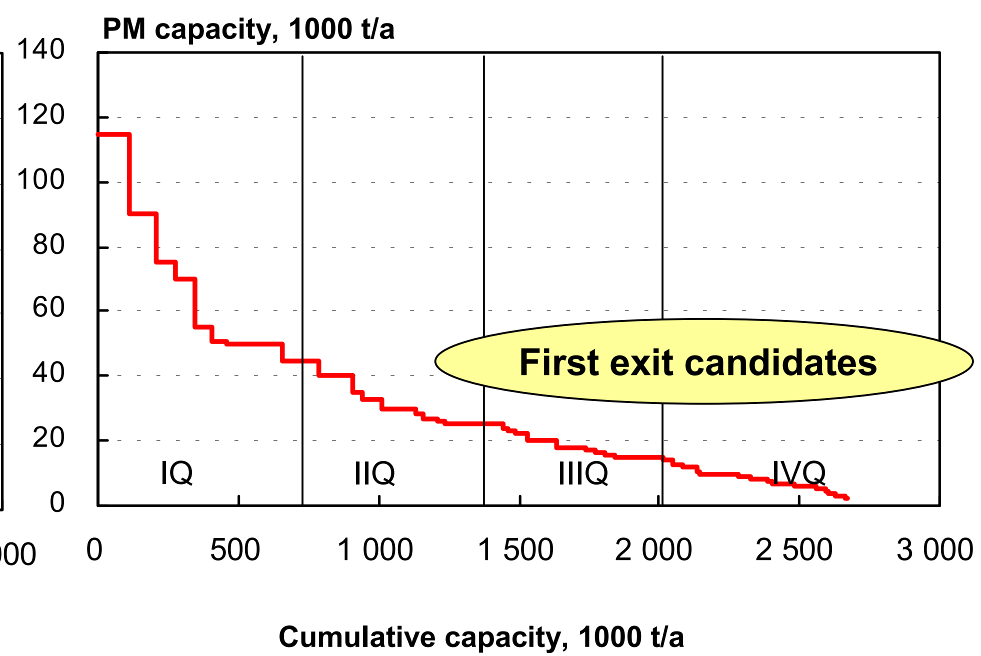
The two largest Indian newsprint machines account for 25 % of the industry and with advantageous fibre sourcing they would have potential to compete against imports in selected local markets. Half of newsprint capacity is on very small machines, which can be considered as shut down candidates in the long term.

In woodfree 75 % of the production capacity is on machines that are smaller than 40 000 t/a. In standard grades these machines have no competitive potential in the long term, for some mills specialisation to higher value added grades may be possible.

NEWSPRINT



WOODFREE PAPERS



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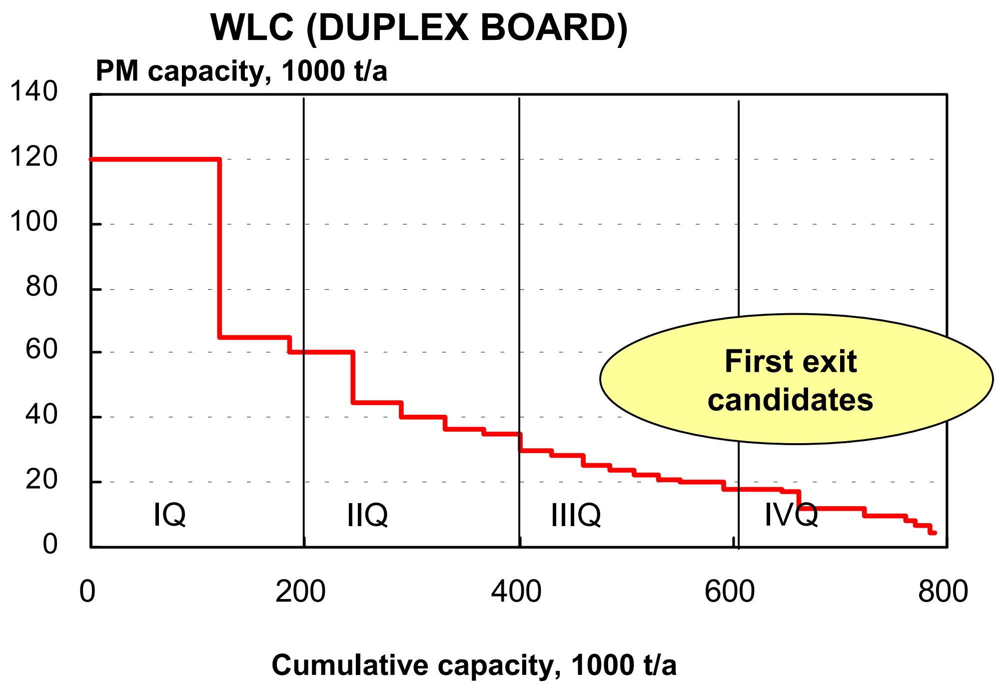
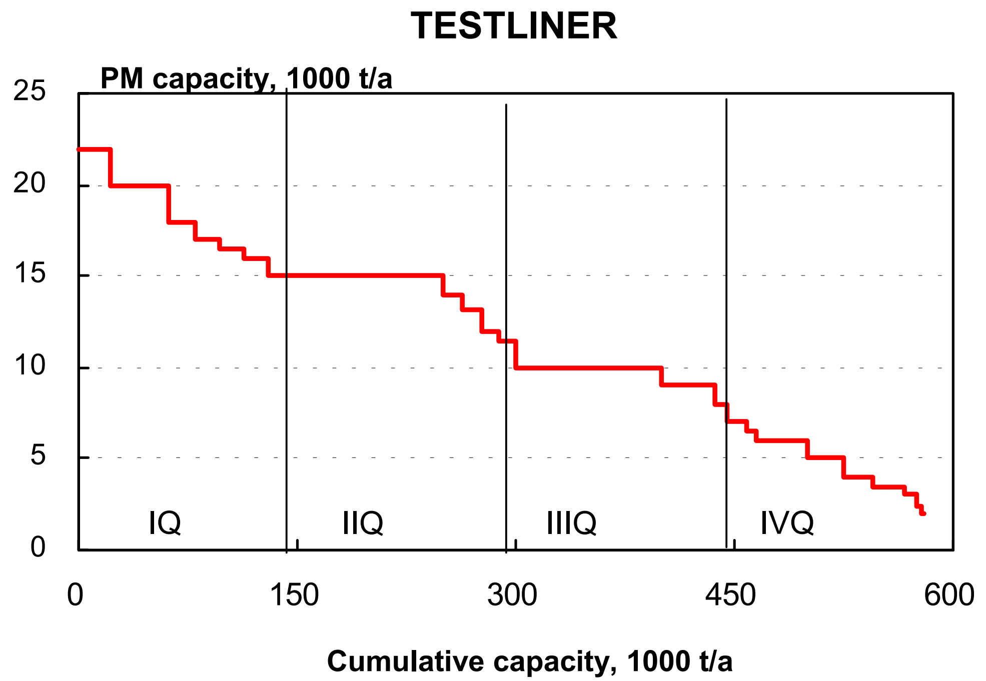
Capacity structure – WLC/duplex board

In boards there is one internationally competitive machine (ITC's Sarpaka BM4), but some 60 per cent of the capacity is on smaller machines than 40 000 t/a.



Capacity structure - Testliner

The Indian corrugated raw material industry is based on very small machines. With this structure and fibre pricing the industry is not competitive, not even in the Indian markets. Thus all the currently operating machines can be considered as shut-down cadidates in the long term. In Indian condition a cost competitive teslinter machine should be over 250 000 t/a.



Import duties and taxes

- Overall import duty for paper and board has declined from 140 % in 1990 to 30 % in 2002
- Joining to WTO will mean further reduction of duties. In China the duties are gradually decreasing.

Import duties for paper in India 1990-2002

	Import duty	SAD	CVD
	%	%	%
1990	140		10 + 1900 INR
1991	110		10 + 2425 INR
1992	85		10 + 2425 INR
1993	65		20
1994	40		20
1995	20		20
1996	20	2	18
1997	20	5	18
1998	25	5	18
1999	30	5	18
2000	30	5	16
2001	35	5	16
2002	30	5	16

Import duties in India and selected countries 2002

Grade	India	China	Indonesia**	Thailand**	Malaysia**	Korea	European Union***
			Import duty %				
Pulp	5	0	0	1-5	0	1-2	0
Waste paper	5	0	0	1-5	0	2	0
Newsprint	5	*	5	1.5	10	2.7	0
Uncoated WF	30	9	0	10	0	3.5	0-1.6
Coated WF	30	11	0	10	5	5	2.4
Liner/fluting	30	10	5	10	15	4	1.6
Cartonboards	30	11	10	10	0-5	3.5	2.4
VAT %	16+4/5 CVD+SAD	17	10	7	10	10	22

* varies depending on C&F price
** preferential duty for ASEAN countries (about 50 %)
*** duty for imports outside EU, free trade within EU
Source: EU market access data base, Custom offices

PM size and speed - economy of scale

Mills and machines are relatively small in India, technology is outdated and quality of raw materials and end products is low.

- Average and maximum mill and machine capacities are small in India. **New machines should be about 50 % of international size**.
- With bigger machines investment costs, production of utilities, effluent treatment and all fixed **costs would be lower per produced ton of paper**. Especially bigger machines can afford better automation (QCS and DCS).
- **High speed machines** (>1000 m/min) are needed for cultural papers and one-layer boards. With a higher design speed, technology and paper quality will be closer to the international standard. Machine width can be less than internationally.
- To be internationally competitive **second hand machinery should be imported very selectively**.
- Machines representing old-dated technology should be **gradually shut down**.
- Mills and machines have to focus on **few grades** to be more effective

Improvement of paper quality

Domestic raw material quality & availability (fibres, pigments and chemicals) must be improved. Level of quality control systems and automation should be better.

- The level of **quality measurement and control** should be better. Cost of automation for a small machine is almost same as for a big machine. Bigger machines can afford better quality control systems (QCS and DCS).
- Classification of products and mills should be based on the customer **requirements** and their **converting processes**. Now the thinking is based too much on raw materials and mill size.
- **Bleaching** sequences should be improved to get the standard ISO-brightness of 89 %.
- **Mills must have export** to be able to improve quality and to meet the international competition and development.
- Indian paper industry needs more **international contacts**, joint ventures, training and applications instead of 100% Indian owned companies and own R&D. Input to **R&D** should be totally (mills and CPPRI) about **1% of turnover**.
- **Internet and mobile connections** from all mills should be working.

Improving raw materials for papermaking

Domestic raw material quality & availability (fibres, pigments and chemicals) must be improved.

- **Plantation trees and recovered fibres** should be favoured over the agro based fibres to be able to improve paper machine speed, runnability, product quality and competitiveness.
- The share of **hardwood sulphate pulp** and **recycled pulp** should be higher to get better paper quality and higher machine speed. Agro based fibre can be mixed up to 25 % of the fibre amount of papers and boards. Mills should be **integrates** of wood/waste and agro based pulping.
- Good quality domestic **carbonate pigment** and **synthetic size** is needed to produce white papers and cartonboards in alkaline conditions.
- The total **amount of pigments** (fillers and coating pigments) should be about double the present level in cultural papers and cartonboards.
- **Cleanliness and order** of all mills should be good to get better efficiency and product quality.

Effluent benchmarking of Indian mills

- Water consumption and effluent flow are high in Indian forest and agro based mills leading to a relatively high effluent load.
- Waste based mills are closer to the international standards but still the loads are almost double.
- Nutrients or total P and total N are also monitored in European mills
- All loads should be controlled and calculated per net air dry finished paper ton.

Effluent by integrated mill type	Flow l/kg	TSS kg/t	COD kg/t	BOD kg/t	AOX kg/t
Indian Agro based mills	120	40	47	10	n/a
Indian Forest based mills	175	11	37	3.7	0.4
European Forest based mills	40	1.5	12	1.5	0.1
Indian Waste based mills	32	2.6	8.7	1.3	n/a
European Waste based mills	10	1.0	5.0	1.0	n/a

Energy benchmarking of Indian mills

- Indian forest based mills consume a lot of steam and electricity, but produce usually all from wood material without any major oil or coal usage or purchased power.
- Indian agro based mills consume considerably less energy but have to purchase about half of the electricity consumption.
- European waste based mills use more energy because deinking process is better and final product cleaner.

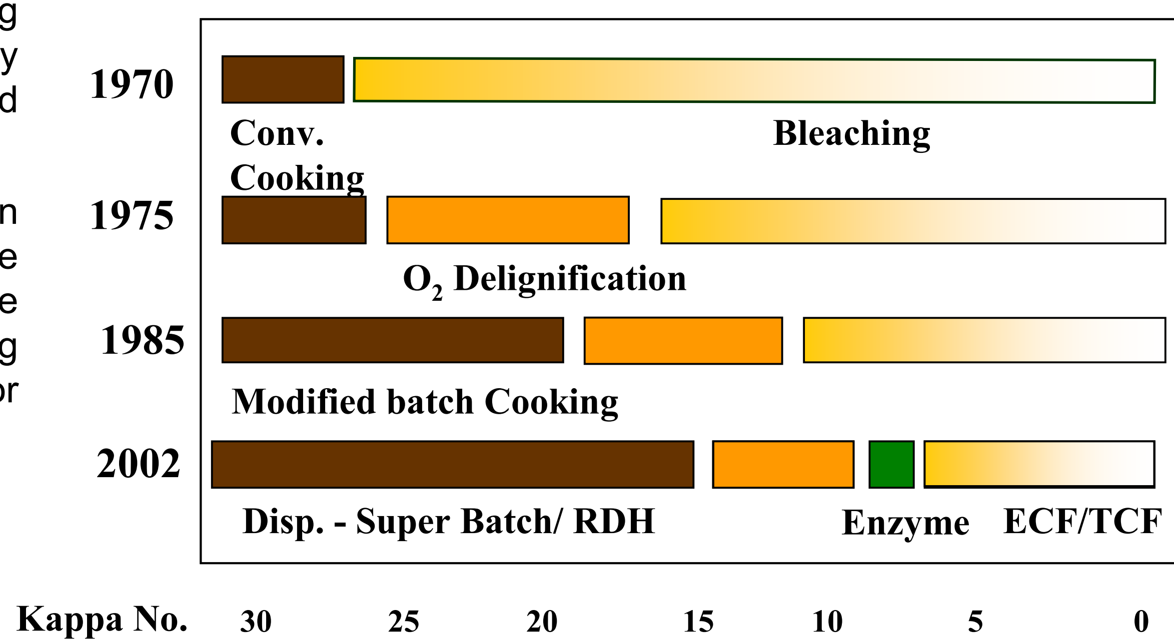
Energy Consumption by integrated mill type	Heat GJ/t	Power kWh/t	External supply GJ/t	External supply kWh/t
Indian Agro based mills	15	1000	0	500
Indian Forest based mills	25	1800	0	0
European Forest based mills	15	1200	0	700
Indian Waste based mills	6	850	5	700
European Waste based mills	8	900	7	900

External supply means based on oil, coal or purchased power

Technology trends in pulp production

- In Europe the move to TCF has almost ceased, TCF is not recommended for India. ECF bleaching gives better pulp, requires less energy and capital, and environmental standards can be met.
- Enzymes are recommended to help bleaching because the original brightness of raw material is low and thus chemical costs are high or final brightness low.
- ECF bleaching and modified cooking methods require so high investment costs that they are not viable investments for small agro based mills.

- So-called ECF-light bleaching using ClO_2 followed by peroxide is recommended method for Indian big mills.
- A considerable reduction in AOX level can only be achieved by closing down the smallest agro based mills using chlorine and hypochlorite for bleaching.



Source: Dr. Kulkarni

SWOT analysis – Indian paper industry

Competitive strengths

– Large and growing domestic paper market
– Some competitive PMs in newsprint, cartonboard and coated woodfree
– Relatively low personnel and fuel costs (although personnel productivity is lower than in many competing countries and the quality of coal varies)
– Up to date research institute (CPPRI)
– Know how in non wood pulping and applications
– Well developed printing industry
– Local market knowledge
– English language

Competitive strength tree should be protected and nurtured

SWOT analysis – Indian paper industry

Competitive weaknesses

– Fibre shortage, especially virgin wood fibre

– Small and fragmented industry structure, many non competitive mills/machines (both quality and cost wise) + fragmented market

– Highly skilled and job specific manpower is not available

– Quality and availability of some of the domestic pigments and chemicals

– Environmental problems of most of the small pulp mills and also some big mills

– Low level of internationalisation of the industry

– Low standard of converting industry

– Infrastructure, transportation

– High cost of raw material including wood, non wood and waste paper

– High energy costs (from grid)

– High cost of financing

– Lack of local capability for design and development and machinery manufacture + process control systems

– Obsolence of technology, quality targets are not met by many mills (eg. newsprint produced by small mills)

– Impact of high local taxes (sales tax, entry tax, etc.) on inputs of paper

– Low input into mill level R&D

The competitive weakness tree should be felled and the roots dug up

SWOT analysis – Indian paper industry

Competitive opportunities

- Enormous domestic market potential
- Modern, world scale paper machine would be cost competitive in most grades
- Forest plantation potential
- Development of the industry cluster on broader basis (including paper industry and related industries:machinery + chemicals) based on FDI and use of local personnel
- Integrates of combined wood and agro based papermaking
- Market DIP mill
- Increasing use of carbonates and fillers
- Government literacy program – increasing demand for printing/writing papers
- WTO: foreign participation/FDI would speed up restructuring
- Low labor costs (allow eg. cost effective sorting of imported mixed waste)
- Back haul possibilities for containers to lower waste paper transport costs
- Export potential

An opportunity tree to be climbed from bottom up

SWOT analysis – Indian paper industry

Competitive threats

- Unprepared mills for international competition (WTO entry) both on price and quality
- Decline in capacity due to environmental pressures
- Decline in capacity as some of the segments/group of mills are unable to compete at national and international levels with respect to quality and cost of products.
- Short term planning for raw material
- Fragmented market makes entry for a world scale unit difficult
- Delayed forest plantations, deficit of wood fibres
- Lack of international perspective in project development and implementation
- Capacity of announced projects is small considering market growth – will speed up import growth
- Weakening competitiveness of domestic industry due to shortage and cost of basic inputs
- Perceived difficulty of operating environment reduces the speed of FDI

A tree with serious consequences

Action plan for Government and industry

Generic issues	Government	Industry
Wood availability	Revision of Forest Policy so that plantations can be increased Forest policy should be revised to have corporate involvment in the plantations of degraded forest lands. Small percentage (eg. 5 %) of degraded lands to be converted as ”production forests” Degraded forest lands should be identified by State Governments and be offered to industry on long leases for plantations.	Cooperation with farmers and State Forest Departments Search for foreign partners Evaluate possibilities for wood imports
Waste paper availability	Allow duty free imports of waste paper Do not introduce recycled content quota type legislation Encourage voluntary agreements to increase paper recovery	Aim for long term contracts with printing/converting waste Global sourcing, foreign partners Sorting of imported mixed waste Market DIP close to ports Fibre fractionation to separate long fibres
Agro fibres	Bagasse should be preferably given for paper industry. Equal subsidy should be made available to paper industry at par with energy subsidy of bagasse. Funds for technology development	Restructuring needed due to quality and environmental reasons Develop pulping and papermaking technology based on non wood fibre

Action plan for Government and industry

Generic issues	Government	Industry
Financing	Financing costs typically 13-14 %/a (in Europe clearly under 10 %). Libor 1.75%. Allow duty free imports of new and second hand machinery/equipment for technology upgradation	Better access to international financing Seek for foreign partners
Infrastructure	Improvement of key ports, roads and railway (will benefit all industries) Better mobile and internet communication	Location of mills close to ports or fibre sources (especially agro fibres)
Energy policy	Better availability and quality of coal. Possibly privatisation of coal to reduce coal price? More uniform energy policy gy States	Co-generation in pulp and paper mills
Research and development	Closer cooperation with CPPRI and industry in promoting application oriented R&D. Facilitate closer cooperation with other Asian countries. Encourage cooperation and networking inside the forest cluster and other industries to make the sector more competitive R&D funding shoud be increased to 1 % of turnover primarily through funding by industry.	Focus on R&D to improve quality and to meet customers' requirements More and closer international connections Closer cooperation and interaction between CPPRI and industry
Small scale paper industry policy	Ensure fair competition between different mills regardless of fibre base and size Easier exit policy, BIFR filing, labour policy	Specialisation and change of fibre base to waste paper/market pulp, where possible
Export potential	Rise export incentives for paper industry at the same level as for other industries (DEPB), bring all paper varieties under one nomenclature. Infrastructure improvement to reduce cost/time taken for transportation to/handling at ports	Quality improvements needed Export marketing network development

Action plan for Government and industry

Generic issues	Government	Industry
Taxation	Uniform excise duty policy regardless of paper mill size should be the long term objective. Existing concessions should be time bound. Newprint, newspapers and educational books are free of excise duty, which is normal in many countries Tax holidays for export oriented investments/FDI and tax incentives for companies operating in Free Trade Zones are already used. Accelerated depreciation to partially migitate high capital intensity	
Literacy	Continue free educational campaigns to increase literacy levels	
Environmental policy	Follow global norms and standards. The first step should be to enforce existing norms uniformly. Improvement of norms and standards progressively towards global norms. Uniform policy as regards to non-biodegradable materials (e.g. ban of plastic bags in certain States) Eco labelling scheme based on sustainable raw material base (wood/ waste paper/agro) and environmentally friendly processes	Bigger mills and modernisation to meet environmental standards Closure of small unviable mills Actively participate development of Eco label schemes so that industry's interests can be taken into consideration

Action plan for Government and industry

The industry should focus more on customer needs and quality than fibre base

Paper grade related issues	**Government**	**Industry**
Newsprint	Imports of newsprint without duty or minimal dutry is common in many countries. Tighter control that papers used for other purposes are not imported under newsprint. Duty free imports of waste paper	Improve quality (eg. brightness and smoothness) to meet import competition, use more recycled fibre Seek for foreign partners
Printing/writing papers	Important customer due to central purchasing of paper for textbooks, etc.	Location of mills close to ports or fibre sources (especially agro fibres) Improve quality and invest in high speed machines
Corrugating materials	Promote forward integration, this would help industry to get more waste paper from converting waste and to improve customer oriented product development Duty free imports of waste paper	Restructuring needed for board production (today small and non competitive units) Foreign partners and imported OCC Increase forward integration
Duplex board	Duty free imports of waste paper	Aim for higher quality coated boards
Tissue paper	Small but growing sector, likely for FDI's Promote forward integration	Seek for foreign partners (know how, investments, etc.)

Management practices

Indian mills are increasingly adopting ISO 9000 and ISO 14 0000

Practice area	Objectives	Current state and development needs
Marketing management	Marketing planning, organisation, implementation and control	Large companies have adequate marketing organisation for domestic sales. Experienced export managers are needed when exports start to grow Demand growth and international competition will create new challenges for marketing management
Quality management	Ensure even and high quality of production and deliveries	Quality variations are still one of the main problems of most mills. Raw materials, technology and machinery must be improved.
R&D management	Research and development, product/quality testing, finding new products and technologies Focus on applied R&D	Large companies have R&D departments and laboratories for testing. Calibration of measurements needs to be improved. R&D costs shoud be about 1 % of turnover. Both industry and company wise R&D is needed.
Inventory management	Optimise inventory investments, important function in India, where long delivery times of raw materials, spare parts, etc. are common.	Large mills have more developed systems. Just-in-time system difficult to apply in India due to infrastructure. Becoming more important due to increasing competition and growth of company size.
Financial management	Financial planning and control. Minimise capital costs, currency exchange risks, maintain profitability and cash flow. Investment financing.	Importance of financial management will drastically increase in line with the industry growth, mill size expansion, modernization of technlogy and entry to WTO.
HRD	Human resource recruiting and development. Training for new international applications.	Large mills have on going training processes like TPM (Total Production Management). Growth of industry will increase the need for qualified personnel at all organisational levels and in all functions.

Short and long term strategies

For industry improvement

Short term

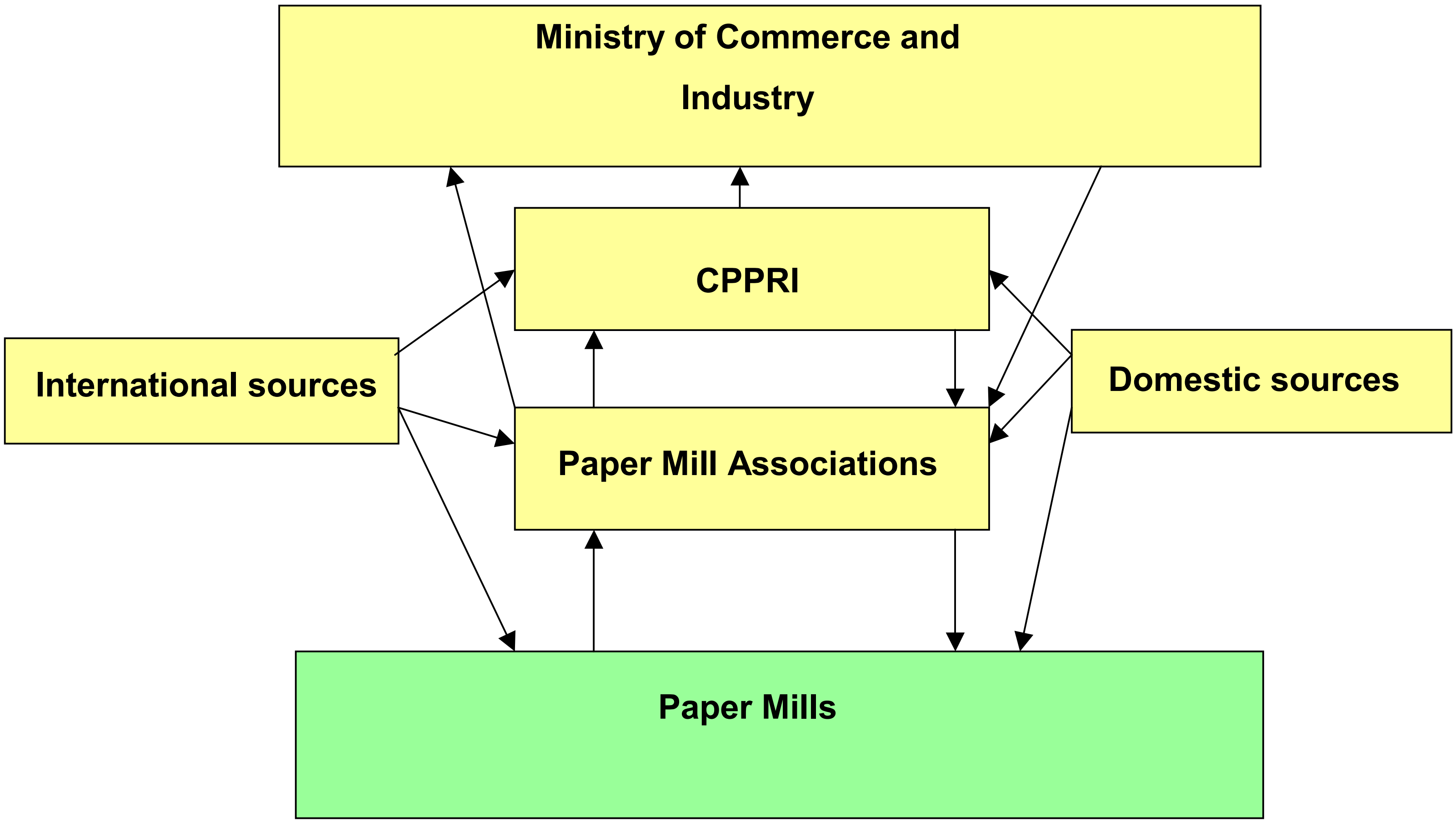
– Import of waste paper without duty + development of domestic recovery systems
– Increase plantations (possibly 100 % FDI) – will take 7-8 years to grow – review raw material policy and agree on reforestation. Possible incentives for forest plantation establishment could be a combination of the following actions
    – allocated degraded forest land for industry for plantations, and charge later based on cuttings (eg. 2-3 USD/m3)
    – tax deductions/partial reinbursement of plantation costs for industry
– Increase of fillers and pigments in paper production
– Adapt international best production and process practices
– Develop policy for whole forest industry cluster including machinery and chemical suppliers + converting and end user industries
– Review overall policy and ensure consistency of all intervening regulations in line with the cluster approach

Long term

– Industry restructuring and consolidation – will ensure competitiveness also during international recessions
– Full utilisation of plantations
– Large scale and cost competitive mill investments (possibly with foreign partners)
– Global expansion of sales in large scale
– R&D
– Integration/combination of wood/agro/waste paper as fibre raw materials

Monitoring mechanism – information flow

Aim of the monitoring mechanism is to help Government and industry to follow changes in the operating environment and the implementation of action plans. Ministry of Industry/CPPRI and Paper Mill Associations may also consider a joint team/task force to enhance especially the collection of international information



Monitoring mechanism – key participants

Ministry of Industry and paper industry should jointly agree on key policy changes and new investments. This mechanism should improve the interaction between R&D and pro active role of the industry.

CPPRI's expertise and facilities should be increasingly used for the benefit of the industry.

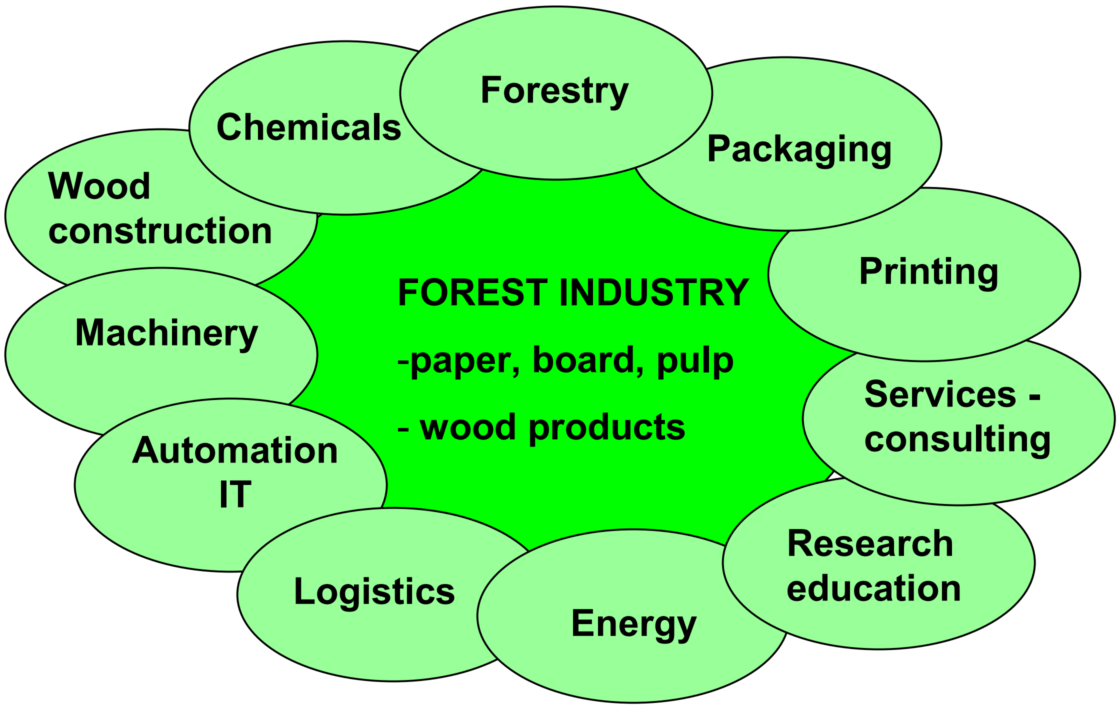
Participant	Key activities
Ministry of Industry	Follow changes in key monitorables and results of the action plans eg. on a monthly or quarterly basis.
CPPRI	Report Ministry of Industry of the changes in key monitorables, and give feed back to the industry
Paper Mill Associations	Collect key information of the mills on production, operating rates, investment plans, etc. Give feed back to the mills
Paper Mills	Inform Associations about the mill performance

Monitoring mechanism – key monitorables

Monitorables	Sources	Information
International pulp and paper prices	International sources like FOEX index, paperloop, etc. from internet	International price levels and price changes
International investments , capacity and ownership changes	Trade journals, internet	Changes in global competition
Indian production of pulp and paper	Paper companies	Monthly production of pulp and paper Operating rate of the industry Financial performance
Imports and exports in India	Customs statistics, paper companies	Monthly imports and exports (volume and value) of pulp, waste paper and paper grades
Domestic prices	Paper companies	Domestic prices + comparison with import/international prices
Unit costs	Paper companies	Changes in raw material, energy, labour, etc. costs.
Investment and shut down plans in India	Paper companies	Future capacity changes
Others affecting the operating envrionment of paper industry	Paper companies/outside sources	Changes in eg. legislation affecting the industry, etc. should be reported when necessary

Forest industry cluster

Focus on the development of the whole forest industry cluster would benefit all parties



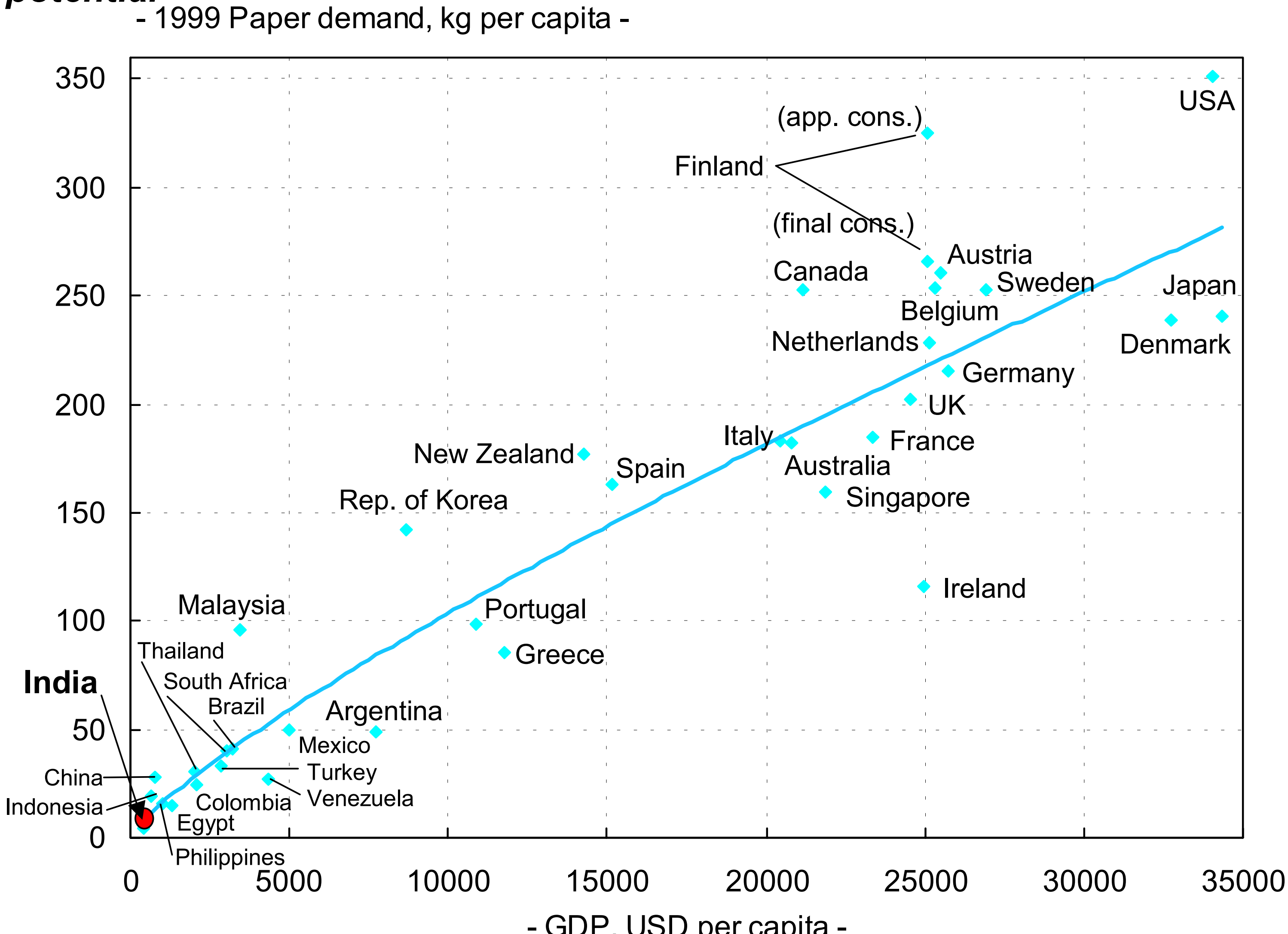
1. Demand Forecasts

1.1 Global Demand Outlook

GDP and paper demand per capita

Project Number 52A0087

Paper consumption is correlated with economic growth – India has a huge growth potential



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Main driving forces affecting

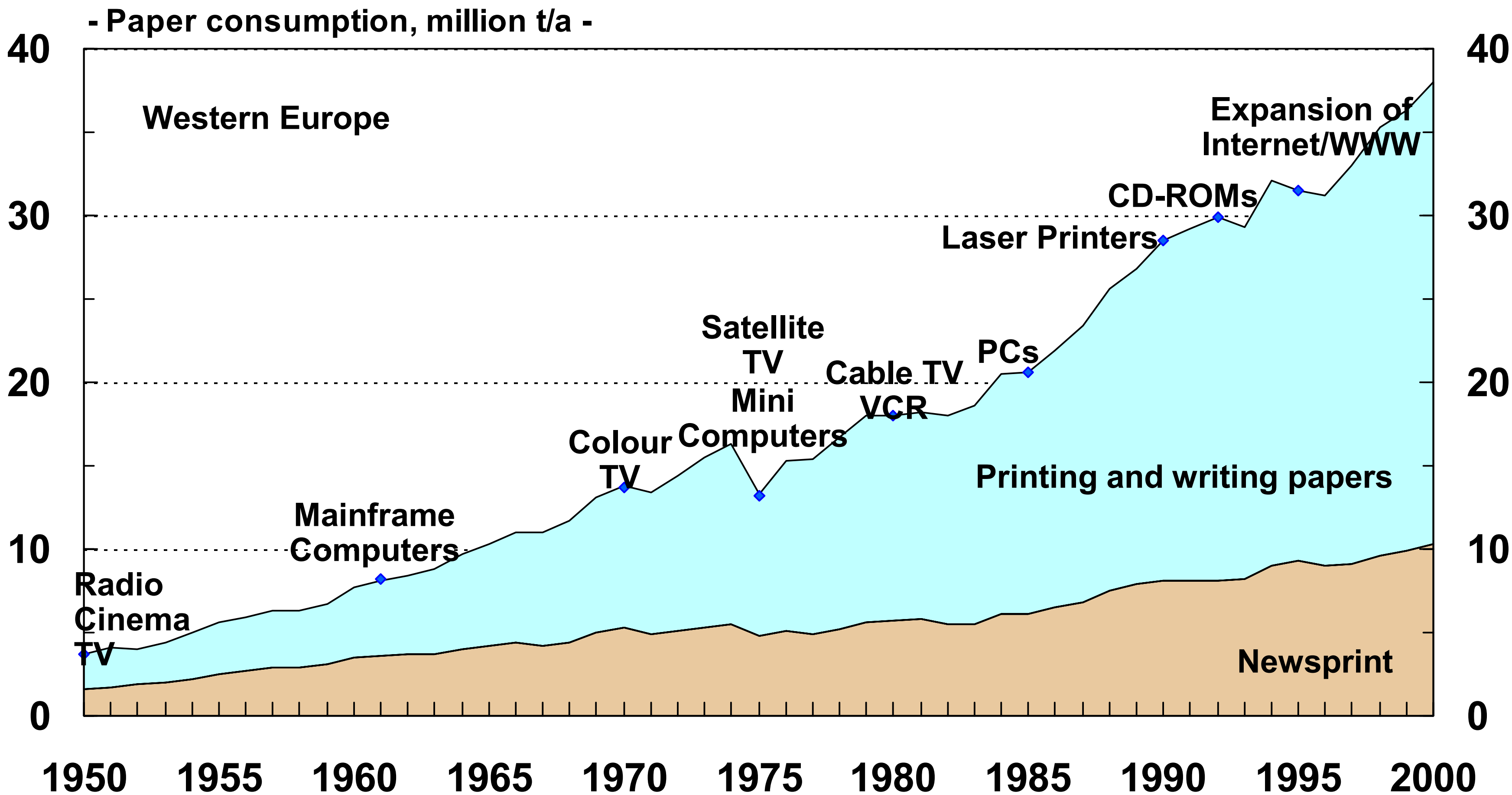
The demand for paper and board

	Primary effect on: Newsprint and Printing and Writing Papers	Primary effect on: Packaging and Industrial Grades
Demographic Factors		
• Population (growth)	√	√
• Age structure	√	√
• Urbanisation		√
• Number of households	√	√
• Literacy rate	√	
Economic Development		
• GDP	√	√
• GDP per capita	√	√
• Disposable income	√	√
• Industrial production		√
• World trade		√
Advertising	√	
Communication Technology		
• Printing technology	√	√
• New electronic media	√	
• Office technology	√	
Environmental Issues	√	√
E-commerce	√	√

Newsprint and pr/wr paper consumption

The Proliferation of Electronic Media 1950 - 2000

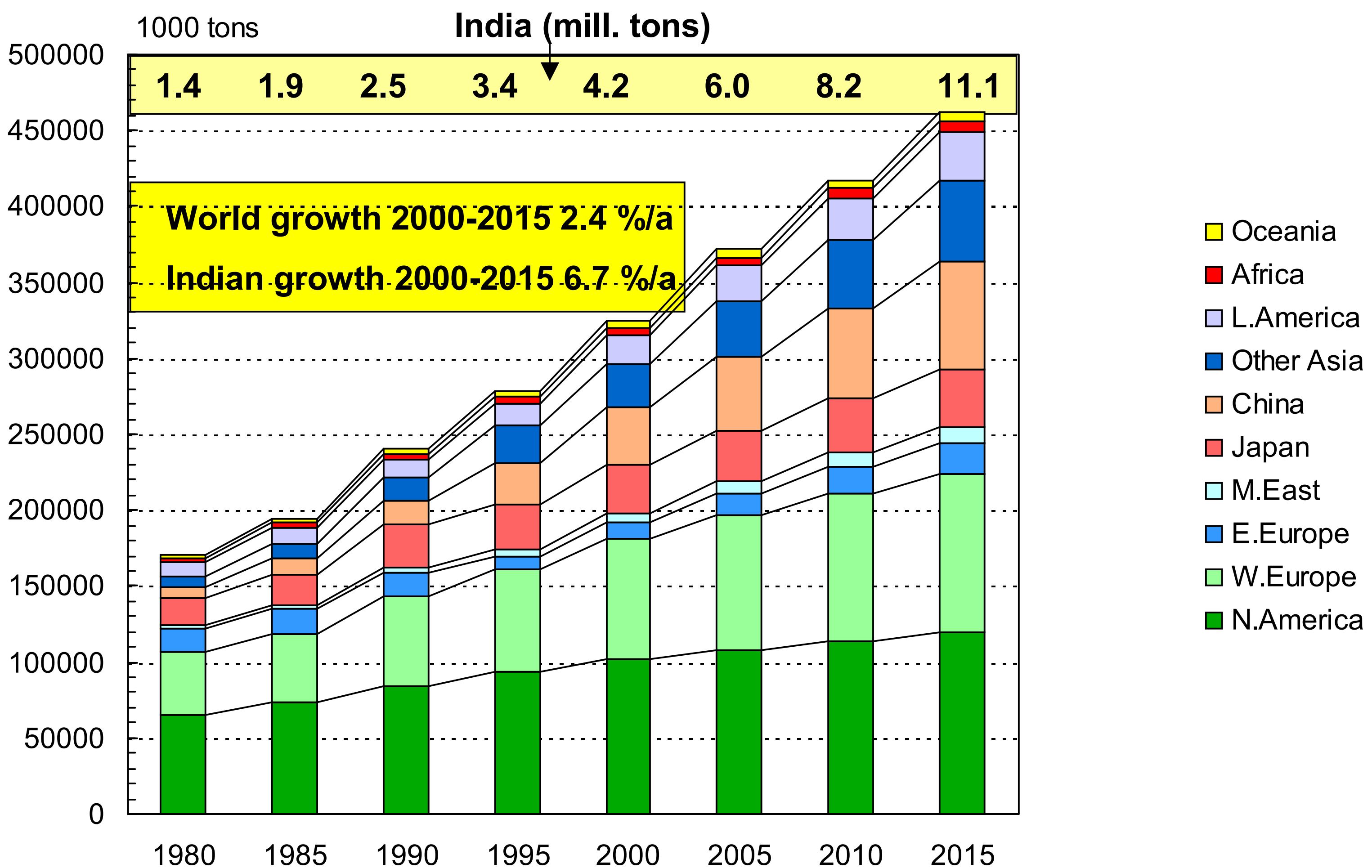
Electronic media has had positive impact on paper consumption



World demand for paper and board up to 2015

Project Number 52A0087

World demand for paper and board is expected to grow to over 450 million tons by 2015. China/Asia will have the fastest growth.



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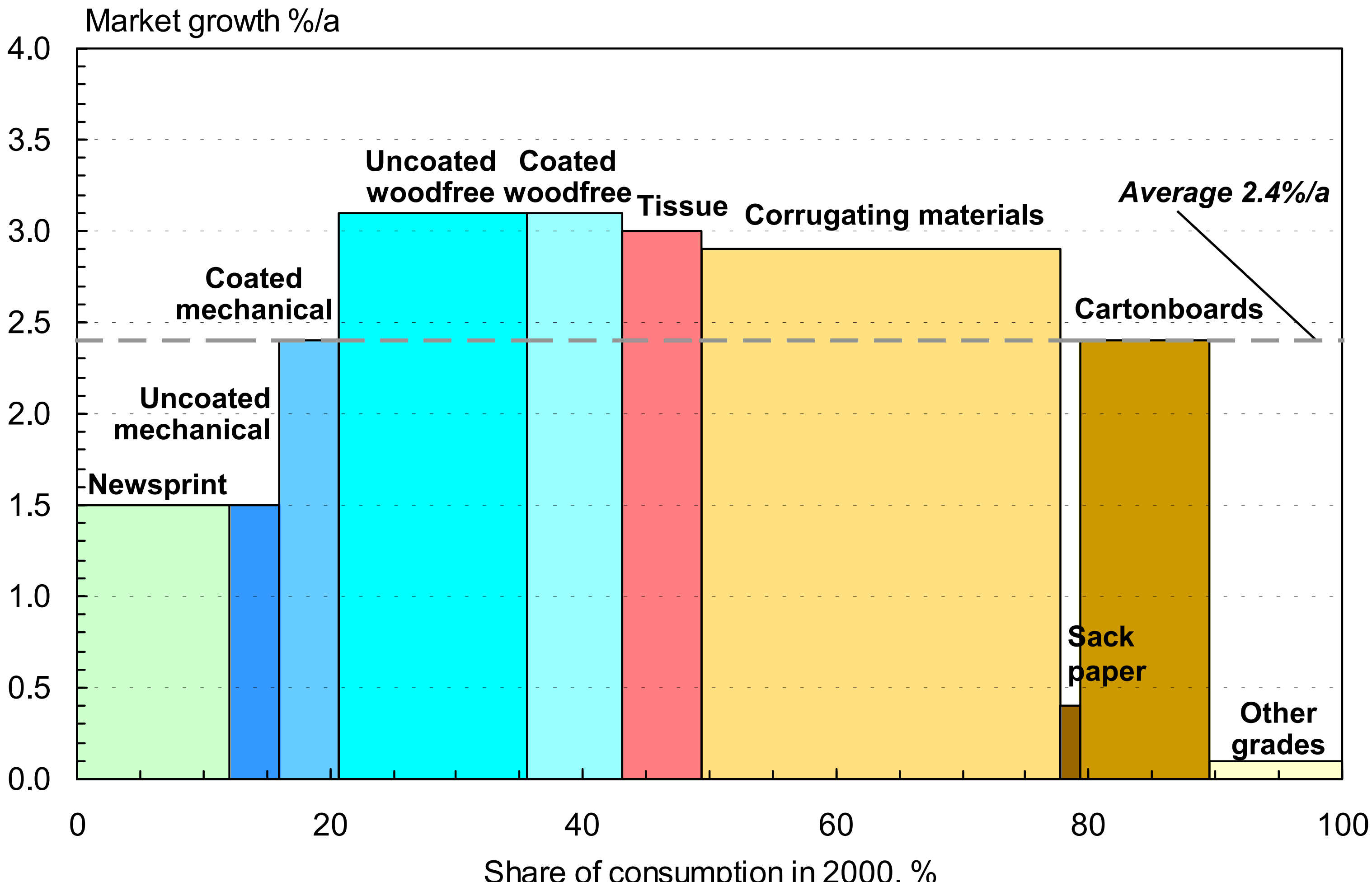
World demand for paper and board

Project Number 52A0087

2000 - 2015

Demand for printing and writing papers, tissue and corrugating materials will grow fastest



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1.2 Indian Demand Outlook

Current paper market

The consumption of paper and board in India was 4.2 million tons in 2000. India is a major net importer of newsprint. The main grades exported are woodfree printing and writing papers and cartonboards.

Paper market in India 2000

	Production	Imports	Exports	Consumption
		1000 tons		
Newsprint	456	388	0	844
Printing/writing	1530	60	60	1530
- Uncoated mechanical	0	35	0	35
- Coated mechanical	0	5	0	5
- Uncoated woodfree	1315	15	20	1310
- Coated woodfree	215	5	40	180
Tissue paper	30	8	0	38
Corrugating materials	806	8	0	814
Cartonboards	828	0	30	798
Sack/kraft paper	50	0	0	50
Others	150	6	15	141
Total	**3850**	**470**	**105**	**4215**

Paper consumption – past development

Since 1980 Indian paper consumption has grown 5.7 %/year (2.8 million tons in total), Indian per capita consumption is still below the main Asian countries.

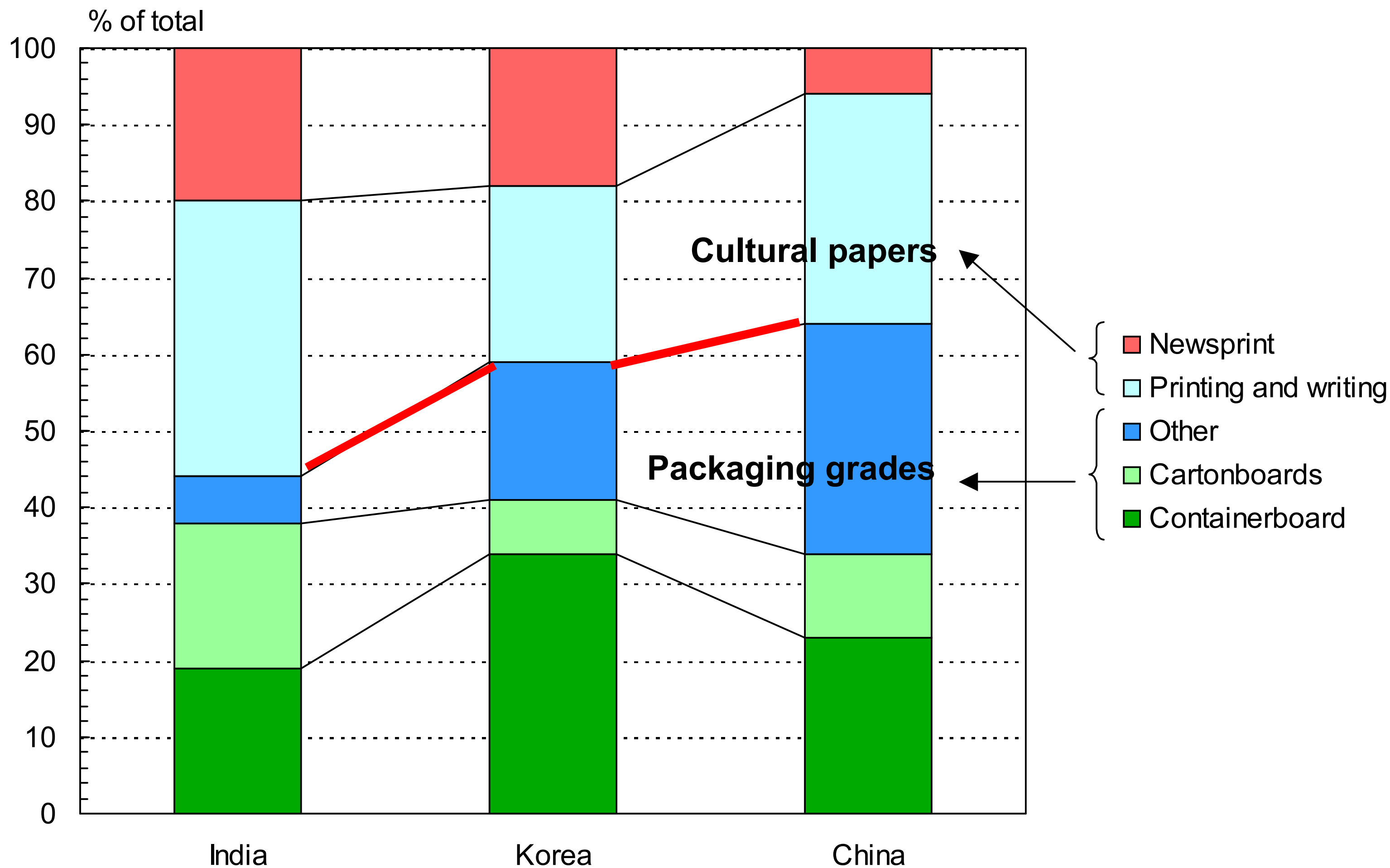
Indonesia and Malaysia have had the fastest growth of consumption in the region, volume growth has been highest in China.

Paper consumption in India and selected Asian countries 1980-2000

	1980	1990	2000	Growth 1980-2000 %/a	Mill. tons	Per capita kg 2000
India	**1379**	**2525**	**4215**	**5.7**	**2.8**	4.2
China	6777	15592	37290	8.9	30.5	29.1
Mainland China	6205	14429	36154	9.2	29.9	28.4
Hong Kong	573	1163	1136	3.5	0.6	167.0
Indonesia	512	1371	4386	11.3	3.9	20.8
Rep. of Korea	1533	4376	7385	8.2	5.9	156.2
Malaysia	317	924	2240	10.3	1.9	96.3
Philippines	453	698	1087	4.5	0.6	14.2
Singapore	263	459	686	4.9	0.4	170.7
Taiwan	1414	3360	5067	6.6	3.7	228.5
Thailand	475	1190	2320	8.3	1.8	37.2

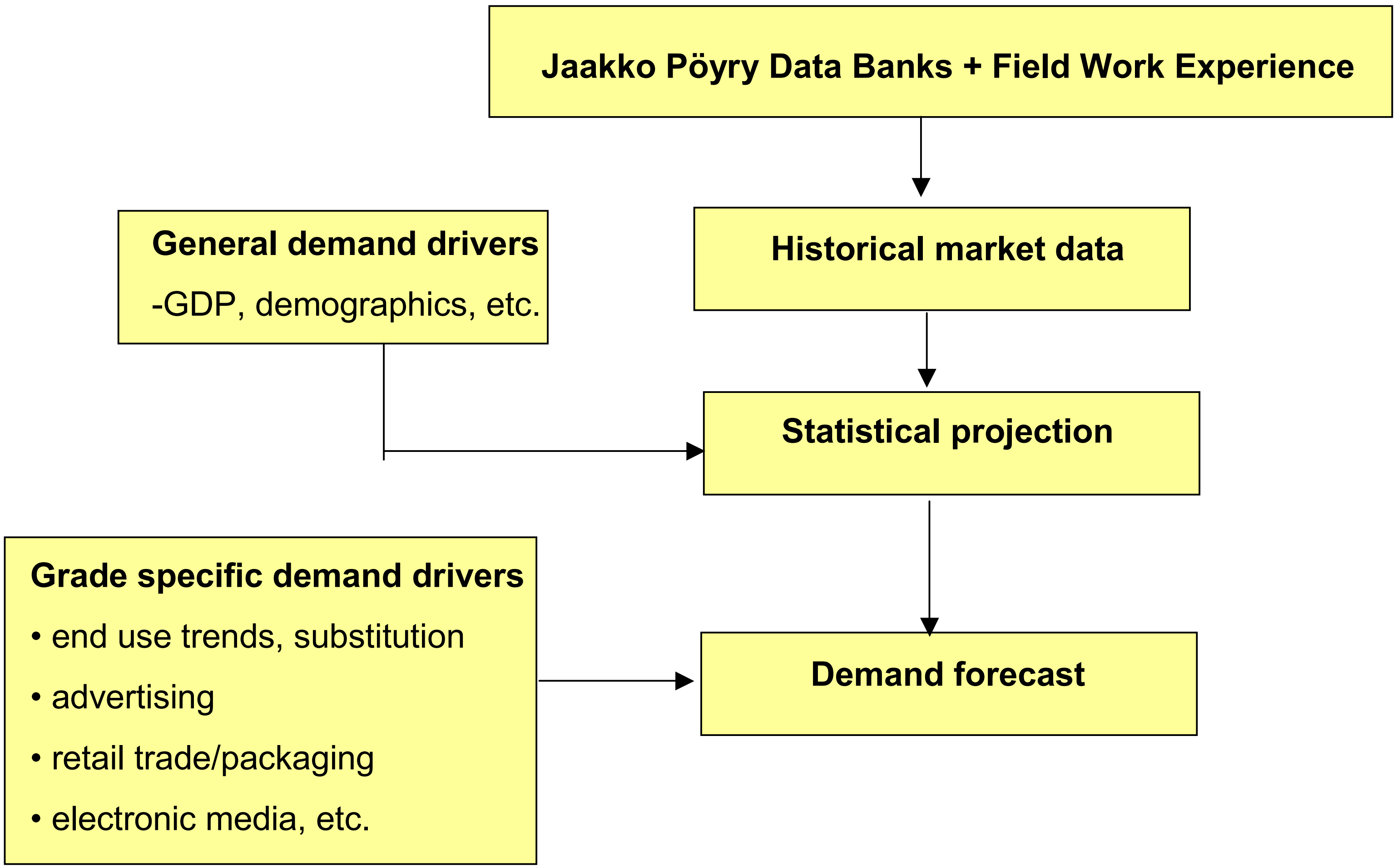
Paper consumption structure 2000

In India the share of packaging grades is smaller than in Korea and China. In the future the share of packaging grades will grow in India (growing packaging standards, export oriented industries using good quality packaging)



Demand forecasting methodology

Jaakko Pöyry demand forecast is a combination of statistical projection combined with end use analysis



Basic assumptions for demand forecasts

The following are the most important demand determinants for paper and paperboard in India:

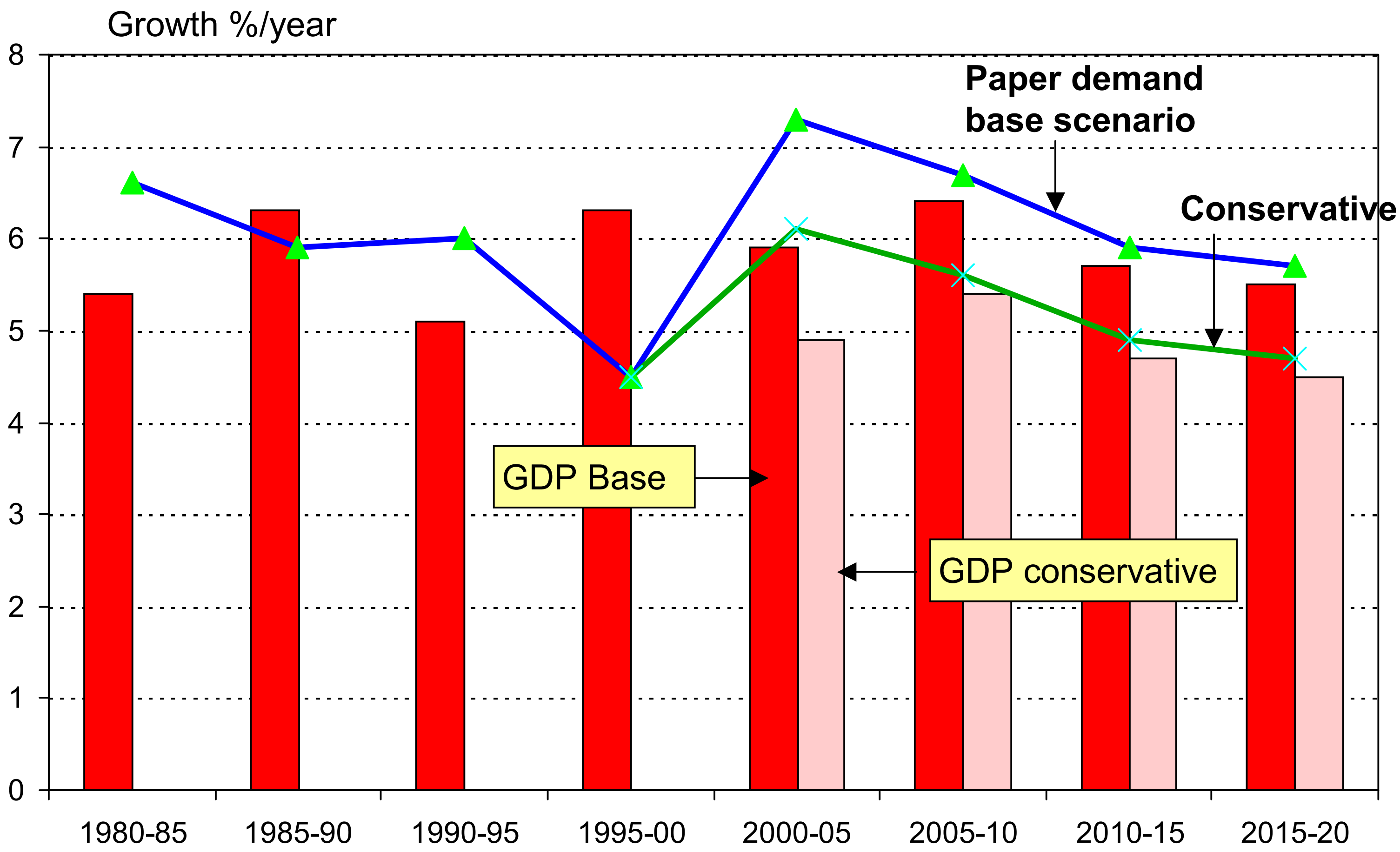
- India's population is forecast to grow from 1 billion in 2000 to 1.15 billion by the year 2010, corresponding to an average long-term growth rate on 1.4 %/a.
- The long term growth of GDP is expected to be about 6 %/year (base scenario) and about 5 %/year (conservative scenario).
- The emerging middle class in the country will change the overall consumption habits in India with favourable impacts on paper and paperboard demand.
- The manufacturing and export sectors are expected to grow even faster than the economy in general, vigorously increasing the demand for packaging materials with more emphasis on the quality of packaging.
- The literacy rate in India has been steadily growing (52 % in 2000), although it is still below the Asian average.

Impact of paper substituting technologies

Paper grade	Substituting technology	Impact on paper demand in India
Newsprint	Television Internet	TV advertising growing faster than newspaper advertising Has reduced classified advertising in newsprint in Europe and North America. No major impact in India in the medium term due to low internet penetration
Printing and writing	Office technology/internet	Has actually increased paper consumption. Grade shifts will take place e.g. from business forms to cut size printed forms.
Packaging/wrappings	Plastics	Will take market shares in bags and wrapping applications. On the other hand paper is considered as more environmentally friendly material. Some States in India have banned plastic bags. Biodegradable plastic in the long term (still expensive).
Packaging/corrugated board	Plastic crates Plastic wrappers	Returnable plastic crates have captured small market share in Europe, not likely in India as well developed retail distribution is required Some substitution likely to take place, but corrugated board has better protective properties + environmental advantage
Packaging/folding cartons	Plastic/flexible packaging	Plastic will take market shares in applications where e.g. good moisture resistance is needed. On the other hand folding cartons are superior as regards to protective properties + printing surface
Packaging/sacks	Bulk shipments (e.g. cement in loose form)	Bulk shipments of e.g. cement have reduced sack paper consumption in Europe/USA, gradually coming to India.

Paper demand forecast – basic assumptions

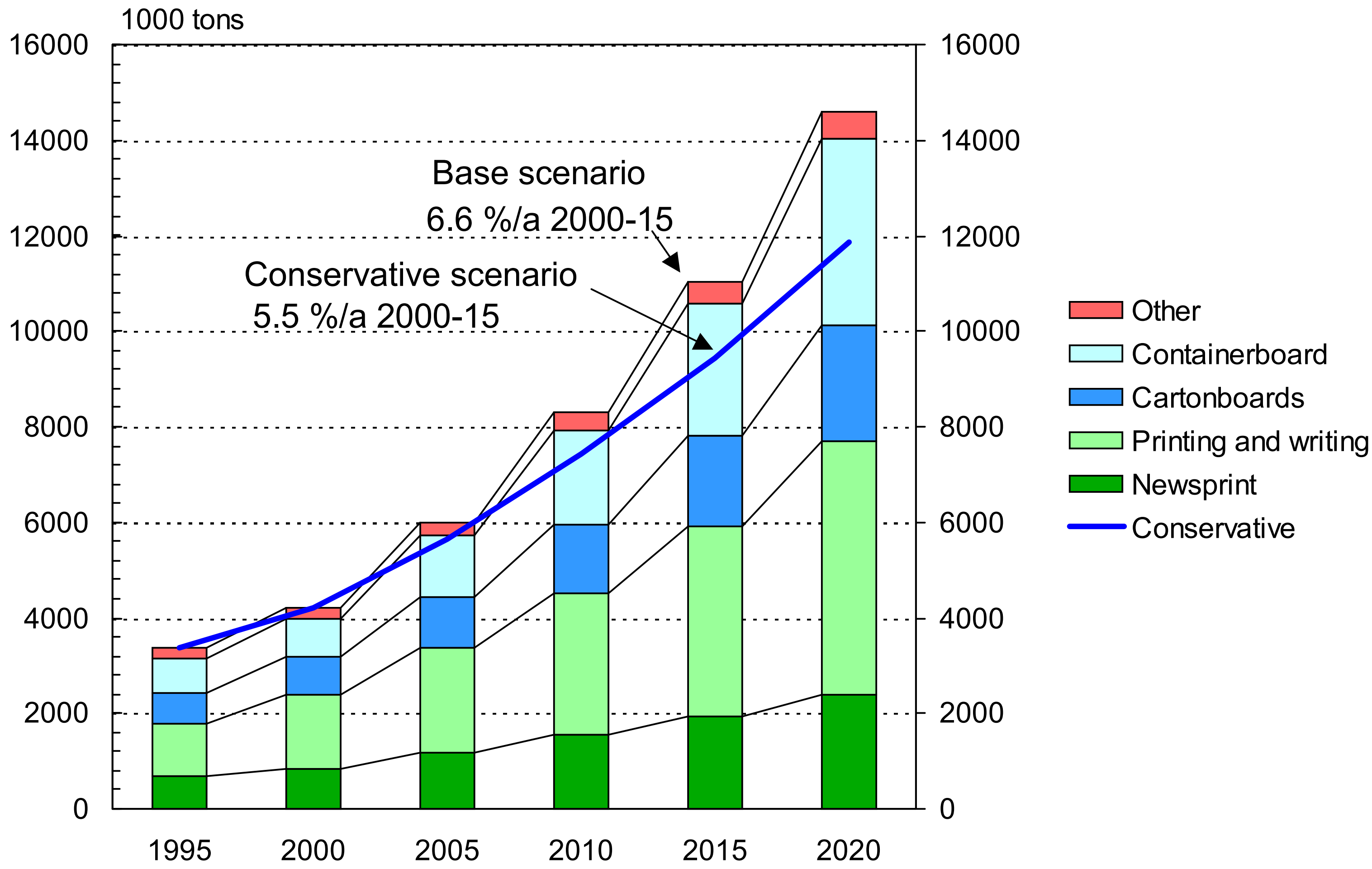
Two demand scenario were made based on different GDP growth assumptions



Total demand for paper in India up to 2020

Project Number 52A0087

Demand for paper and board is expected to grow to over 14 million tons by 2020 (to 12 million tons with the conservative scenario)



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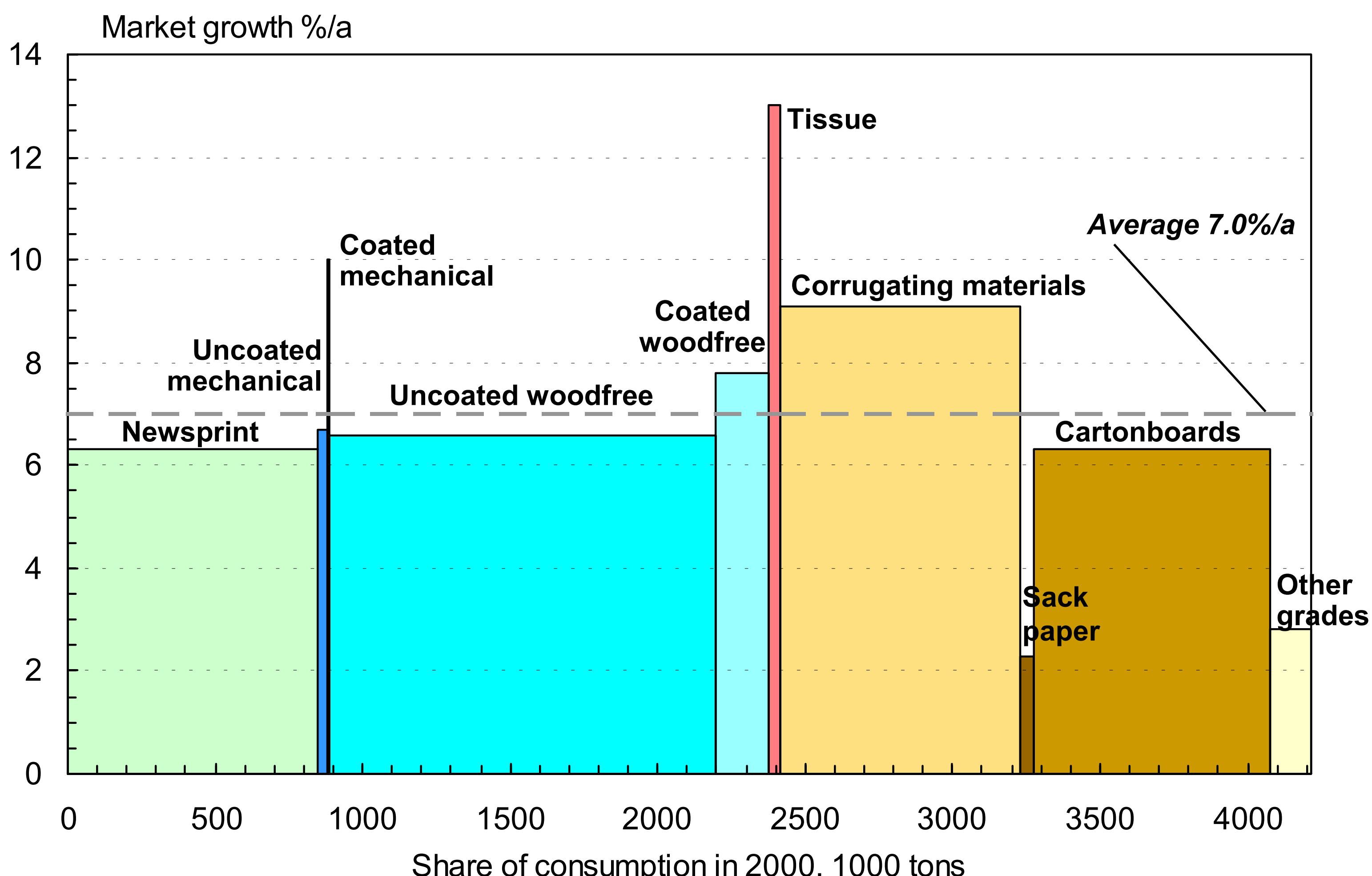
Demand for paper and board in India

2000 - 2010

Corrugating materials and tissue will have the highest growth rates



Paper supply/demand scenario for India

Total demand growth in 2000-2015 is expected to be 6.8 million tons. Supply is estimated to increase by about 6 million tons during the same period (depends on investments)

		2000	2005	2010	2015	Growth 2000-2015	2020
				1000 tons			
Newsprint	Demand	844	1177	1552	1937	1093	2380
	Supply	456	700	1040	1390	934	1800
	Net trade	-388	-477	-512	-547		-580
WC printing/writing	Demand	40	61	80	99	59	110
	Supply					0	
	Net trade	-40	-61	-80	-99		-110
WF printing/writing	Demand	1490	2125	2870	3880	2390	5215
	Supply	1530	2000	2580	3600	2070	4600
	Net trade	40	-125	-290	-280		-615
Tissue	Demand	38	75	130	185	147	235
	Supply	30	55	100	170	140	225
	Net trade	-8	-20	-30	-15		-10
Containerboard	Demand	814	1276	1942	2773	1959	3900
	Supply	806	1155	1840	2650	1844	3600
	Net trade	-8	-121	-102	-123		-300
Cartonboards	Demand	798	1070	1468	1895	1097	2430
	Supply	828	1100	1300	1800	972	2200
	Net trade	30	30	-168	-95		-230
Others	Demand	191	222	249	276	85	315
	Supply	200	225	245	265	65	300
	Net trade	9	3	-4	-11		-15
Total Base scenario	**Demand**	**4215**	**6006**	**8291**	**11045**	**6830**	**14585**
	Supply	**3850**	**5235**	**7105**	**9875**	**6025**	**12725**
	Net trade	**-365**	**-771**	**-1186**	**-1170**		**-1860**
Total Conservative	**Demand**	**4215**	**5660**	**7430**	**9435**	**5220**	**11870**

Print media in India

Publishing sector

The majority of publishing companies are under private ownership. There are numerous publishing companies, the most important of which are:

- Times of India
- Indian Express
- Hindustan Times

The largest newspapers are printed in several major cities and distributed to the surrounding areas with limited circulation beyond the city areas or states, where they have been printed. The main limitations to wider geographical coverage are the poor transport conditions and the short time span of distribution. Consequently, the power of regional newspapers edited in local languages is well established, and therefore the largest newspapers print regional editions to reach local readership.

The magazine sector (weekly, fortnightly and monthly magazines) is less restricted by the transport distance as their sales time is longer. However, the language areas set limitations also for magazine circulations. Some large magazines such as India Today have tried to overcome this problem through establishing regional editions. For example, India Today is published in English, Hindi, Malayalam, Tamil, and Telugu.

The publishing sector is already highly developed. Recently foreign direct investments up to 26 % are allowed, which will further improve the development and growth of this sector.

Print media in India

Printing sector

The printing sector is relatively advanced with modern printing machinery and well-trained and experienced personnel. There are some 120 000 printers in India.

Major printer concentrations are found in large cities. Mumbai and its surroundings account for some 40 % of the total printing capacity. Delhi is another major printing area, and smaller concentrations are found in Chennai and Kolkata.

The printing machinery is modern compared to many other industry segments in India. The prevailing printing method is offset. About 70-80 % of offset printing machines are sheet-fed, and 20-30% reel offset. The Indian printers usually purchase new printing machines from international suppliers.

The largest demand is for printing of books (24 %), followed by newspapers and periodicals (23 %) and packaging (21 %).

Based on discussions with the printers, Indian consumers are increasingly looking for better designed printed products and displays, colourful newspapers, state of the art advertising material and good quality packaging.

For paper industry this will mean:

– **increasing quality requirements, especially minimising quality variations in paper**

– **trend towards coated papers and boards**

Print media in India

Newspapers are published in the 19 main languages and some 81 dialects in India. Circulation has steadily grown during the last five years.

Over 45 000 dailies, periodicals, etc. are published currently in India:

No. of publications in India 2001

	No.
Daily	4719
Bi-weekly	325
Weekly	14743
Fortnightly	5654
Monthly	11505
Miscellaneous	4759
Total	41705
Other publications	3292
Grand total	**44997**

Largest number of periodicals are published in Hindi followed by English and Malayam. Uttar Pradesh has the highest number of publications, followed by Delhi, Maharashtra and West Bengal.

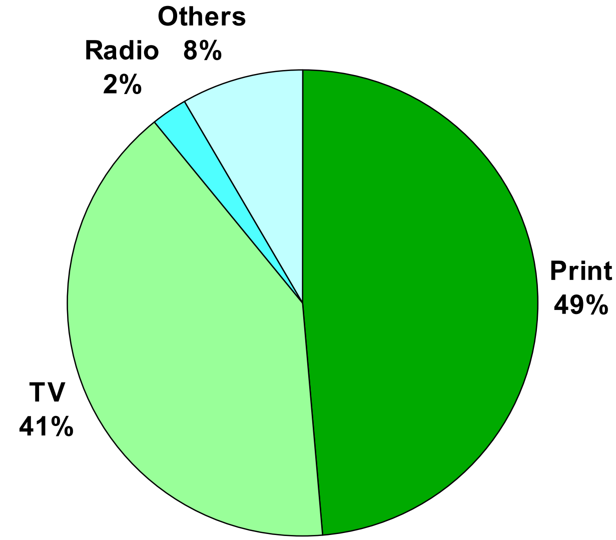
Advertising media in India

Print is the main advertising media in India. Although the growth of TV advertising is expected to be faster than print advertising, paper based advertising will still continue to grow in the future (in newspapers, periodicals, brochures, etc.)

The growth of paper-based advertising will set requirements for high quality paper and printing, especially in areas such as direct mail, brochures, annual reports, etc.

The importance of sheet-fed multi-colour offset printing will increase. Higher-quality domestic coated and uncoated woodfree printing paper will be required for better print result.

Advertising expenditure in India

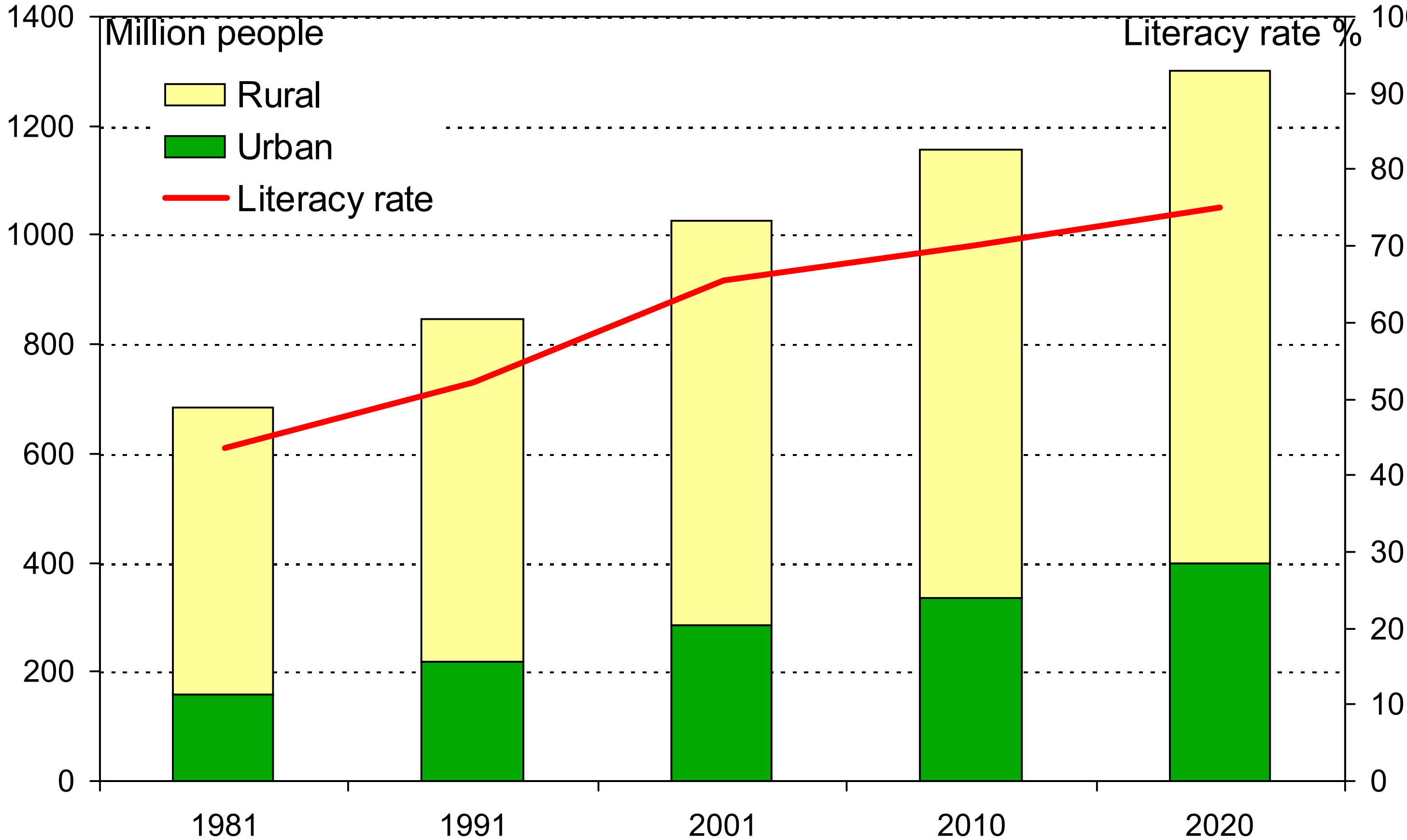


Total advertising spending 2001: 1.7 billion USD

Source: Zenith Media

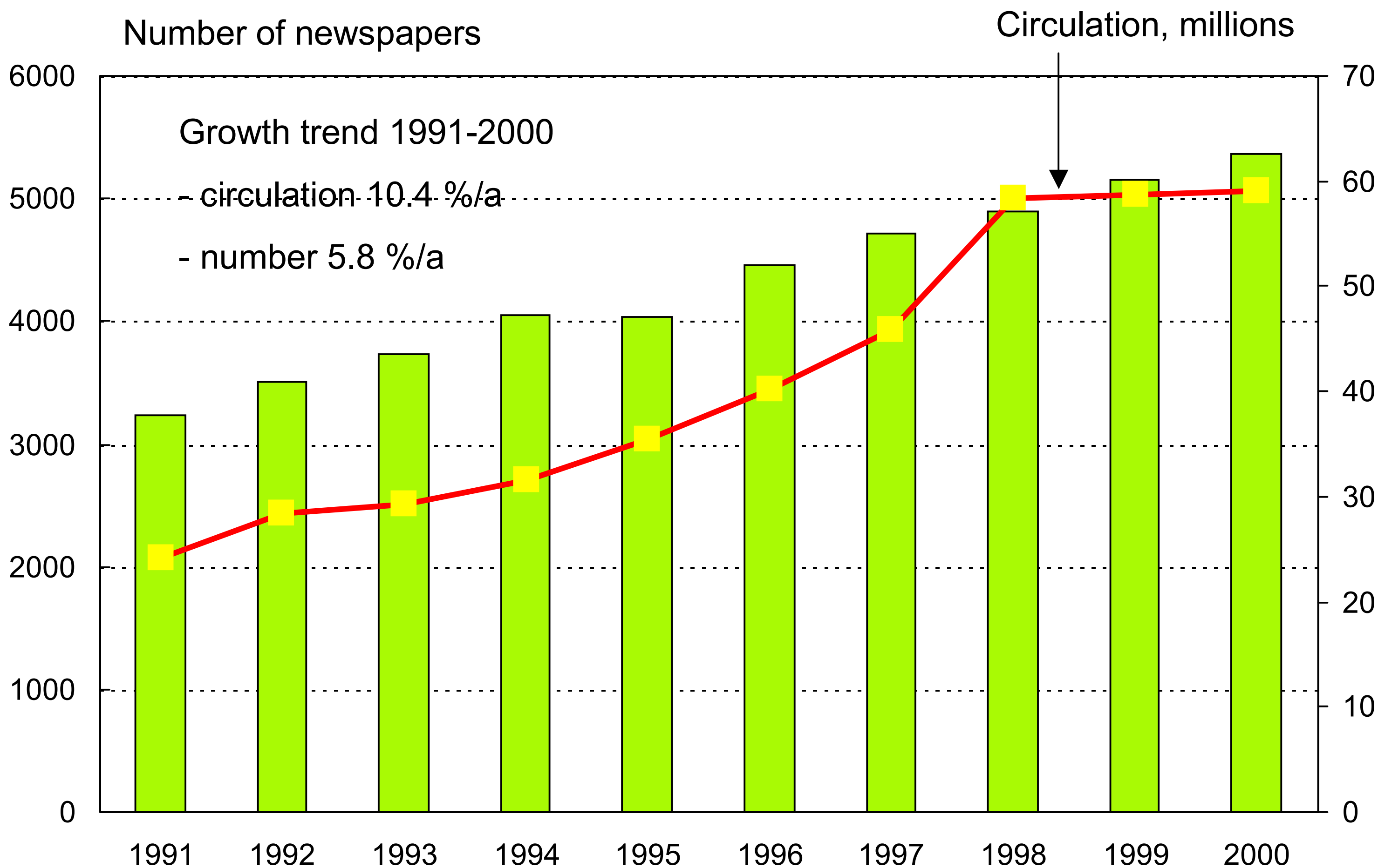
Indian population and literacy rate

Indian population is expected to grow by 1.2 %/year reaching 1.3 billion by 2020. The share of urban population will grow steadily. Literacy rate is expected to grow to over 70 % by 2020



Circulation of main newspapers in India

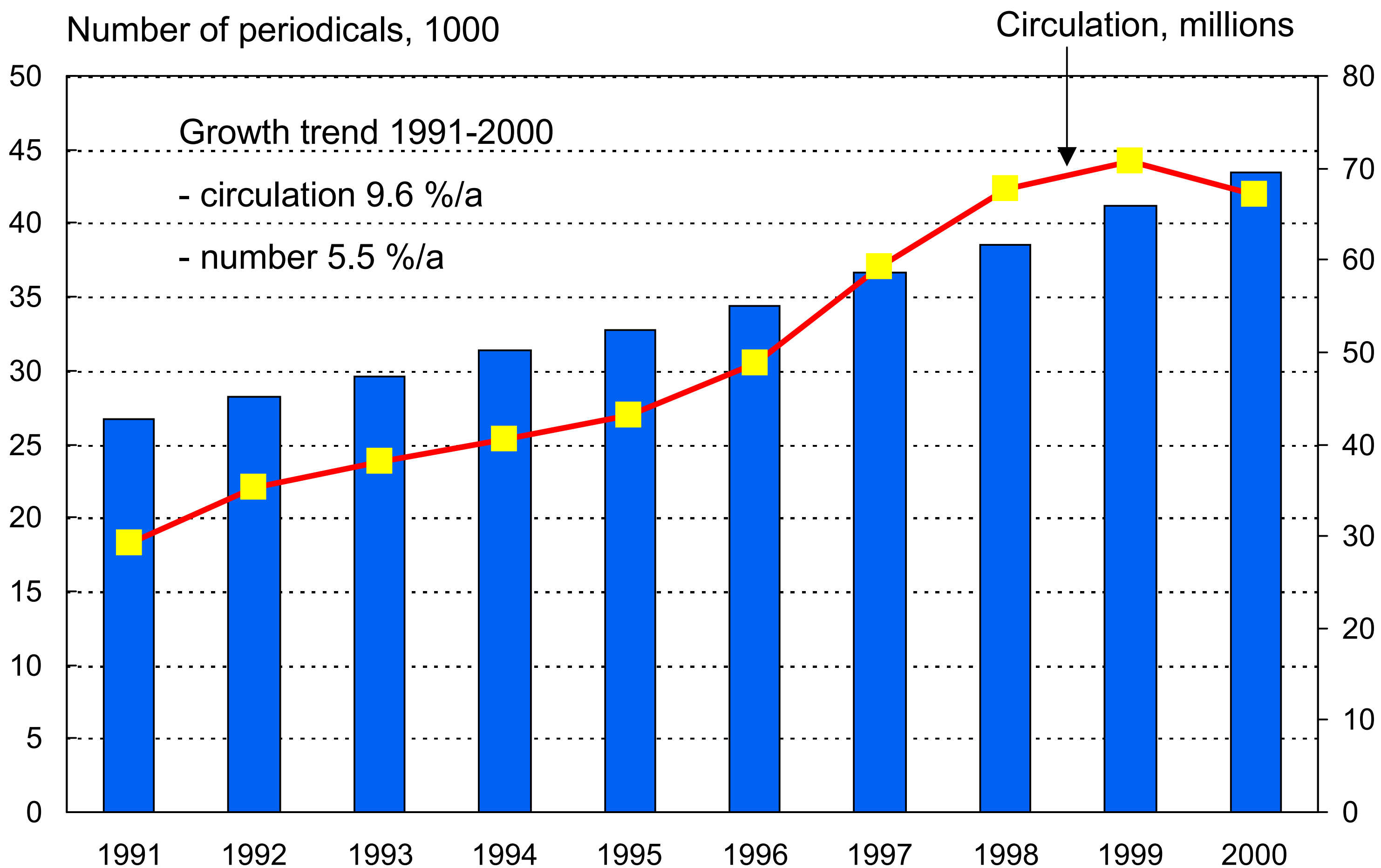
Number of daily newspapers has grown steadily. The growth of circulation has been over 10 %/year since 1991, although it slowed down in 1998-2000.



Ministry of Information

Circulation of main periodicals in India

Number of periodicals has grown steadily. The growth of circulation has been close to 10 %/year since 1991, altough it slowed down in 1998-2000.



Ministry of Information

Newsprint demand forecast in India

The demand for newsprint is expected to grow from 680 000 t/a in 1995 to about 910 000 t/a by the turn of the century, corresponding to an average growth of 6 %/a. The demand is projected to grow by 5 %/a beyond the year 2000, reaching 1.5 million t/a by 2010, and 1.9 million tons by 2015.

The key driving forces for newsprint demand in India are:

- Rapidly increasing newspaper circulations driven by increasing disposable income and literacy
- Increasing pagination supported by favourable advertising trends due to economic growth
- Increasing literacy rate and newspaper readership
- Growth in urban population
- Increasing affluence of the literate classes which will foster new titles
- Relatively low prices of newspapers enabling subscriptions for a second/third main newspaper along with one or two economic newspapers. This effect is reinforced by the increasing disposable income of the middle class
- There are several major language areas, each of which requires its own provincial/local dailies and economic newspapers. The largest newspapers have their own editions for major areas
- Increase in business activity compared with dominating role of press advertising in India boosts newspaper consumption

The major factors limiting newsprint demand growth are:

- Increasing newsprint prices due to escalating labour costs in India and a depreciating Rupee
- Fluctuations in international market prices
- Keen competition in the newspaper markets, consequent low subscription prices and thus limited editorial contents of newspapers
- Competition from other advertising media (TV, for example) where spending on advertising is growing much faster. Internet advertising in the long term.
- Undeveloped transport conditions, limiting newspaper distribution and coverage.

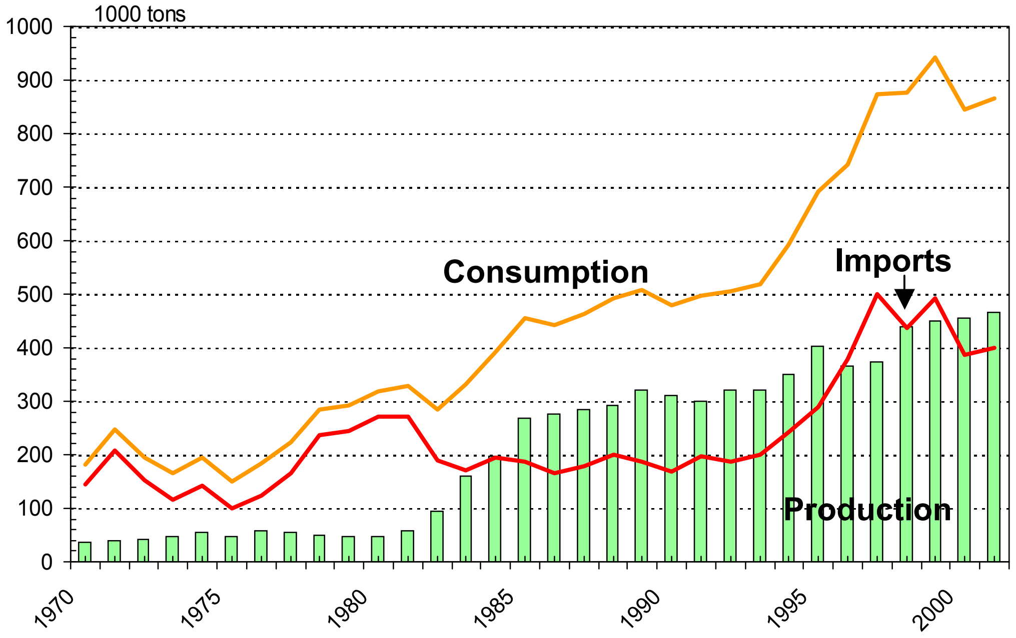
Newsprint market in India 1970-2001

Newsprint consumption has grown steadily reaching 0.9 million tons in 2000.

Government policy has had an important impact on the market:.

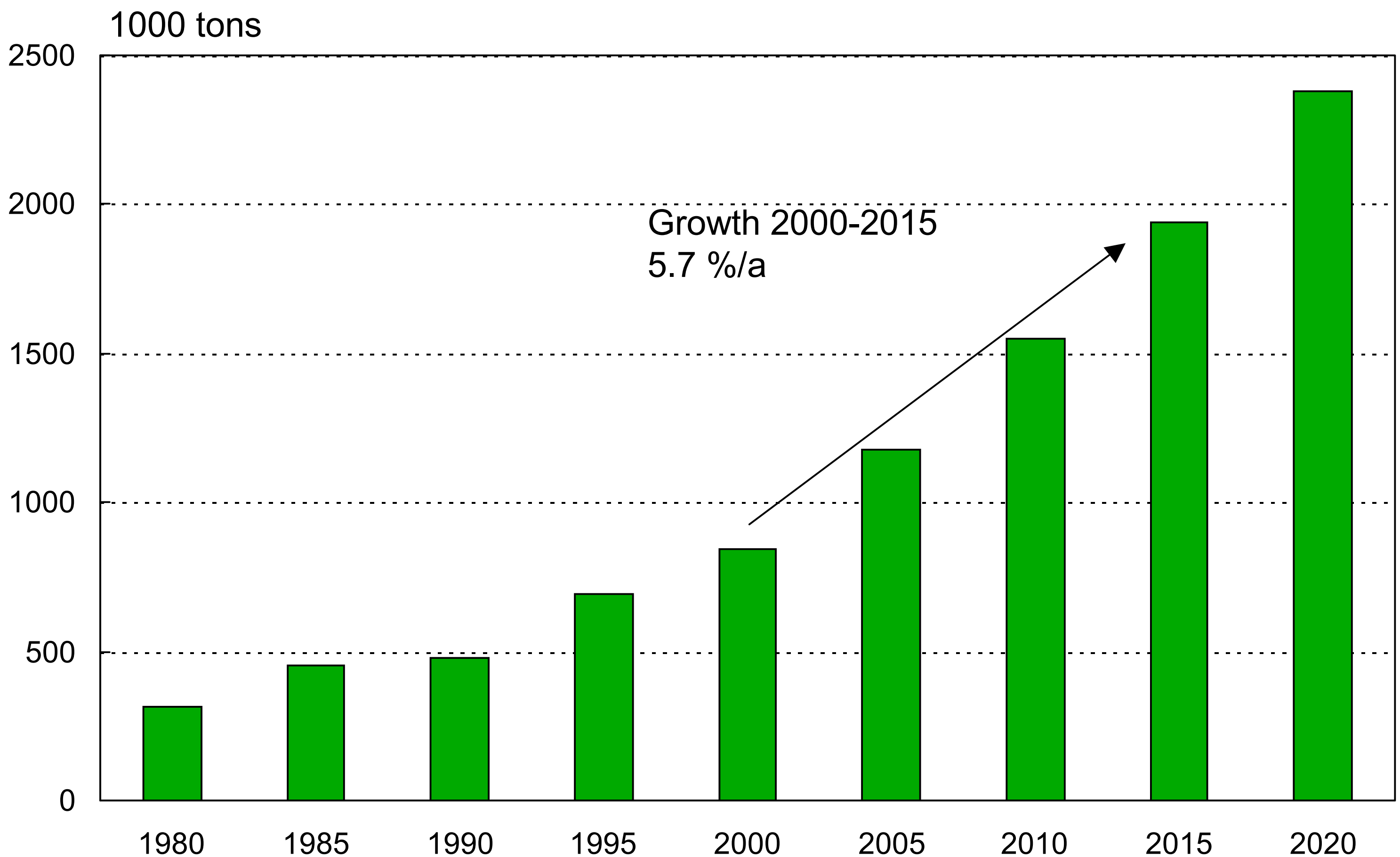
- Newsprint control order in 1962 regulated purchase, sales and consumption of newsprint
- Decimalisation of newsprint in 1992. Zero duty and quantitative restrictions of using 2 tons of domestic newsprint for every 1 ton of imported newsprint
- Removal of quantitative restrictions in 1995 lead to rapid increase of newsprint imports.
- Basic duty for newsprint was reduced from 10 % to 5 % in 1998.

Newsprint market in India 1970-2001



Newsprint – demand forecast in India

The demand for newsprint is expected to grow to 1.5 million tons by 2010 (0.7 million tons in 2000-2010), and reach 2.4 million tons by 2020.



Pr/Wr paper demand forecast in India

The demand for printing and writing papers is expected to grow from 1.5 million tons in 2000 to close to 3 million tons in 2010, and to about 4 million tons by 2015.

The demand for printing and writing papers will be driven by the following factors:

- Increasing literacy rate and government allocation for the educational sector. **The literacy mission for education requires about 100,000 tonnes per year growing at a rate of 5-6%.**
- Increasing school enrolment, number of primary/secondary schools and educational institutes at college level
- Emerging new magazine titles
- Increasing business activity boosting the demand for cut-size copy and stationery grades. Copiers and computers are becoming increasingly common and high-speed copiers are also being introduced
- Mounting needs for colour printing are expected to boost the demand for coated papers, and encourage the industry to quality upgrading

The major uncertainties for continued growth are:

- Supply-driven market where actual demand levels partly depend on available local/domestic supply
- Import dependency on coated mechanical grades

Printing/writing demand in India

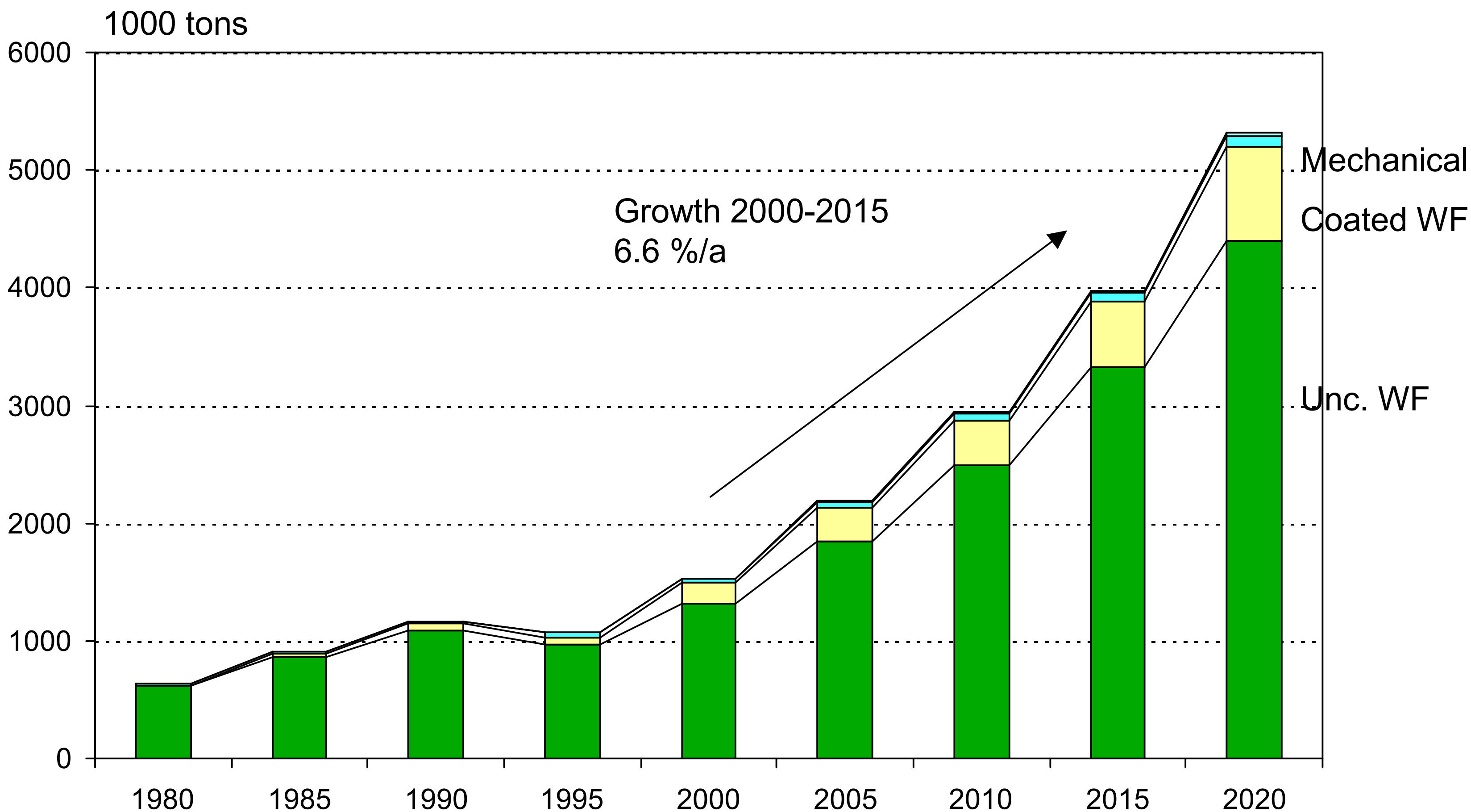
Demand for coated grades will grow fastest due to increasing colour printing

Demand for printing/writing papers in India 2000-2020

	2000	2005	2010	2015	Growth 2000-2015	2020
		1000 t			%/year	1000 t
Uncoated woodfree	1310	1850	2490	3322	6.4	4400
Coated woodfree	180	275	380	555	7.8	800
Unc.mechanical	35	52	67	82	5.8	95
Coated mechanical	5	9	13	20	9.7	30
Total	**1530**	**2186**	**2950**	**3979**	**6.6**	**5325**

Printing/writing - demand forecast in India

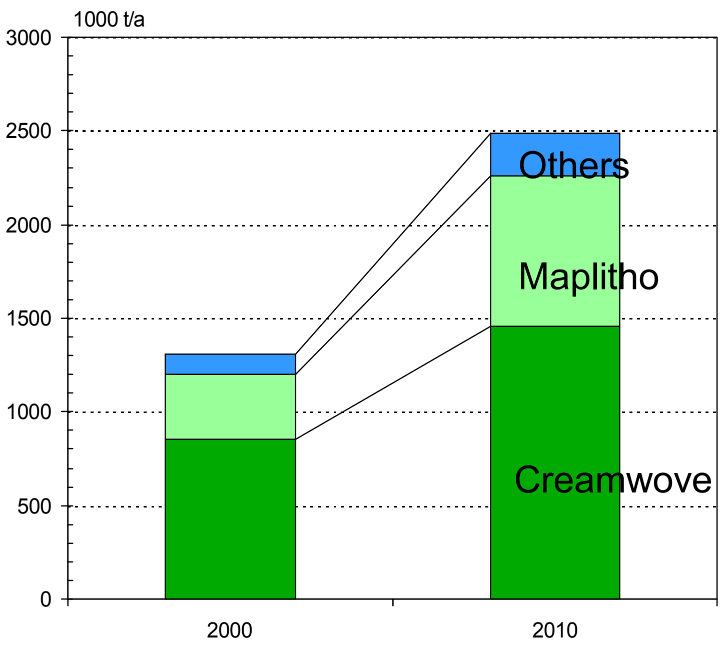
The demand for printing and writing papers is expected to grow to 3 million tons by 2010 (1.4 million tons in 2000-2010), and reach 5.3 million tons by 2020.



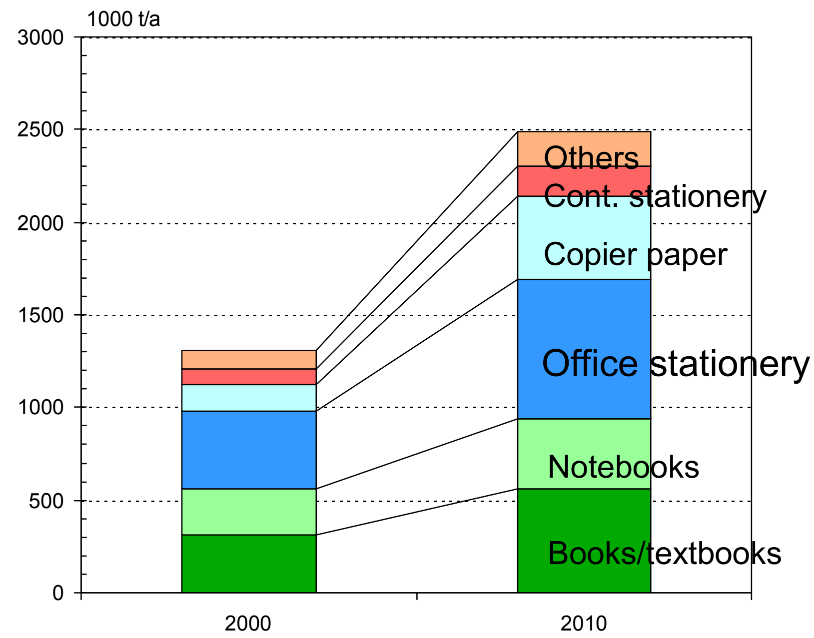
Uncoated WF demand in India 2000-2010

- The trend is from creamwove to maplitho due to increasing quality requirements
- Copier paper will be the fastest growing end use (12 %/a) due to increasing use in photocopiers and ink jet/laser printers

Demand by paper grade



Demand by end use



Printing and writing papers – end use trends

Books and textbooks

– State Textbook Corporations are the key buyers

– STCs prefer to use cheap creamwove (from agro based mills)

– Demand is seasonal, tenders are normally placed in July

Notebooks

– Notebook converters are the main buyers

– Demand is seasonal (January, July)

– Creamwove is mainly used, some converters are shifting to better qualities

Office stationery

– Includes envelopes, calenders, diaries and other stationery

– Demand is sensitive to corporate performance and business cycles

Computer stationery

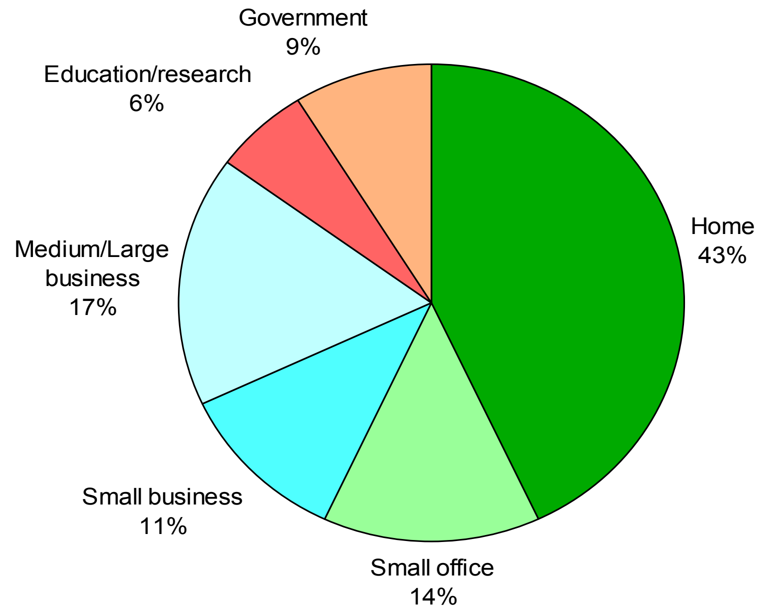
– The four metro cities are the main buyers

– Good growth prospects in the medium term, in the long term trend to page printing using cut sizes

Personal computer market in India

- About 2 million personal computers/year are sold in India. The market is expected to grow at about 12 %/year in the short and medium term.
- Over half of the computers are sold to home and small office use
- 97 % of the computers are lap tops, the rest being portable PCs and PC servers.
- There are 1.3 million active internet users in India, the number of users has grown at about 15 %/year. Significant part of e-mails will be printed as well as documents published in the internet, which will have positive effect on the paper consumption.

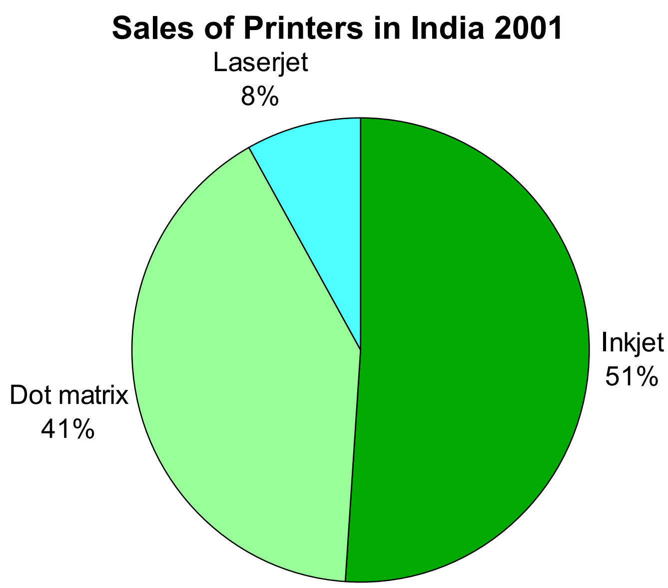
Unit sales of Personal Computers in India 2001

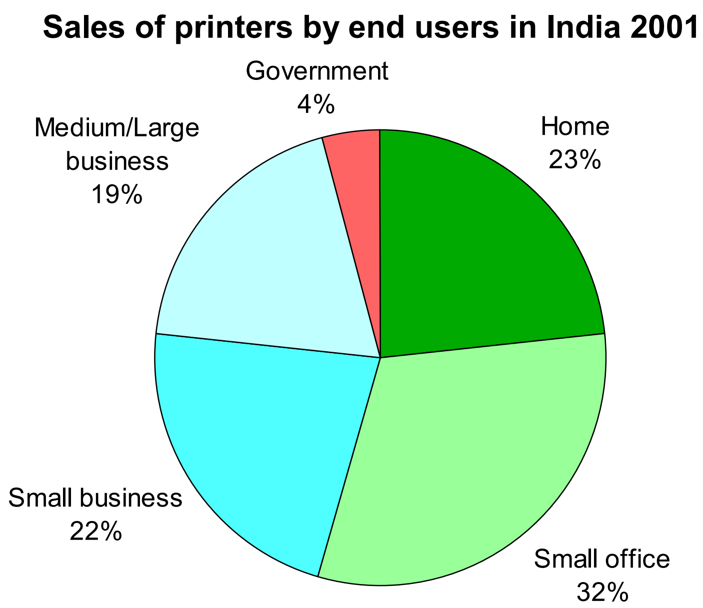


Source: Industry estimates

IT peripheral market in India

- About 0.8-1.0 printers/year are sold in India. The annual growth has been close to 30 %/year in unit terms.
- Over half of the printers are inkjet printers, 41 % dot matric and 8 % laserjet. In the future the fastest growth is expected for ink jet and laser printers, which will boost the demand for cut size papers
- Small office and home account for about 50 % of the end use





Source: industry estimates

Copier and digital printing market in India

The total print-on-demand market in India is about 32 billion US dollars. The value of the market has grown about 25 %/year during the last three years.

Xerox is the leading supplier of photocopiers in India having a market share of about 40 %. The company is positioning itself as a document management firm focusing on applications related to just-in-time manufacturing, one-to-one marketing and e-commerce.

The cost differential between colour and monochrome copier is getting smaller, and the share of colour copying is expected to increase its share in the future. As also the speed of copying machines is increasing, the quality requirements for paper suppliers will continue to increase.

At the moment there are only a few digital printers in India, but the growth potential is good. With digital printing books, manuals, etc. can be printed on order.

Role of Central Government Purchasing

Central Government is an important paper buyer (mainly printing and writing papers).

The government acquires paper through DGS & D (Director General of Supplies and Disposal). This is 15% of the total production of writing & printing for a particular year and grows with the production level.

The paper is mainly used for printing of books (State Textbook Corporations).

The current level of writing and printing paper (2001) is over 2.0 million tonnes of this some 400,000 tons goes for Government..

The literacy mission for education requires about 100,000 tonnes per year growing at a rate of 5-6%.

In the states, maximum consumption per capita is Kerala (highest literacy rate) while lowest is Bihar & U.P. (high population and lower literacy rate).

If ECO-labelling scheme is launched in India, government could be in a key role supporting it.

Cartonboard demand forecast in India

The demand for cartonboards is expected to grow from 0.8 million tons to 1.5 million tons by 2010 (6.3 %/a).

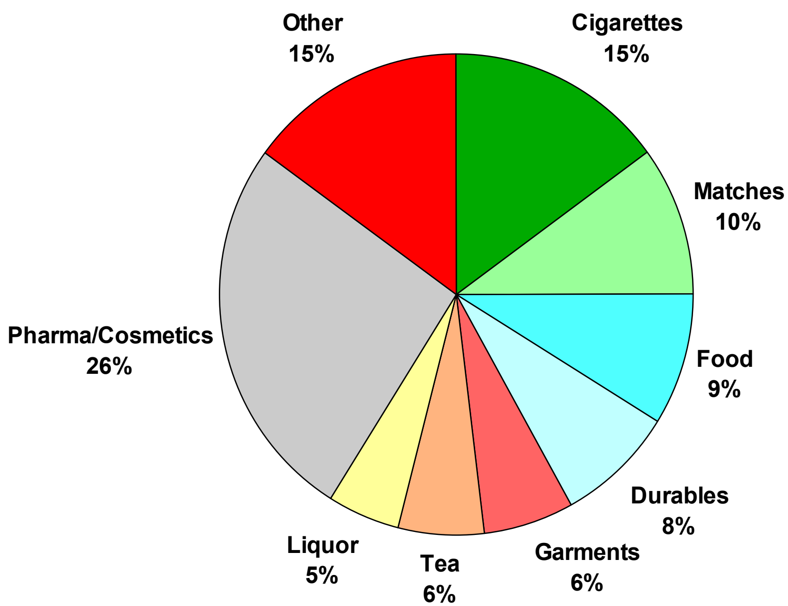
The major demand drivers for the cartonboard market (premium art, chromo board, ivory, and duplex board) are:

- Favourable growth prospects for merchandize exports and the trend towards more processed items in the long run
- The fastest growing end-use segments for cartonboards are foodstuffs including confectionery and bakery products, consumer durables and garments.
- In the future, increasing emphasis will be put on higher-quality, packaging which will be reflected in increasing demand and a growing share of coated cartonboards at the expense of uncoated grades
- Boxboard packaging will grow rapidly, following the general social changes in India, including increasing participation of women in the work force, increasing consumerism and changes in the retail trade, with an increasing number of supermarkets and other self-service outlets
- Both fast food and dried convenience food sectors are emerging, thus creating new markets for coated greyback, whiteback, manilla and laminated/PE coated boards in the future.

Cartonboard market structure in India

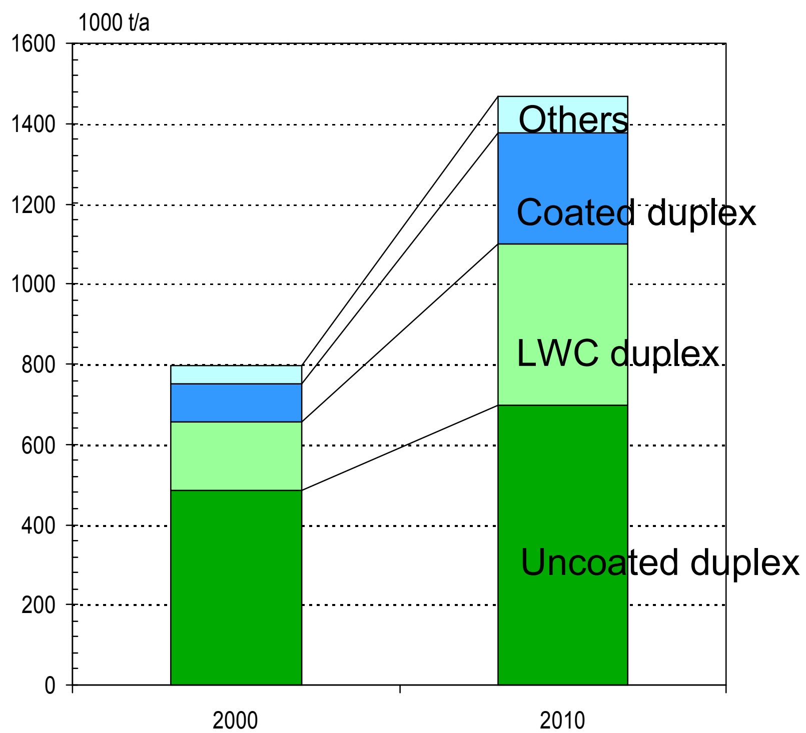
- Pharma/cosmetics, cigarettes and matches are the main end uses
- Uncoated duplex accounts still for most of the consumption, but the trend is towards coated grades

Cartonboard consuption by end use 2000



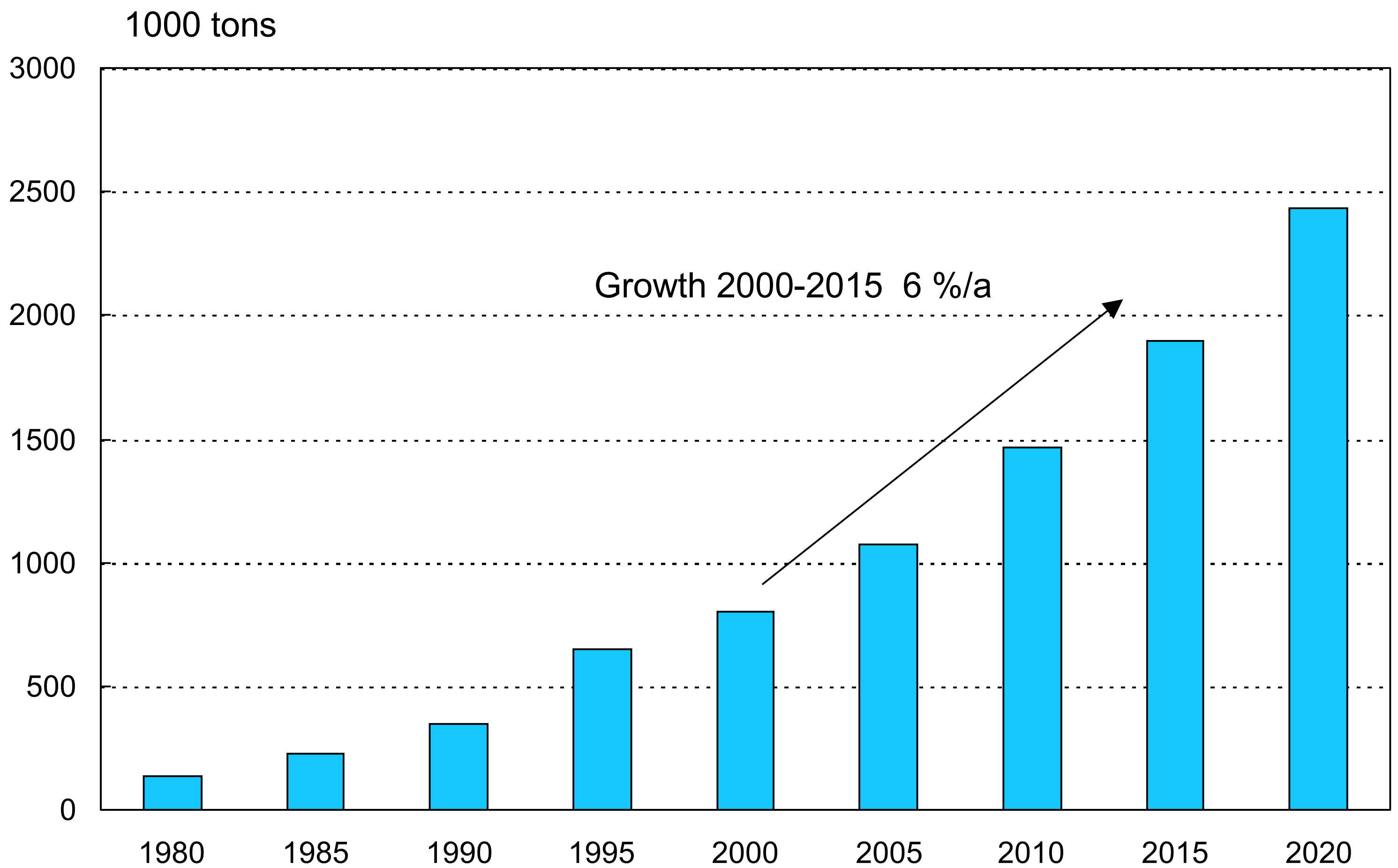
Total cartonboard consumption: 0.8 million tons

Cartonboard consumption by grade 2000-10



Cartonboard demand forecast in India

The demand for cartonboards is expected to grow from 0.8 million tons to 1.5 million tons by 2010, and to 2.4 million tons by 2015.



Corrugating materials demand forecast in India

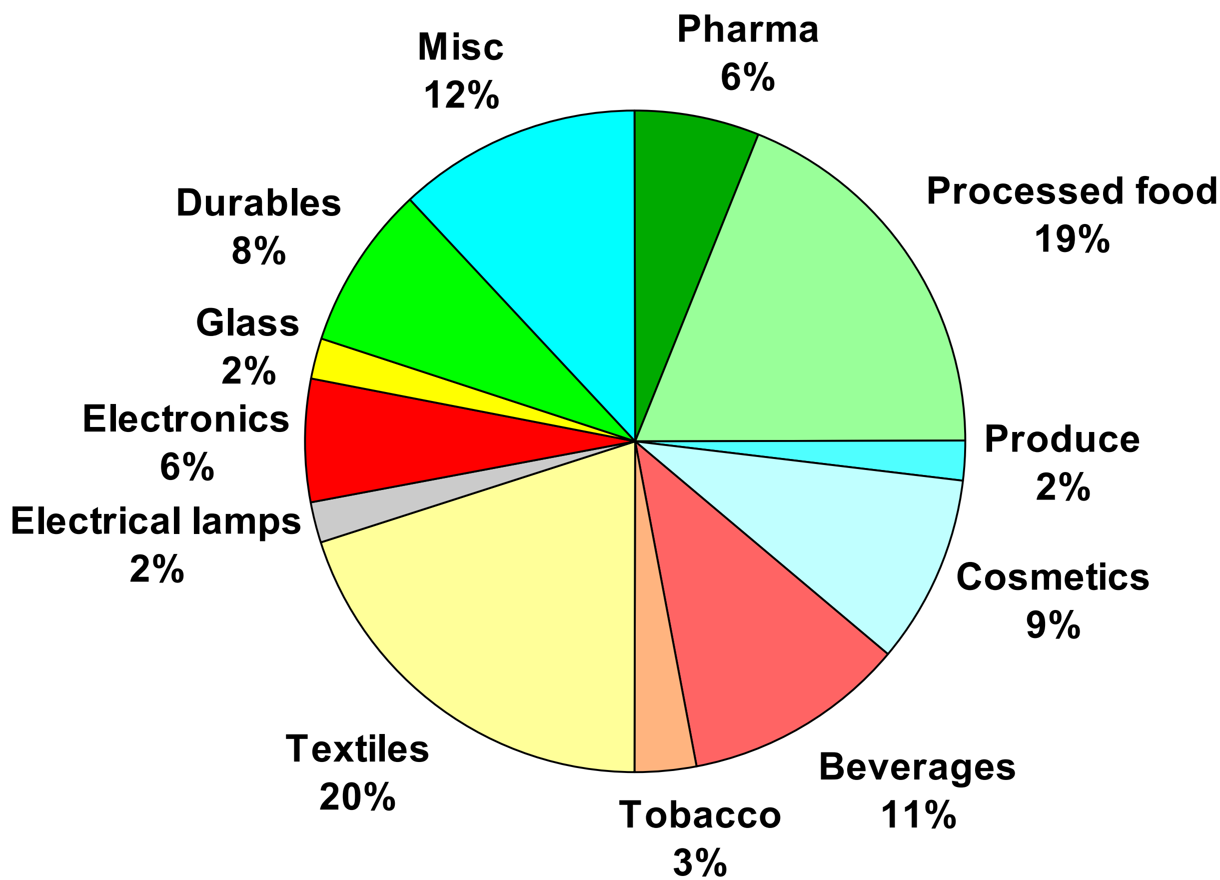
The demand for corrugating materials (liner/fluting) is expected to grow from 0.8 million tons to 1.9 million tons by 2010, and to 2.8 million tons by 2015.

The major demand drivers for corrugating materials in India include:

- Growth of manufacturing and export-led industries in India
- Increasing local manufacturing by multinational companies
- Pharmaceuticals, consumer durables, other consumer products and garments are the key growing end uses
- Growing agro-based sector, including horticultural products, fresh and canned fruits, marine products etc.. This, together with the Government policy to replace wooden crates by containerboard boxes particularly in fresh fruit packaging, will create new demand for corrugated board packaging in the future
- The retail market is developing rapidly and focusing at first to serve the large middle class. Along with the traditional wet markets, modern supermarket style outlets are emerging rapidly with favourable impact on containerboard packaging
- Increasing packaging will boost the demand for containerboard boxes with increasing emphasis on box quality
- New developments and innovations in corrugated board (e.g. small flute/micro flute growth)

Corrugated board end uses in India 2001

Food and textiles are the most important end uses

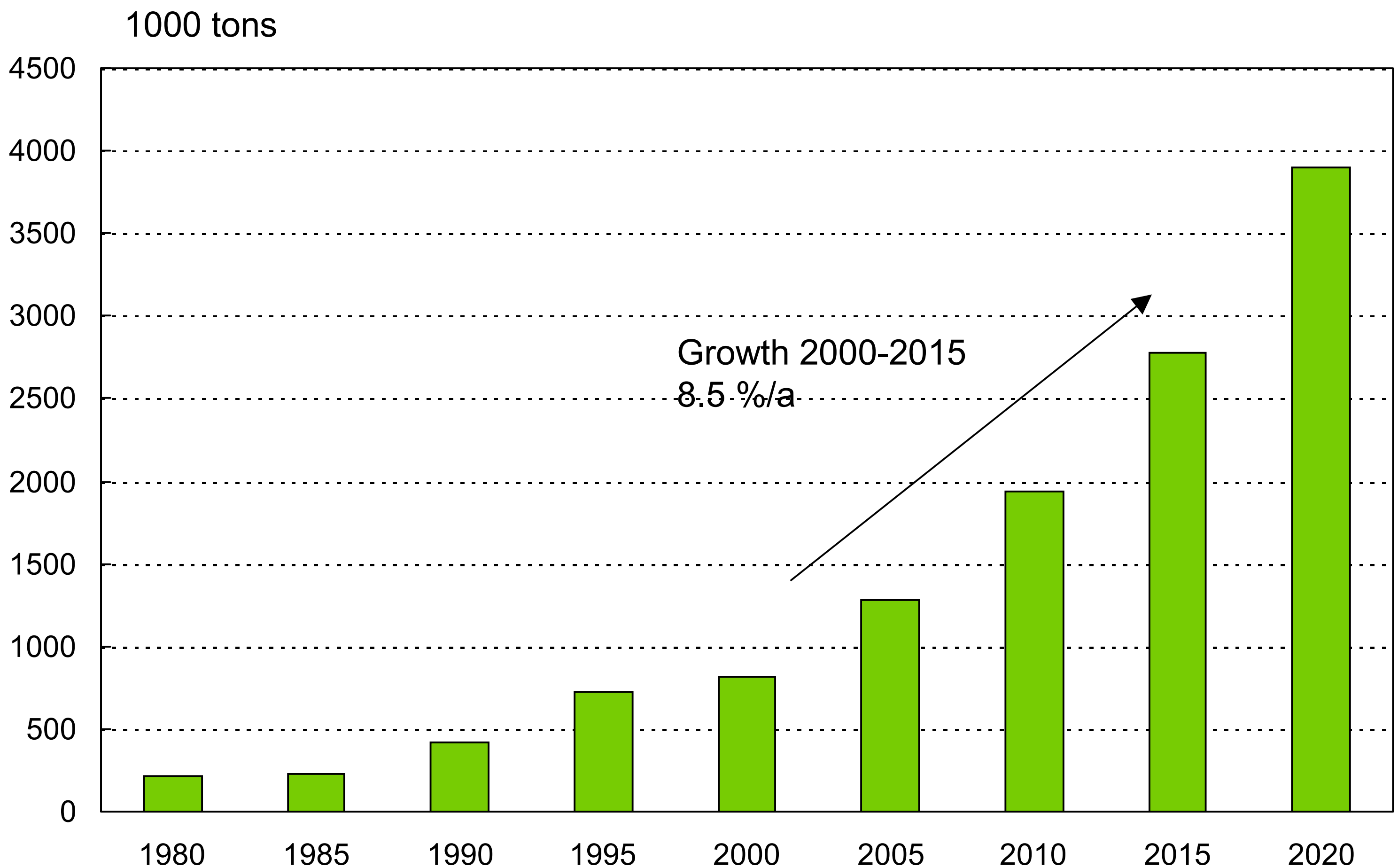


Total liner/fluting consumption: 0.8 million tons

Corrugating material demand forecast in India

Project Number 52A0087

The demand for corrugating materials (liner/fluting) is expected to grow from 0.8 million tons in 2000 to 1.9 million tons by 2010, and to 3.9 million tons by 2020.



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Corrugated board converting industry

There are about 2500 corrugator and box plants in India. The industry provides direct employment for more than 100 000 workers. Corrugators are primarily located near end users, with major concentrations in the Bombay region, around Delhi (also northwest of the city of Delhi in Haryana and Punjab states), Kolkata, Chennai, Bangalore and Ahmedabad, as well as in the vicinity of other major industrial cities.

There are about 700 corrugators and box manufacturers in the Mumbai region, which corresponds to nearly 30 % of the total number of corrugated box units in India.

The converting industry typically consists of single companies with operations at one location only. A converter company typically has 1-2 corrugators and there are only a few corrugating groups in the country. The paper mills are usually not integrated with box making operations. In Europe and North America major part of containerboard industry is forward integrated with corrugated board converting.

The Indian corrugators are typically narrow, ranging from 40" to 62" (1.02-1.57 m). About 60 % of the corrugators have a width of 52" and an average speed of 2800 feet/hour (14 m/min). Several corrugating companies are now replacing their existing machinery with 62" (1.57 m) wide corrugators running at 5600 feet/hour (28 m/min).

The average capacity of corrugators is estimated at 2 t/day, or 500-600 t/a, which is very low by international standards, as the latest technology worldwide is based on 2.5 m units (even 3 m units) with capacities up to 70 000 t/a.

The rapid growth of corrugated board consumption will offer possibilities for investments in modern corrugators. Restructuring of the liner/fluting and corrugated board converting industry is likely to take place, including more forward integration of board making with converting.

2. Potential Export Markets

Potential export markes for India

India currently exports

- 55-60 000 tons of woodfree printing and writing papers
- 30 000 tons of board
- 10 000 tons of other grades

Export potential by grade is analysed in the following pages. The following can be noted:

- Export opportunities exist in all above grades + newsprint and liner/fluting
- Neighbouring countries (Bangladesh, Sri Lanka, Nepal, Myanmar and Pakistan) provide natural export markets for most grades
- Other potential export markets include Gulf countries and other Asian countries

Key factors for successful exports include:

- product quality should meet international standards.
- cost competitiveness of the mills should be good so that mills are able to supply also during recessions when strong price competition is common.
- reliable deliveries are essential
- experienced agent net work (or foreign partner) is required in the main export markets, own sales offices could be established later on when to volumes increase

Newsprint – potential export markets

India is currently a net importer of newsprint, and domestic market is expected to absorb most of the possible new newsprint capacity to be installed in India. However, export possibilities exist in the neighbouring Asian countries as the following table indicates. Main international competition comes from North America, Nordic countries and Russia.

Potential export markets for Newsprint

Selected export markets	Imports 2001
	1000 tons
Bangladesh	80
Pakistan	72
Sri Lanka	10
Myanmar	4
Nepal	2
Taiwan	414
Hong Kong	340
Turkey	296
Israel	170
Singapore	170
China	154
Malaysia	142
Egypt	125
Thailand	113
Iran	70
Saudi Arabia	48
United Arab Emirates	30

Uncoated WF – potential export markets

Export possibilities for uncoated woodfree papers exist in the neighbouring Asian countries as the following table indicates. Main international competition comes from Indonesia and Europe.

Potential export markets for Uncoated woodfree printing/writing papers

Selected export markets	Imports 2001
	1000 tons
Bangladesh	30
Pakistan	10
Sri Lanka	30
Nepal	10
Myanmar	8
China	366
Malaysia	335
Egypt	150
Hong Kong (excl. re-exports)	130
Saudi Arabia	110
Taiwan	65
Turkey	60
Singapore	50
Iran	40
Israel	30
United Arab Emirates	25
Thailand	10

Coated WF – potential export markets

Export possibilities for coated woodfree papers exist in the neighbouring Asian countries as the following table indicates. Main international competition comes from Indonesia and Europe.

Potential export markets for Coated woodfree printing/writing papers

Selected export markets	Imports 2001
	1000 tons
Bangladesh	8
Pakistan	5
Sri Lanka	10
Nepal	2
Myanmar	2
China	1000
Hong Kong	126
Singapore	80
Israel	80
Malaysia	70
Iran	70
Turkey	40
United Arab Emirates	40
Taiwan	37
Egypt	30
Saudi Arabia	20
Thailand	10

Coated duplex board – potential export markets

Export possibilities for coated duplex board exist in the neighbouring Asian countries as the following table indicates. Main international competition comes from Korea, Taiwan, Indonesia and Europe.

Potential export markets for coated duplex board (WLC)

Selected export markets	Imports 2001
	1000 tons
Bangladesh	30
Pakistan	30
Sri Lanka	15
Nepal	5
Myanmar	4
China	800
Hong Kong (excl. re-exports)	130
Singapore	100
Israel	98
Malaysia	65
Iran	60
Turkey	55
United Arab Emirates	50
Egypt	45
Saudi Arabia	30
Thailand	20

Recycled liner/fluting – potential export markets

Export possibilities for recycled liner/fluting exist in the neighbouring Asian countries as the following table indicates. Main international competition comes from other Asian countries. The main corrugating raw material traded in international markets is virgin fibre based kraftliner (coming mainly from North America).

Potential export markets for recycled liner/fluting

Selected export markets	Imports 2001
	1000 tons
Bangladesh	80
Pakistan	30
Sri Lanka	15
Nepal	5
Myanmar	5
China	450
Malaysia	400
Saudi Arabia	100
Turkey	90
Singapore	90
Egypt	70
United Arab Emirates	50
Israel	30
Hong Kong (excl. re-exports)	30
Iran	10
Thailand	5

3. Fibre Raw Materials

Current fibre balance in India

Indian fibre balance is analysed in the following table and compared with China

- Wood pulp, non wood pulp and waste paper are important fibre components both in India and China
- Both countries are significant importers of waste paper, domestic recovery rate is higher in China
- China is a major importer of chemical pulp

India – pulp and waste paper 2001

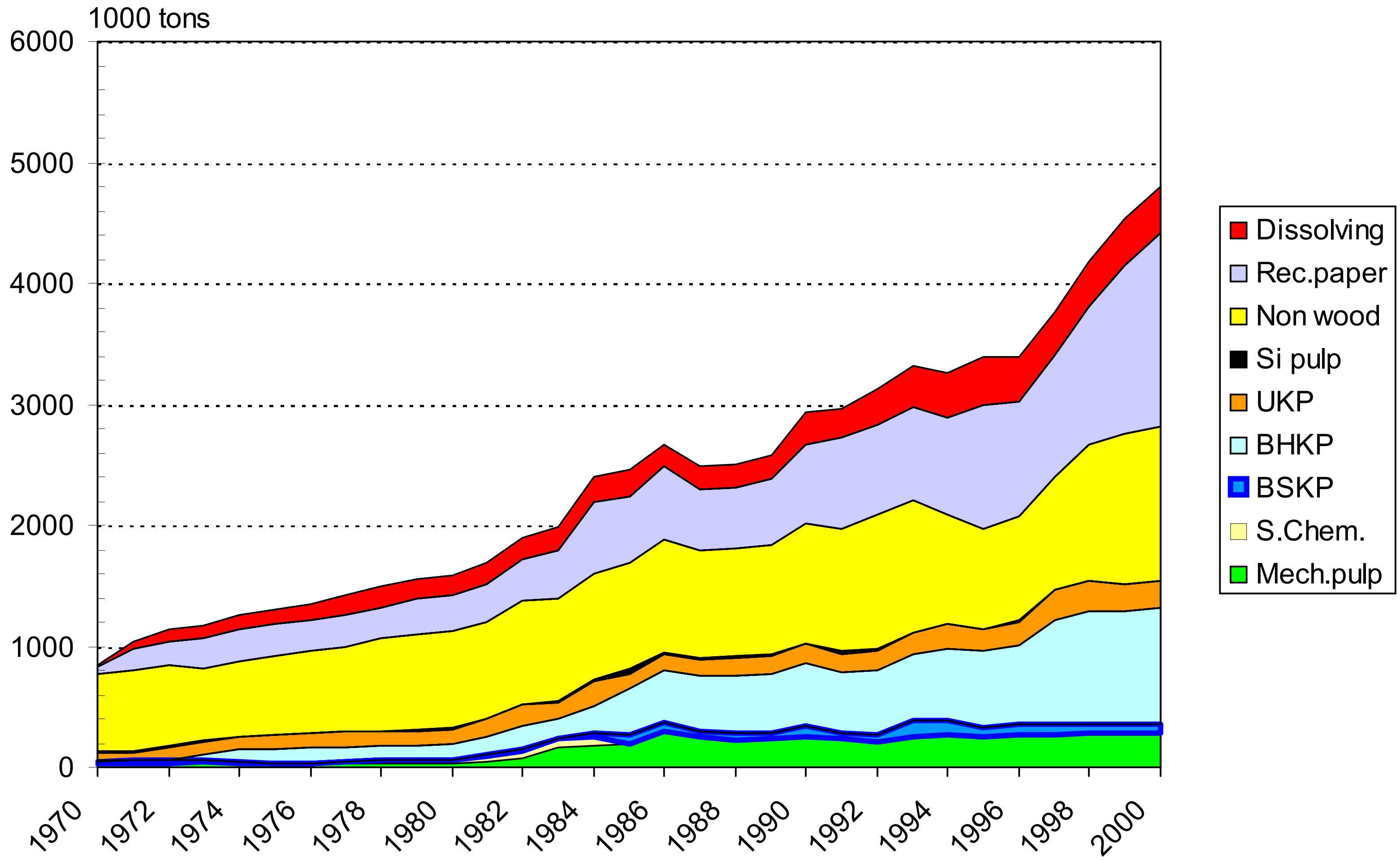
	Production	Imports	Consumption
		1000 tons	
Chemical pulp	865	167	1032
Mechanical pulp	275	53	328
Semi-chemical	72		72
Non wood	1433	23	1456
Recovered paper	850	1075	1925
Recovery rate	20%		

China – pulp and waste paper 2001

	Production	Imports	Consumption
		1000 tons	
Chemical pulp	1420	4233	5653
Mechanical pulp	565	224	789
Semi-chemical	1710	196	1906
Non wood	11900	220	12120
Recovered paper	12720	6418	19138
Recovery rate	33%		

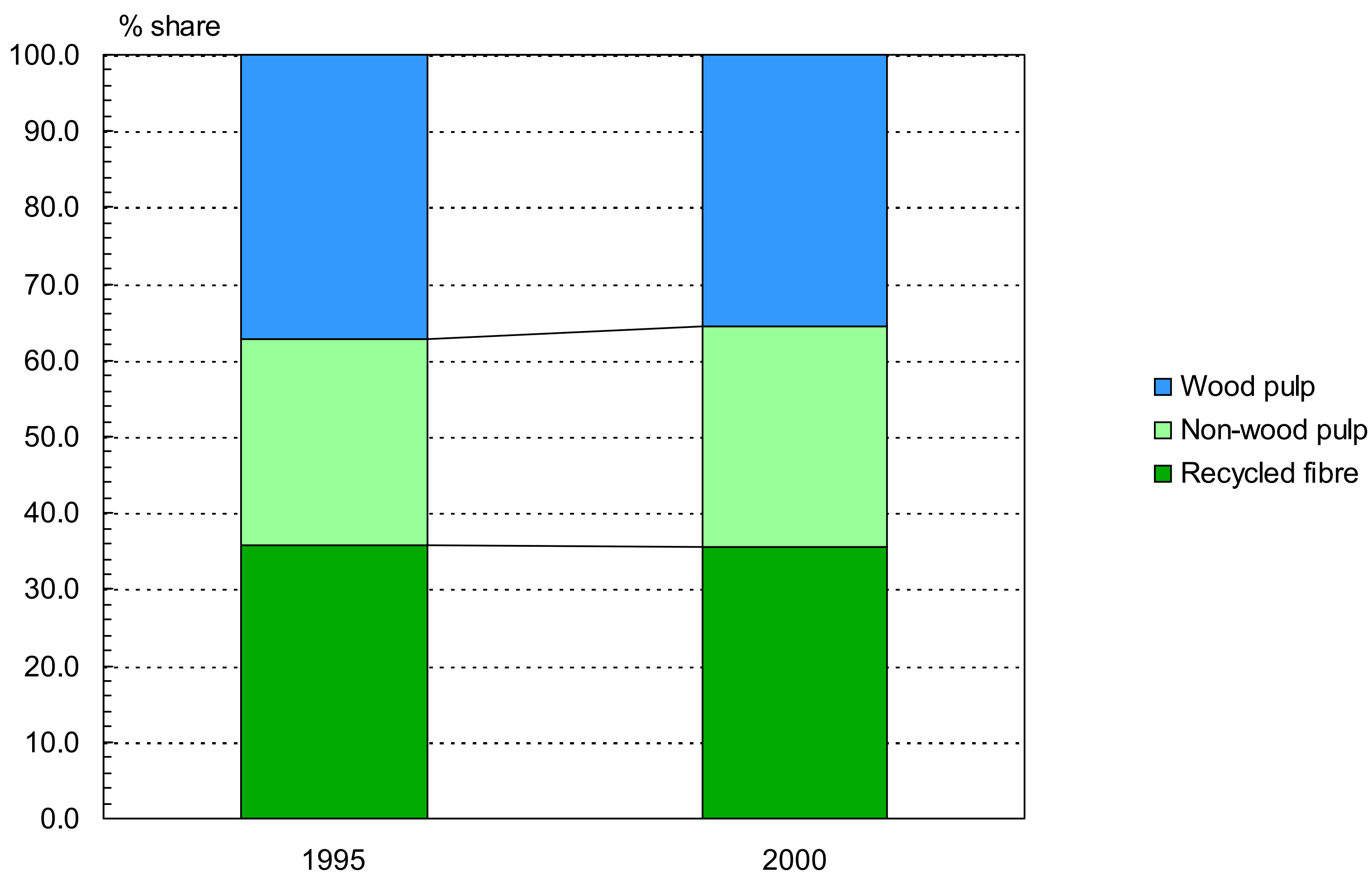
Pulp/waste paper consumption in India

Non wood pulp and waste paper are important fibre raw materials in India



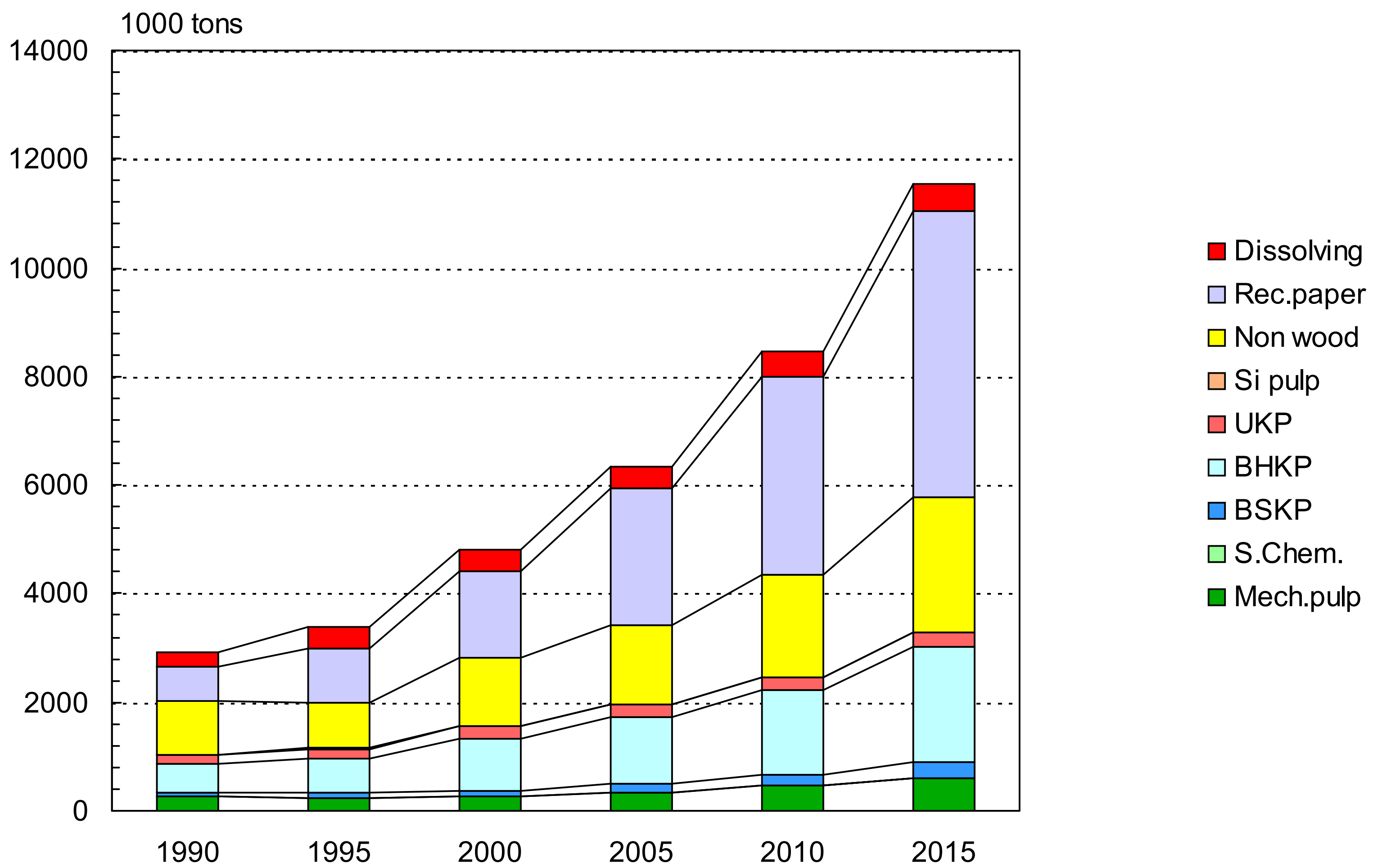
Fiber use of Indian paper industry

The share on non wood pulp in the fibre furnish has increased since 1995



Demand for pulp and waste paper in India

Demand for pulp and waste paper is expected to grow to close to 12 million tons by 2010



Future fibre supply/demand scenario

The future fibre supply scenario depends very much on the following:

- Increase of domestic wood availability. Hardwood pulp production is expected to increase from 0.9 million tons in 2000 to 1.5 million tons by 2015 and 1.8 million tons by 2020. The growth could be higher (or lower), depending on development of plantations in India. Most of softwood pulp, and the rest of hardwood pulp is expected to be imported.
- Development of recovery rate in India. In this scenario the recovery rate is expected to increase to 38 % by 2020. If it remains lower, then imports of waste paper would grow faster than forecasted.
- Non wood pulp production is expected to grow from 1.3 million tons in 2000 to 3.2 million tons by 2020. Non wood raw material will be available in India for this scenario, but due to technological, environmental, etc. reasons the actual development may be slower. In that case the balance would need to be imported as chemical pulp.

Pulp/waste paper supply/demand scenario

Project Number 52A0087

			Scenario			Growth	
		2000	2005	2010	2015	2000-2015	2020
				1000 tons			
Mechanical pulp	Demand	275	347	453	586	311	760
	Supply	240	340	450	580	340	750
		-35	-7	-3	-6		-10
Semi-chemical	Demand	0	0	0	0	0	0
	Supply	0	0	0	0	0	0
	Net trade	0	0	0	0	0	0
BSKP	Demand	85	140	202	299	214	430
	Supply	0	0	0	0	0	0
	Net trade	-85	-140	-202	-299		-430
BHKP	Demand	957	1234	1568	2150	1193	2930
	Supply	850	1000	1200	1500	650	1800
	Net trade	-107	-234	-368	-650		-1130
UKP	Demand	231	222	231	252	21	270
	Supply	220	220	220	230	10	250
	Net trade	-11	-2	-11	-22		-20
Sulphite	Demand	0	0	0	0	0	0
	Supply	0	0	0	0	0	0
	Net trade	0	0	0	0		0
Non wood pulp	Demand	1267	1490	1889	2481	1214	3200
	Supply	1268	1490	1889	2481	1213	1500
	Net trade	1	0	0	0		-1700
Recovered paper	Demand	1600	2496	3652	5283	3683	7300
	Recovery	850	1400	2500	3800	2950	5500
	Net trade	-750	-1096	-1152	-1483		-1800
Dissolving	Demand	390	420	470	500	110	520
	Supply	390	420	470	500	110	520
	Net trade	0	0	0	0		0

Fibre resources

The fibre resources used by the Indian pulp and paper industry come from three sources:

- **Forests**
  - including bamboos and mixed hardwoods from forest fellings, and Eucalyptus wood from plantations (both organized plantations and farmers' fields/agroforestry plots)
- **Agricultural residues**
  - such as bagasse, rice and wheat straws and cotton stalks
- **Waste paper**
  - including both domestic and imported waste paper.

Currently the proportions of each category in the total production of pulp and paper are 36, 29 and 35 %, respectively. Over the past years the share of forest based industries has declined.

Indian forest resources

India has a total land area of 328.8 million hectares (ha). Agricultural land occupies 47 % (154.7 million ha) of the total land area, while uncultivated, non-agricultural and barren land account for 30 % (99.3 million ha) of the land area. Forests and woodlands occupy around 20 %

Of the total forest area 38.6 million ha is considered as dense forest with a crown density of over 40 % while the rest about 31 million ha is considered as degraded forest lands. A large proportion of India's forest area is used for grazing.

The forests of the country vary from tropical rain forests in the south and the east to dry alpine forests in the Himalayas. They have been classified into 16 broad types and 251 sub-types on the basis of climatic and edaphic conditions for scientific management and development.

- Plantations are 50%, or 32.5 M ha, of the forest area. 90% of them consist of hardwood. However, only part of the plantations are for pulpwood.
- Additionally, there are 400 M ha of bamboo plantations that can be used for chemical pulping.

In spite of population pressure, forest area has increased by 38 M ha/year in 1990-2000.

Fuelwood remains a major competing use for native and plantation-grown wood.

Forest ownership in India

In India forests are mainly the property of the State. Public forest resources are directly managed by the government, or given in use to communities under various arrangements.

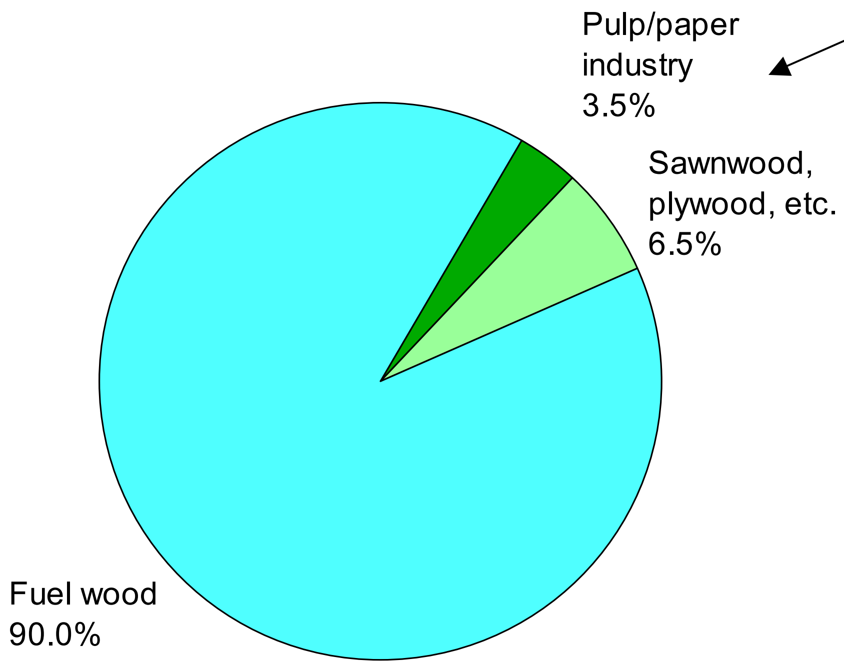
Private trees are grown on farms or community lands. Harvesting is usually carried out by the State Forest Development Corporations (SFDCs), while the private sector is mainly responsible for transport and processing.

Forest harvesting and utilization practices provide a tax base for the government. The management of natural forests through SFDCs and direct sale of timber provide substantial revenue to the state governments for financing major development activities.

Forests also provide direct employment to more than 300 000 people.

Wood consumption in India 2001

Pulp and paper industry uses only 3-4 % of total wood in India



Wood based paper industry uses about 5.8 million tons of wood

Trends in wood fibre use

The pulp and paper industry in India is largely based on the use of bamboos which are found in most of the forest types in India. The total availability of bamboo both from the state forest lands and private sources has been estimated to be 1.6 million t/a.

The trend has been towards increasing use of mixed hardwoods from natural forests and Eucalyptus both from farmers' fields as well as from plantations.

The major driving forces underlying this development have been the increasing scarcity of bamboos along with the technological developments in hardwood cooking and the increasing availability of Eucalyptus wood raw material.

However, the relative share of wood fibre in the papermaking fibre furnish has been declining due to the rapid growth in the use of agricultural residues and recycled fibre in paper production.

Forest policy – main considerations

In 1988, India adopted a new National Forest Policy following the enactment of the Forest (Conservation) Act of 1980. The inadequacy of the 1952 National Forest Policy was clearly recognized, as forests had suffered serious depletion after being treated solely as a revenue-earning resource. Also, the diversion of forest lands to non-forest uses had been allowed to continue without compensatory afforestation and essential environmental safeguards.

The main considerations in the policy governing the supply of wood raw material to the wood-based industries are the following:

- Fuel, fodder and timber requirements of the local community will take precedence over the raw material requirements of the industry
- Natural forest areas will not be allocated to industries as concessions for timber harvesting and plantations
- Imports of wood will be liberalized to reduce "industry pressure" on forests
- Industry-farmer/community partnerships should be established to procure raw material through private sources.

Forest policy – main impacts

The National Forest Policy has not specifically determined the role of the government in facilitating the raw material availability to the forest industry. The following approach has been used to tackle the problem:

- Promoting industry-farmer nexus
- Liberalization of imports of logs, wood chips and market pulp

The industry has taken the initiative through co-operation with private landowners and farmers, which has increased tree planting on private lands. The industry has been motivating the farmers to participate in agroforestry by providing them with supporting services such as technological inputs, good quality planting material, harvesting technology and marketing support. The co-operation between industry and farmers is appropriate but the volumes are not enough to solve the problem of good quality raw material supply to the wood-based industries.

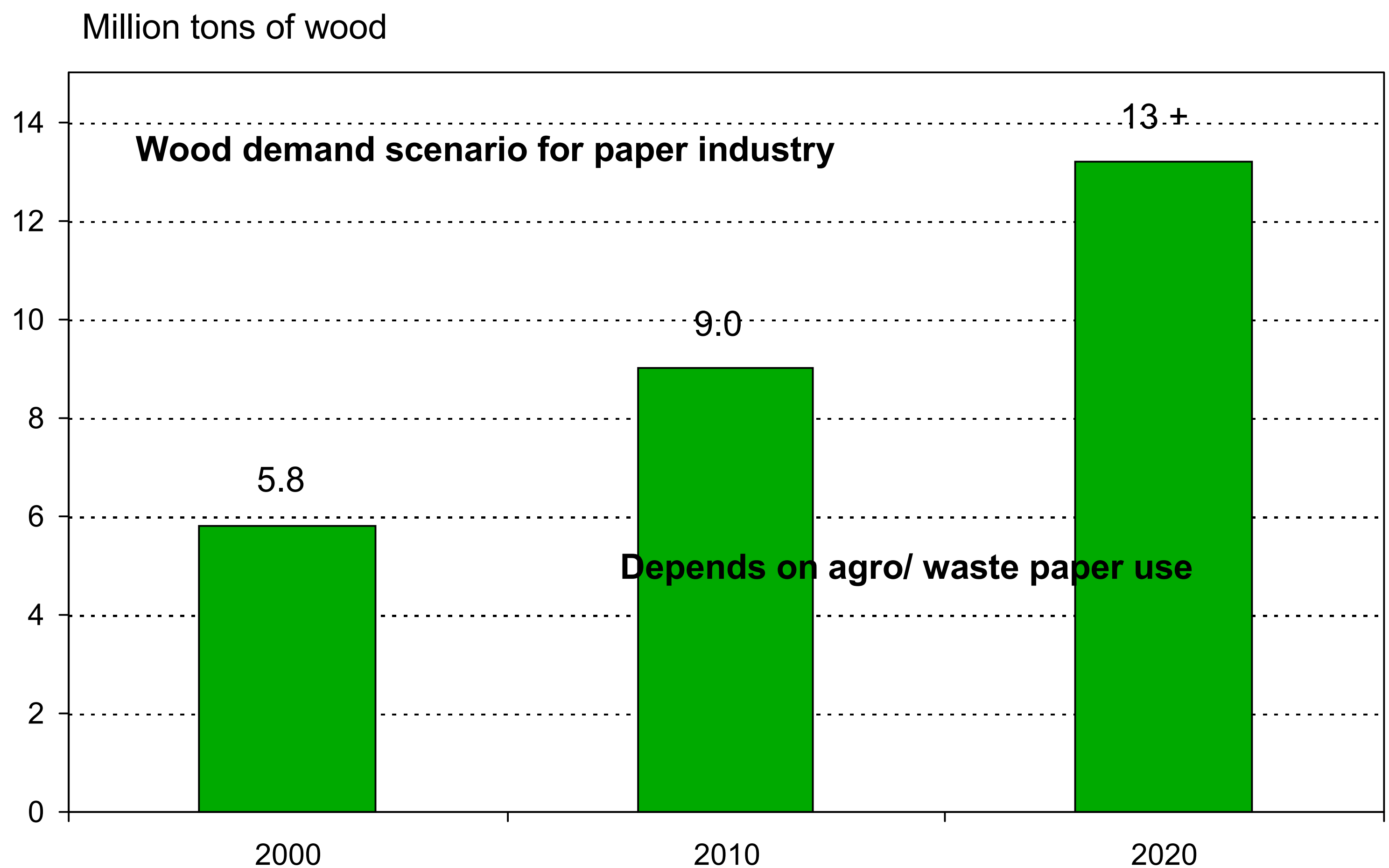
The policy of import liberalization does not provide a long-term cost-competitive solution to the industry's fibre shortage. The cost of imported pulpwood is in many cases too high to make import-dependent pulping operations attractive to the industry. Also the ports are not well equipped to handle wood chips.

However, India has a vast potential of waste and degraded forest land which could be employed for tree-growing operations. With appropriate incentives and the government's approval, these degraded land areas can be made productive through tree planting operations e.g. on a long-term lease basis. Acknowledging the fact that a number of companies are already considering investments in commercial tree planting abroad, there appears to be a case for creating a more precise forest policy framework in India.

Industrial wood demand scenario for India

Project Number 52A0087

The paper industry's wood demand is expected to grow from 5.8 million tons to 9 million tons by 2010, and to over 13 million tons by 2020.



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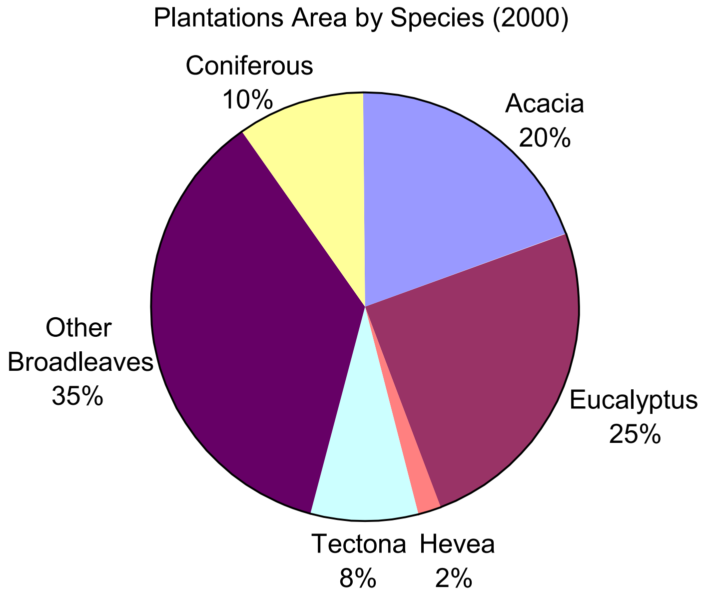
Securing future wood supply

- Current forest plantations in India are 32.5 million ha, of which 90 % is based on hardwood, mainly eucalyptus and acacia.
- The state of the current plantations and their potential for pulp mills should be carefully analysed.
- The paper industry's needs for wood is expected to grow from 5.2 million tons in 2000 to 13.2 million tons by 2020.
- About 0.6 million ha land for plantations would be required to meet the paper industry's wood demand. India has about 100 million ha of waste land and 32 million ha of degraded forest land, small part of which could be allocated for plantations.

Forest plantations in India

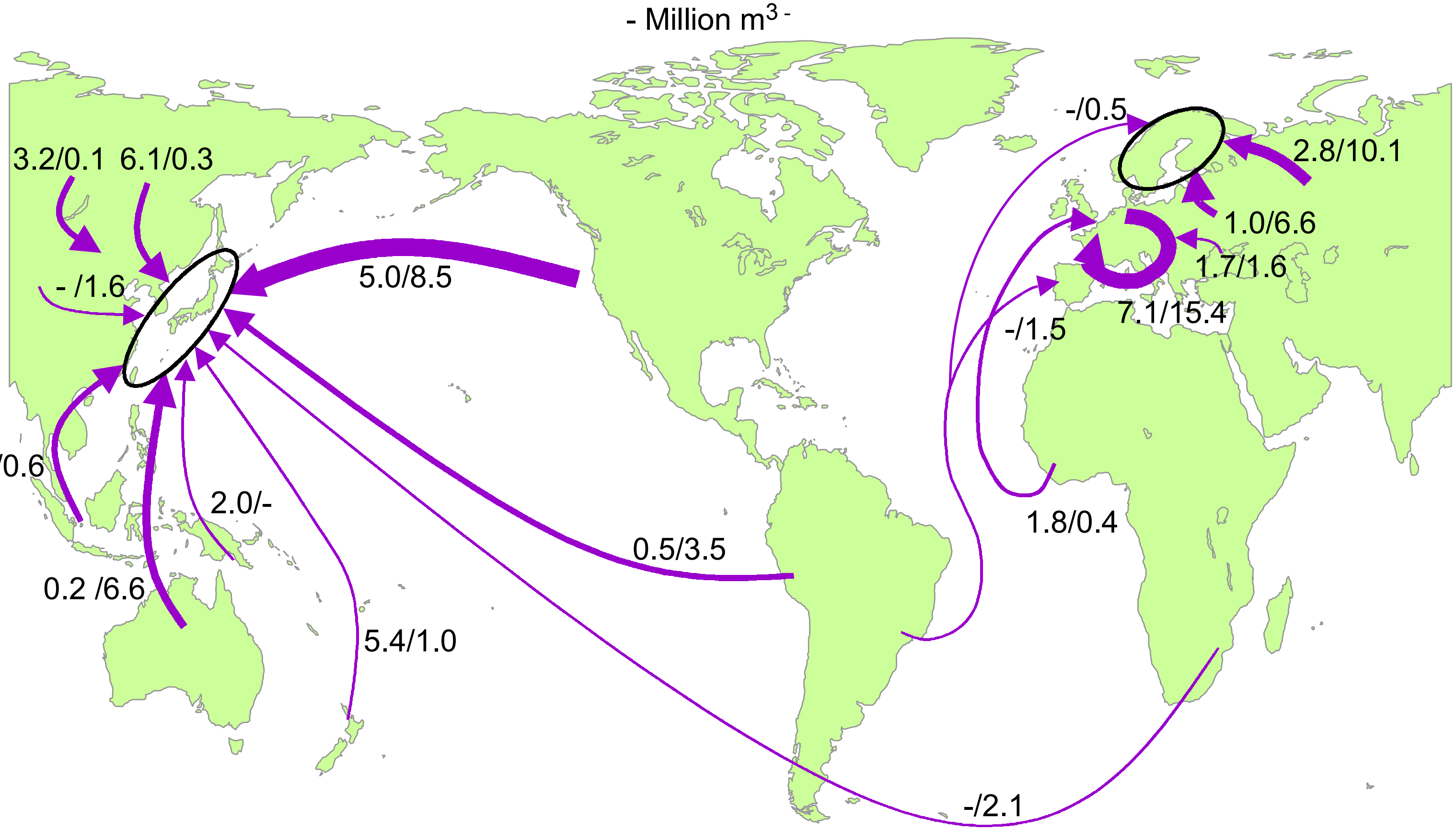


Total 32.5 million ha

Main trade flows of wood raw material 2000

Saw & plylogs / pulowood & ships

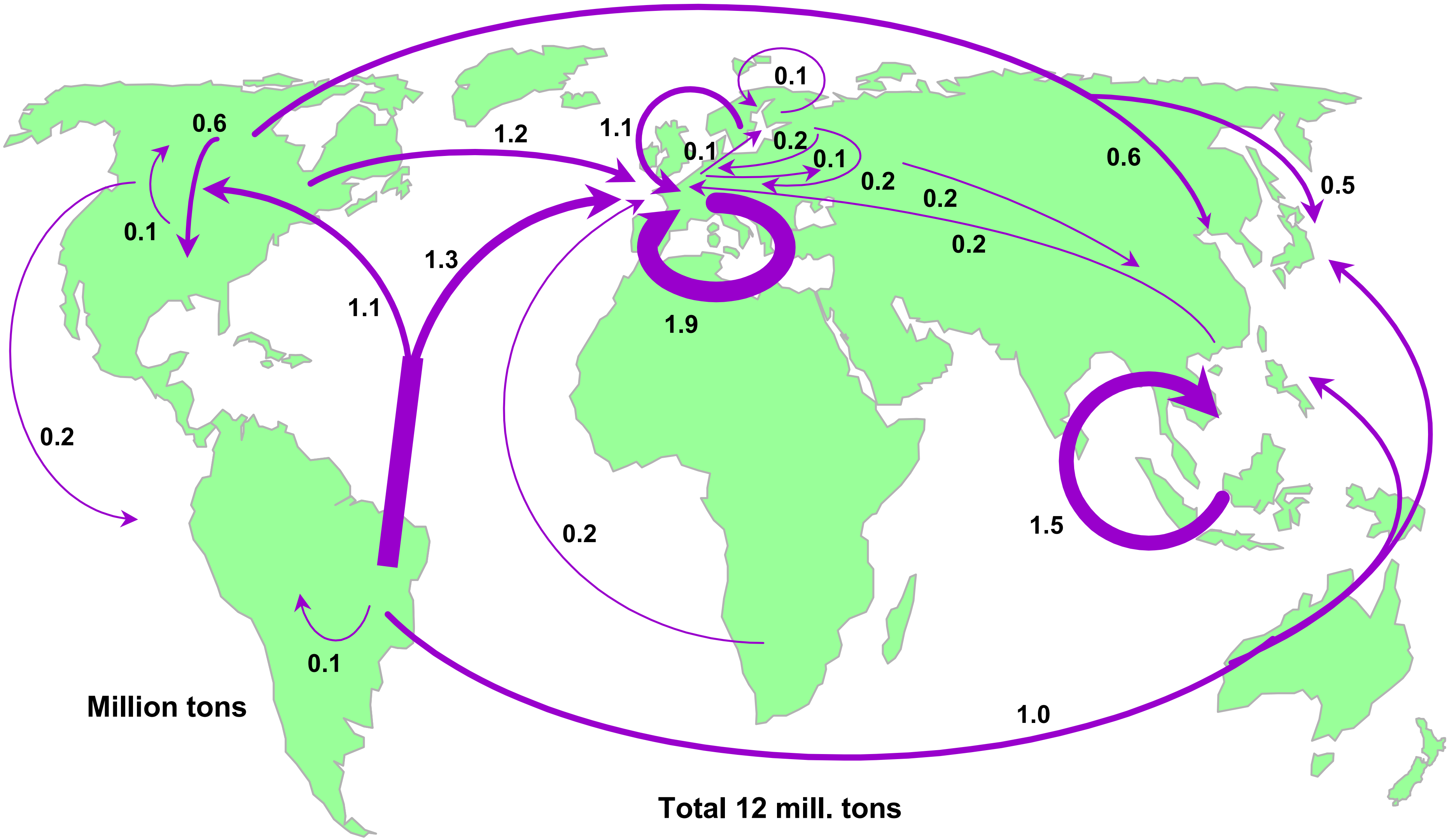
Importing wood is one option to cover wood deficit in India. However, it may not be feasible due to cost reasons*. Also ports are currently not well equipped to handle wood chips.



Imported wood chips would cost 70-90 USD/m3 C&F India

BHKP trade flows 2000

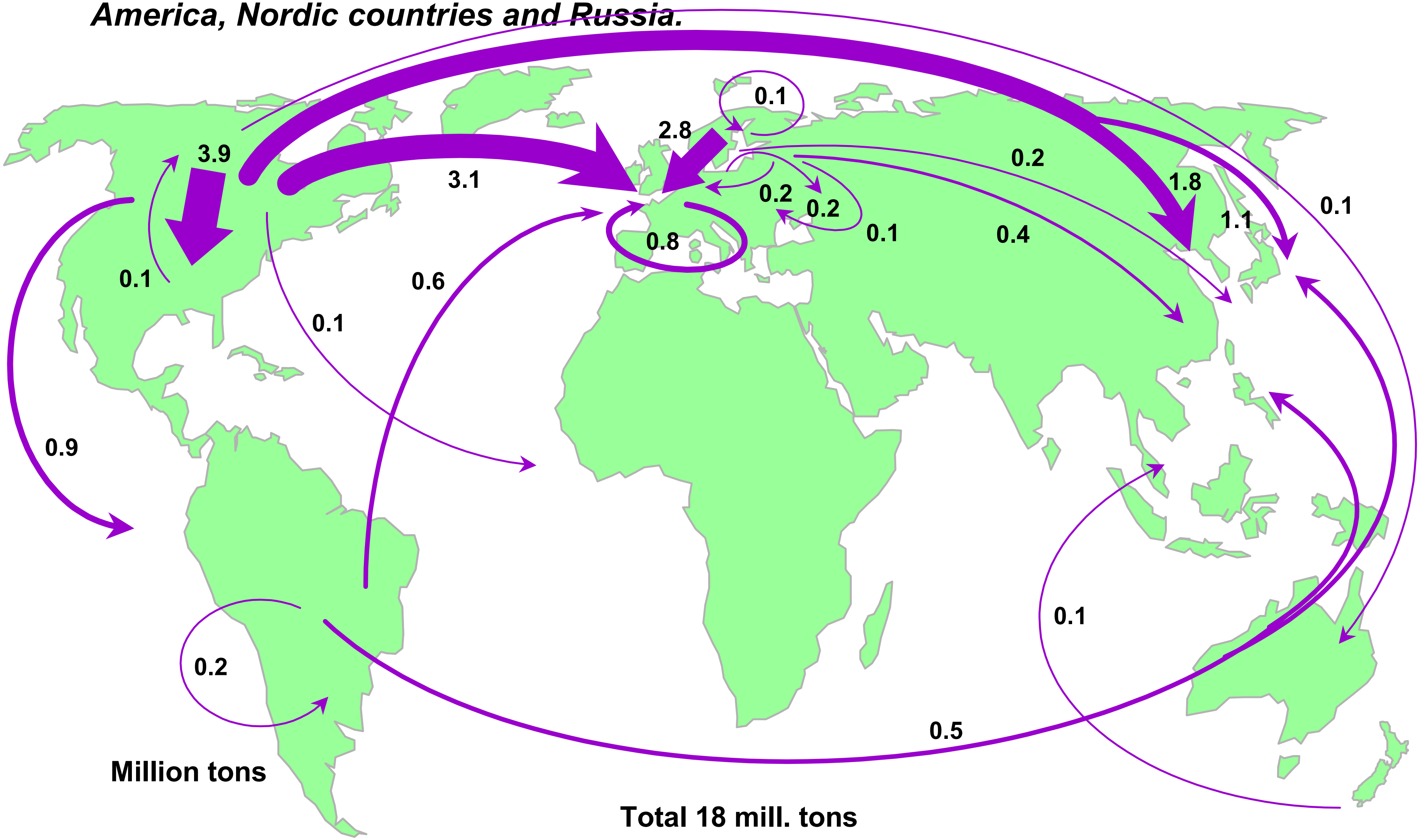
Bleached hardwood pulp would be available to India mainly from Indonesia, Brazil and North America



Total 12 mill. tons

BSKP main trade flows 2000

Bleached softwood kraft pulp would be available to India mainly from North America, Nordic countries and Russia.



Total 18 mill. tons

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Agricultural residues

Agricultural residues are emerging as a significant alternative raw material resource for the pulp and paper industry in India. Their share of total fibre use of the paper industry is 29 % (1.3 million tons). The use of agricultural residues has grown since the early 1970s partly due to the dwindling bamboo resources, and partly due to the government's industrial policy encouraging investments in agro-based paper production. Major incentives for investors included tax holidays, excise duty remissions and liberalized imports of machinery.

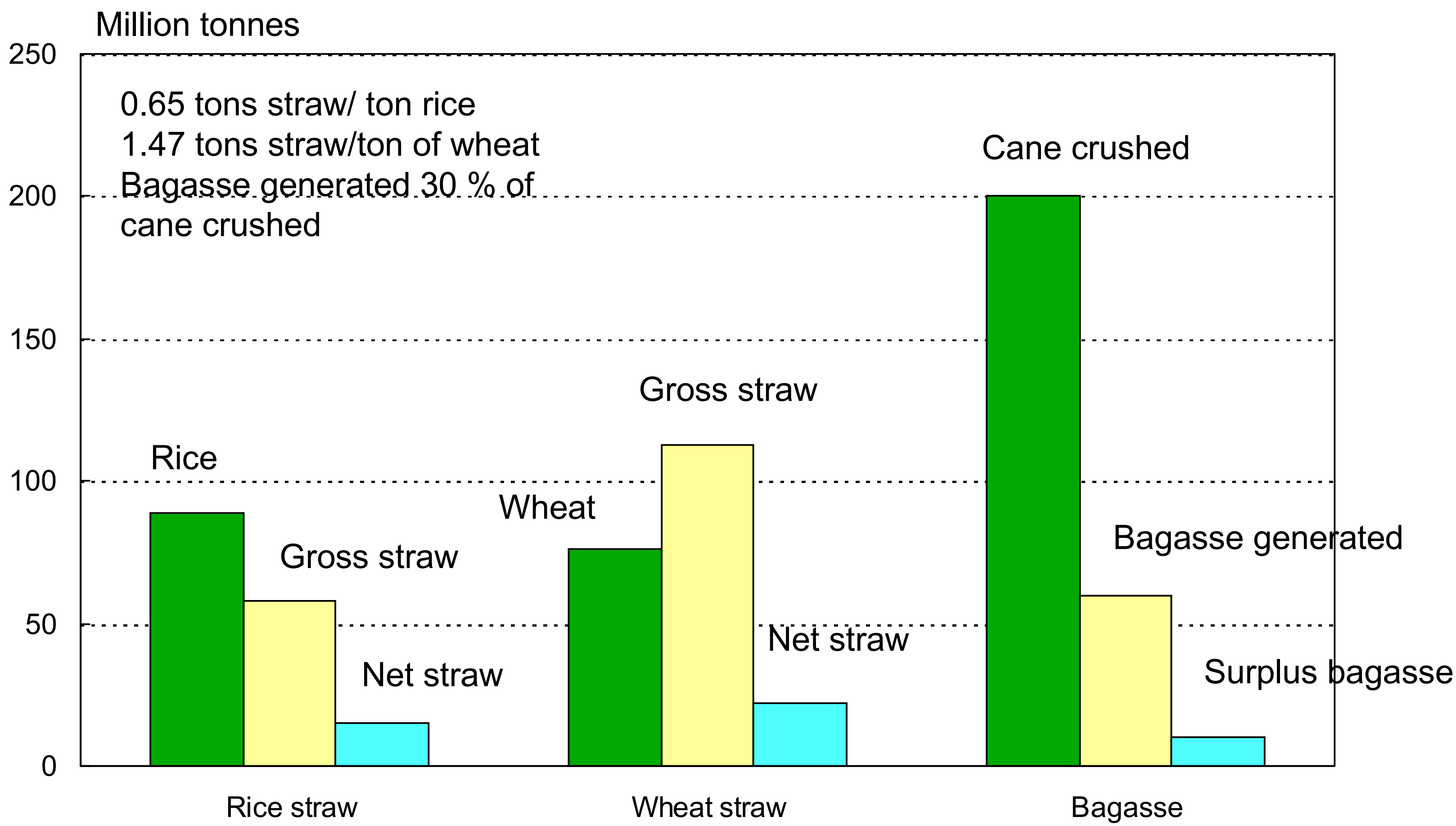
The main agricultural residues utilized by the paper industry include bagasse, cereal straws (wheat and rice), kenaf/mesta, jute sticks, grasses and cotton stalks.

Annual potential of agro based fibres in India 2001 (IAPMA estimate)

Agro residue	Availability Mill. tons	Tons needed for 1 ton of pulp	Pulp potential (theorethical)
Wheat straw	22	2.5-3.5	7
Rice straw	15	2.5-3.5	5
Bagasse	10	5.0-6.0	2
Jute, mesta, kenaf	2		
Total	**49**		**14+**

Today the agro-based paper mills use mainly bagasse and straw as raw material. Even if the theorethical availability of bagasse and straw is high there are limitations in their use – seasonal availability, transportation costs for long distances, investments in pollution control equipment, etc.

Availability of agro residues in India 2001



Source: IAPMA

Agricultural residues

Bagasse

Bagasse is an industrial waste which originates from the processing of sugarcane. India is the world's largest producer of sugarcane with a total production of close to 280 million tons. The sugar industry produces some surplus bagasse which is being utilized by the paper industry, particularly for the production of newsprint, cream- wove and maplitho grades.

Bagasse is released from the sugar mills to the pulp and paper industry in two ways:

– Surplus bagasse, which is released after meeting the energy needs of the sugar mills. The state-owned mills with old boilers hardly yield any surplus bagasse. However, the modern units in the private sector normally produce surplus bagasse in the range of 5-8 %, which constitutes a viable raw material base for small paper mills (<30 t/d).

– Substitute bagasse, which becomes available after replacement by other fuels such as coal, natural gas or fuel oil to meet the energy requirements of the sugar mills.

The average bagasse content in sugar cane has varied from 32 to 34 %, while the average fibre content has been in the range of 14-16 %.

The total supply of surplus bagasse cannot be increased to more than 5-8 % of the total cane crushed in the organized sugar mills. Considering the limited availability of surplus bagasse from the obsolete sugar mills, **the potential of surplus bagasse is estimated to be in the order of 10 million t/a (corresponding about 3 million tons of pulp). The energy use of bagasse is currently subsidised, which limits the availability of bagasse for paper industry.**

Agricultural residues

80 % of the production of sucar cane is concentrated into the following states:

- Uttar Pradesh 43.4 %
- Maharashtra 13.8 %
- Tamil Nadu 12.9 %
- Karnataka 10.3 %

Apart from its geographical concentration, the supply of bagasse poses a number of problems, including:

- Transport and storage of bagasse along with its seasonal availability
- Bagasse pulp offers no specific quality advantages over wood pulp. Bagasse has a number of disadvantages, though, including poor strength and drainage properties, low opacity, bulk and porosity
- Problems of chemical recovery and pollution control measures.

Despite its inferiority to wood pulps, bagasse pulp constitutes a realistic and economical alternative to bleached hardwood pulps particularly in printing/ writing paper applications.

Bagasse will continue to be an important raw material source for the Indian paper industry until alternative raw materials become available on a sustainable basis.

Agricultural residues

Cereal straws

The paper mills in India utilizing rice and wheat straw are typically very small with capacities up to 70-80 t/d or 24 000 t/a. **The total consumption of rice and wheat straws for pulp and paper production has been in the range of 0.4-0.5 million t/a, of which rice straw accounted for an estimated 70 %.**

Even though the use of cereal straw for papermaking is strongly encouraged and the potential availability is high, its use has been restricted to small paper mills. The main problems associated with the use of cereal straws as a source of fibre are:

– Scattered nature of the resource, which increases the cost of collection

– Bulky nature of the commodity, posing difficulties in transport and handling

– Seasonal availability (limited collection period of 45 d/a) necessitating ample space and elaborate arrangement for storage at the mill site

Due to the small scale of the industry coupled with the high silica content of straw raw material, the environmental status of straw-based mills tends to be lower than that of wood-based mills. New technological solutions have been recently developed to solve the environmental problems.

Straw pulp has several notable disadvantages such as poor strength and drainage properties, but also some favourable features such as formation and easy beatability. The uncertainties related to the raw material supply will, however, limit major capacity expansions despite the available surplus supply.

Agricultural residues

Grasses

The main grass species used by the Indian pulp and paper industry include Sabai (Eulaliopsis binata), Moonj (Saccharam bengalensis), Kahi (S. spontaneum), and Elephant grass (Themeda cymbania). Of these, Sabai is considered the most important due to its long fibre. Although the pulp quality obtained from the grasses, particularly sabai, is reasonable, their use is generally limited due to inadequate and uncertain availability, difficulties in harvesting and transport, and inefficient (manual) collection. The natural method of regeneration also contributes to the uncertainty of supply, as the yields from natural grassland areas are considerably reduced during drought years.

Kenaf (Mesta)

Kenaf is a tropical plant (Hibiscus sabdarifa) that is generally grown as a fibre crop for the manufacture of ropes and twines. Mechanical pulps from kenaf suitable for newsprint have been produced on an experimental scale in India. The bast fibre from the bark of the plant yields high quality pulp which can be utilized for the manufacture of paper. However, the different pulping properties of the bark and the stalk have caused a strong technical debate on the utilization of kenaf, which centres mainly around the use of the whole plant instead of the long-fibre bark alone. Consequently, kenaf has not been taken up on a significant scale as a fibre source for the manufacture of paper in India.

Jute and Jute Sticks

Jute is available for pulping in the form of old sacks, hessian and burlap cuttings, or jute sticks. The utilization of jute has been restricted although considerable work has been done by various Indian agencies on the use of jute sticks for pulp and paper manufacturing. Some official sources have also recommended that in view of the total quantity available (over 400 000 t/a), jute should be given more attention in pulp and paper manufacture.

India is one of the leading producers of jute in the world. West Bengal is the leading state followed by Assam, Bihar and Orissa. However, high collection costs, annual variations in production and high transport cost have inhibited its use. Besides, jute sticks are available only on a seasonal basis (November-January) and liable to rapid deterioration during storage. These disadvantages preclude serious consideration of jute sticks as a basis for new mills' capacity expansions.

Agricultural residues

Cotton Stalks/Cotton Linters

Both cotton stalks (residues of cotton crop) and cotton waste (clean cotton cuttings from textile mills, first cut linters, mill-run linters, second-cut linters and fluff from cotton mill exhaust systems) can be utilized for paper production. Cotton linter pulps are particularly advantageous for speciality paper grades (filter, laminate, bank note etc.) and cellulose derivatives that typically require high chemical purity. The price of cotton linters market pulp can be 2-3 times the price of standard BSKP.

The availability of cotton is restricted since the production is concentrated in few geographical zones. The production is highly sensitive even though the average annual availability of cotton stalks is estimated at 1.2 million t/a.

Sunn Hemp

Sunn hemp is widely grown in India as a fibre, green manure or fodder crop. Traditionally bast fibres of sunn hemp were used for manufacture of cordage. Due to competition from synthetic fibres and reduced export demand, the use of bast fibre for cordage has declined. However, there has been an increase in the use of hemp for papermaking, particularly specialty papers such as cigarette tissues. As with all other agricultural residues, the heavy cost of harvesting, handling and transport has restricted the use of this fibrous raw material.

Waste paper

Waste paper based industry accounts for about one third of Indian paper capacity. The recovery of waste paper has increased from 650 00 tons in 1995 to 850 000 tons in 2000. Most of paper is recovered, but due to alternative uses the recovery rate for paper industry is still only about 20 %. This is low by international standards: Thailand (42%), China (33%), Germany (71%).

Waste paper recovery and trading are still unorganised in India. The collection is being carried out by individual wheelers, and the system of sorting is unsophisticated. The Indian recovery is not keeping pace with recycled paper utilization, resulting in increase in Imports (700 000 tons in 2000). Multiple use of paper products (as wrapping papers, packaging applications, etc.) is common in India, and often these end uses pay better price for waste paper than paper industry.

The total availability of waste paper is divided between geographical regions as follows:

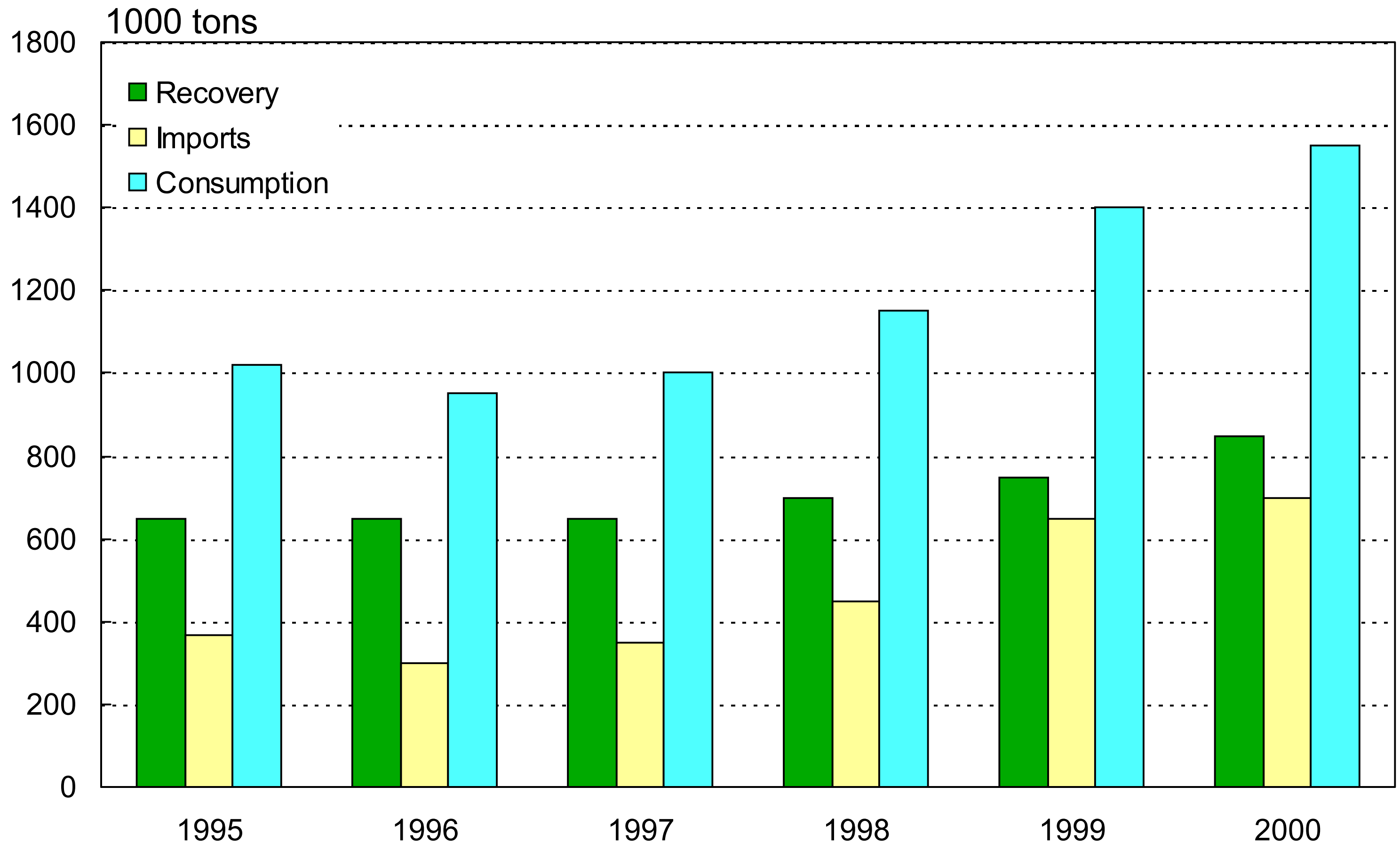
- Northern region 30 %
- Eastern region 10 %
- Southern region 20 %
- Western region 40 %

The main waste paper grades available for recycling are:

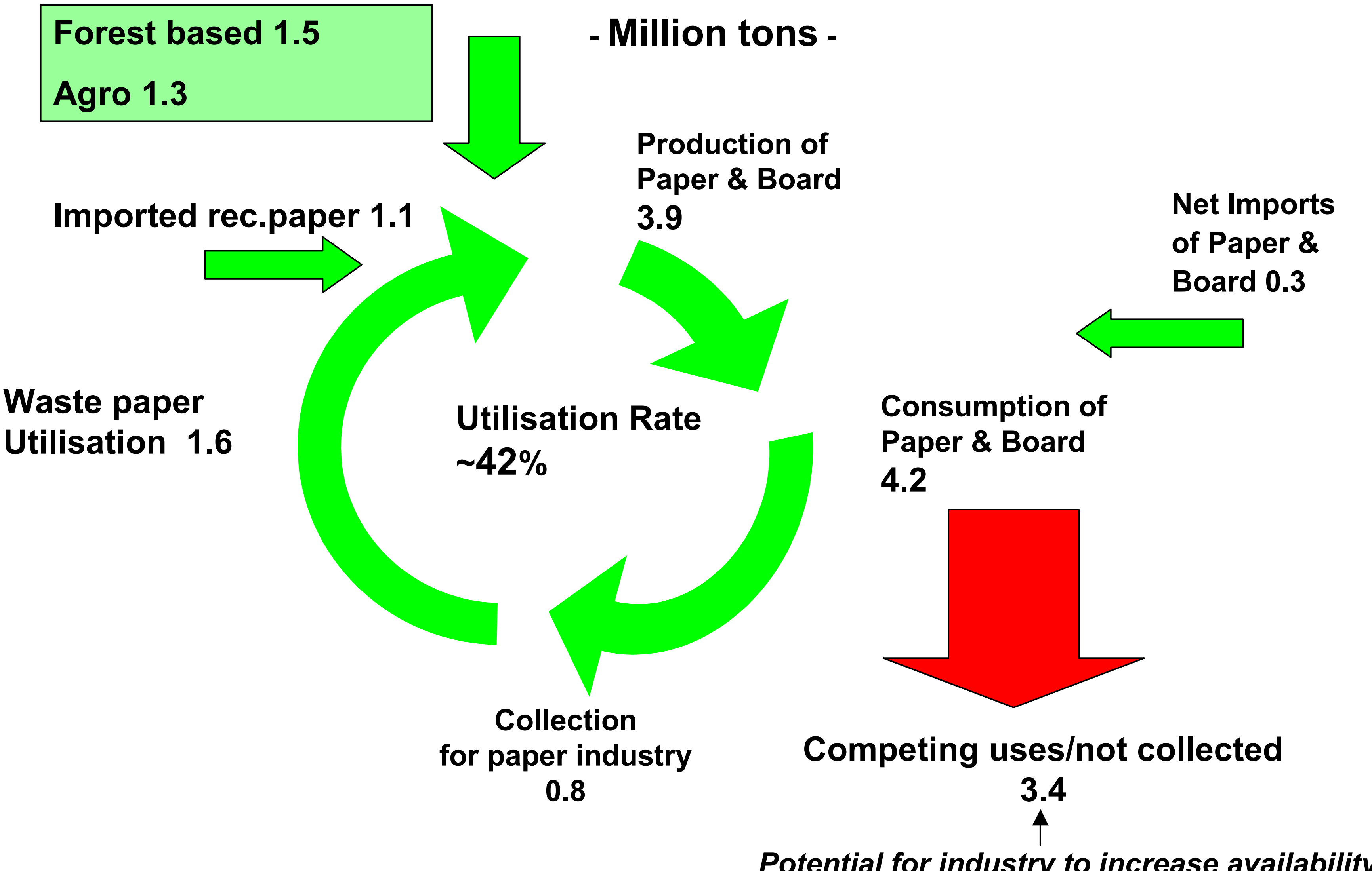
- Old corrugated containers 40 %
- Office refuse 20 %
- Old newspapers and magazines 20 %
- Mixed paper 20 %

Waste paper in India 1995-2000

Imports of waste paper have continuously increased accounting for about half of the consumption



Fibre flows in Indian paper production



India – waste paper utilisation 2000

Waste paper is used mainly for newsprint (as de-inked) and for packaging grades

Waste paper utilisation in Indian paper industry 2000

	MIXED	OCC	DE-INK	HG/PS	TOTAL	PAPER PROD.	RCP UTIL %
			1000 tons				
NEWSPRINT	0	0	210	0	210	456	46.0 %
WC PR/WR	0	0	0	0	0	0	
WF PR/WR	0	0	0	80	80	1530	5.3 %
TISSUE	7	1	7	6	20	30	65.7 %
CONTAINERBOARD	90	290	70	40	490	806	60.8 %
CARTONBOARDS	199	170	150	130	650	828	78.4 %
OTHER P&B	40	65	41	4	150	200	75.2 %
TOTAL P&B	**336**	**526**	**478**	**260**	**1600**	**3850**	**41.5 %**

Jaakko Pöyry estimates

Waste paper

The increasing recovery of recycled paper in India is driven by the following factors:

- Increasing total and per capita consumption of paper and paperboard
- Increasing urbanization and concentration of paper consumption
- Increasing demand for recycled paper by the paper industry which is partly dictated by the severe shortage of papermaking fibres in the country
- Government incentive policy promoting the use of non-conventional fibre raw materials
- The risk of an international shortage/price peaks of waste paper due to increasing recycling levels in North America and Western Europe, and the increasing dependence of Asia-Pacific and Latin American paper industries on offshore waste paper supply.

The above factors will all work in the same direction, i.e. improve the collection organizations and increase the paper industry's participation in collection and sorting of domestic wastes.

Importing low priced mixed waste paper, and sorting it in India could be a feasible solution to increase availability of waste paper to mills at lower costs.

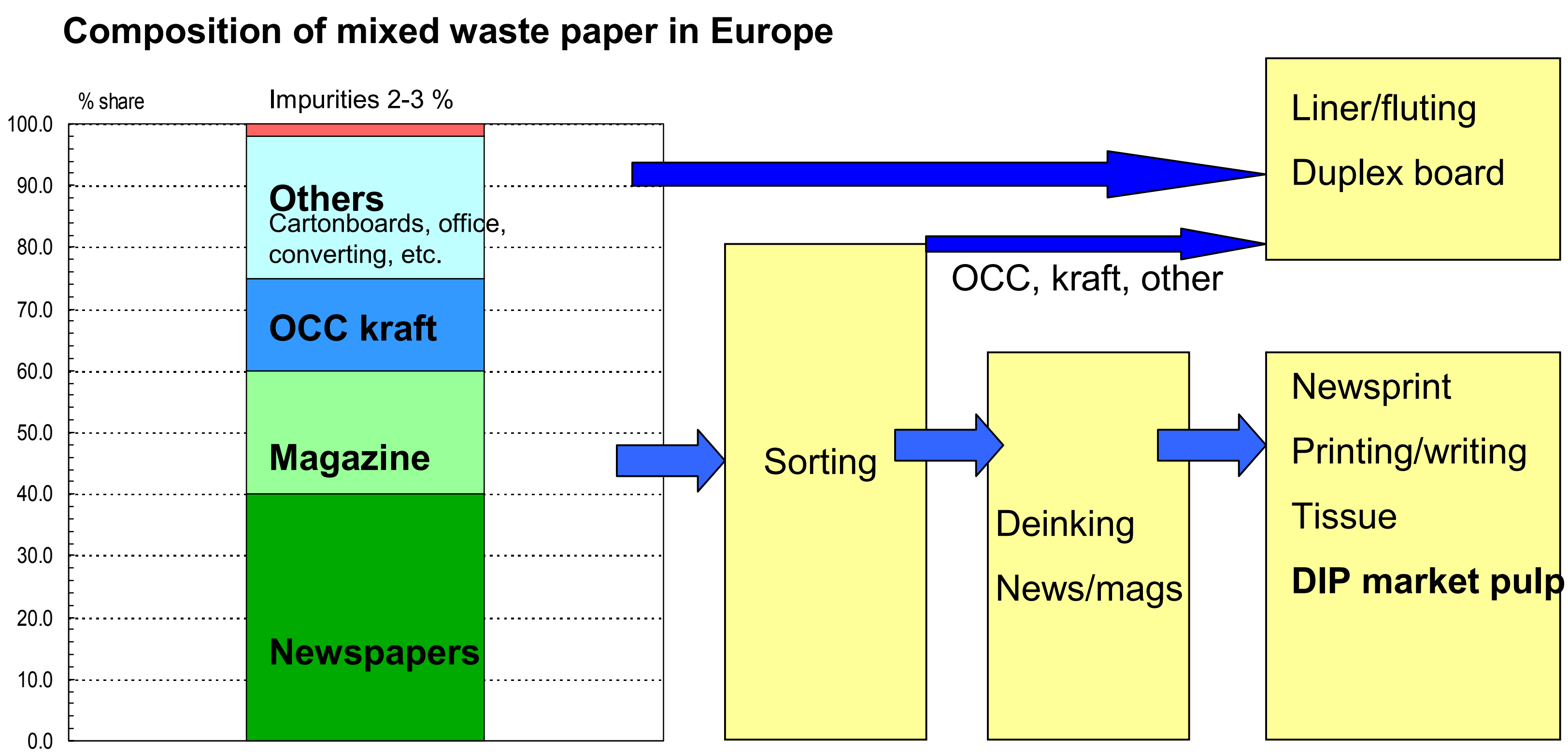
Separating long and short fibres by fibre fractionation from waste paper at the mill is one possibility to improve the supply of long fibres.

Source for waste paper in India

Sources	Type of waste paper	Improving availability
Households	Old news, mags, mixed	Difficult to increase collection rapidly due to competing (and better paying) uses for waste paper
Supermarkets/shops	OCC, packaging waste	**Paper mills and collectors could try to tie these sources with long term contracts, etc.**
Publishers/printers	Overissued news, high quality printing waste, cuttings etc.	
Paper converters	OCC/good quality converting waste	**Forward integration with converting would ensure availability of converting broke**
Industry	OCC/Packaging waste	
Offices	Office waste	Potential source in big cities

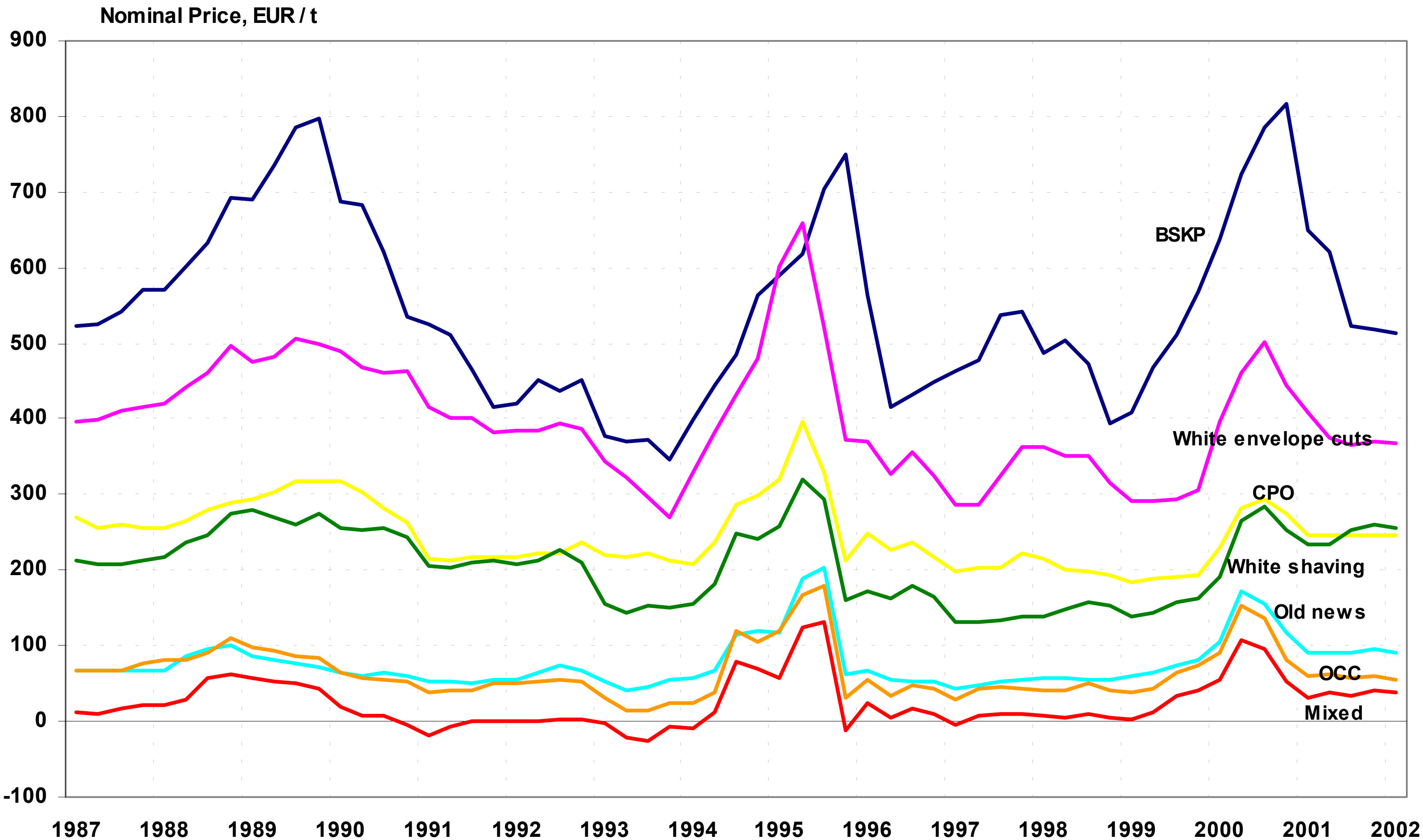
Sorting of mixed waste paper

Sorting of imported mixed waste paper could be one option to enhance the value of the fiber. The "white" and "brown" parts of the mixed waste paper could be used for different applications.



Waste paper price development in Germany

Waste paper prices fluctuate in international markets. The price of mixed waste paper has been several times 0 or even negative



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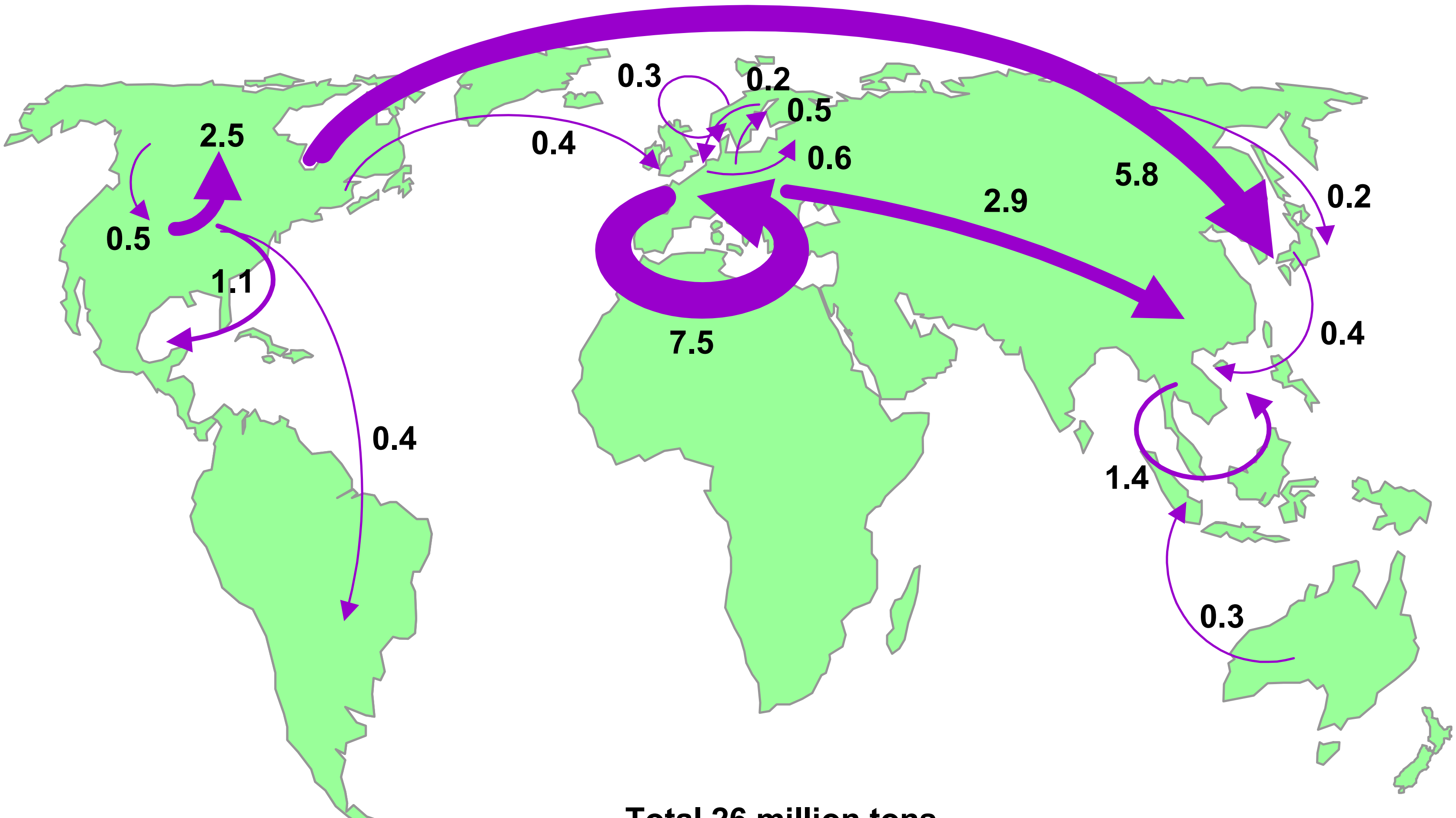
Waste paper

Major trade flows 2000, million tons

Main sources of waste paper from international markets are the USA and Europe



Total 26 million tons

4. Industry Structure

Indian pulp and paper industry

The Indian paper industry consists of 500 mills with mill capacities ranging from less than 1000 t/a to over 100 000 t/a. In 2002, the country's total paper and paperboard capacity amounted to 6.2 million t/a, of which about 5.1 million t/a was registered as operational while the balance 1.1 million t/a was reported as idle capacity.

The industry is highly fragmented. Top five producers account for about 25 % of the capacity.

The largest paper companies in India are typically owned by large private industrial conglomerates, or by the state. The paper companies belonging to major industrial groups have a better financial structure to carry out large expansion or modernization investments. The main producers are shown in the following chart.

Most of Indian pulp and paper companies are small, independent producers running only one mill. Most of them are village-scale producers with limited influence beyond their respective market areas.

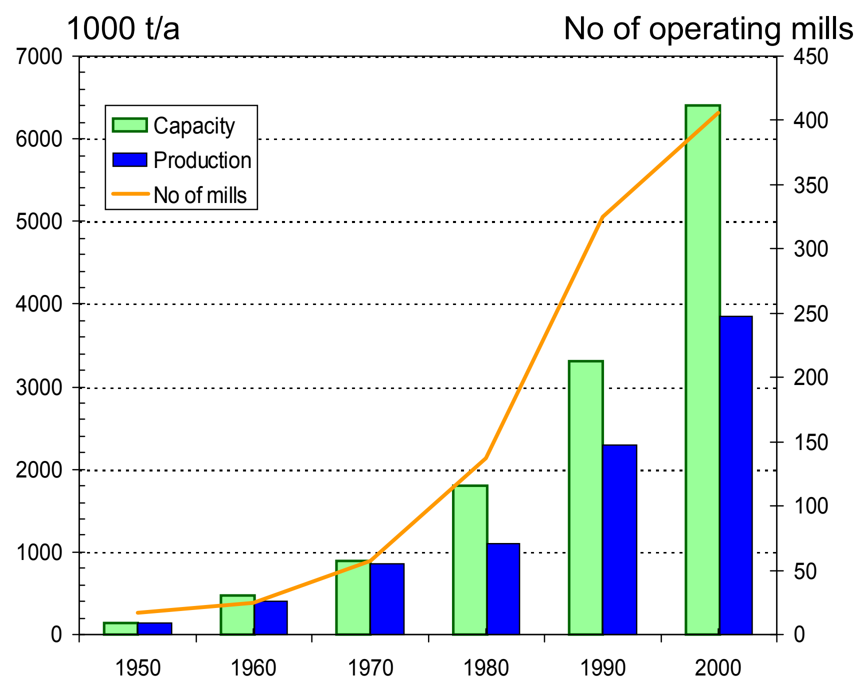
The geographical concentration of the industry is determined by market access, raw material availability and availability of other production inputs (water, electricity, skilled labour, etc.). The main production centres are: Bombay area, Delhi area (widely spread in Uttar Pradesh, Pujab and Haryana), around Kolkata in West Bengal and north of the city of Madurai in Tamil Nadu.

Development of Indian paper industry

Indian paper industry is highly fragmented, which is largely due to government policy in the 1970s

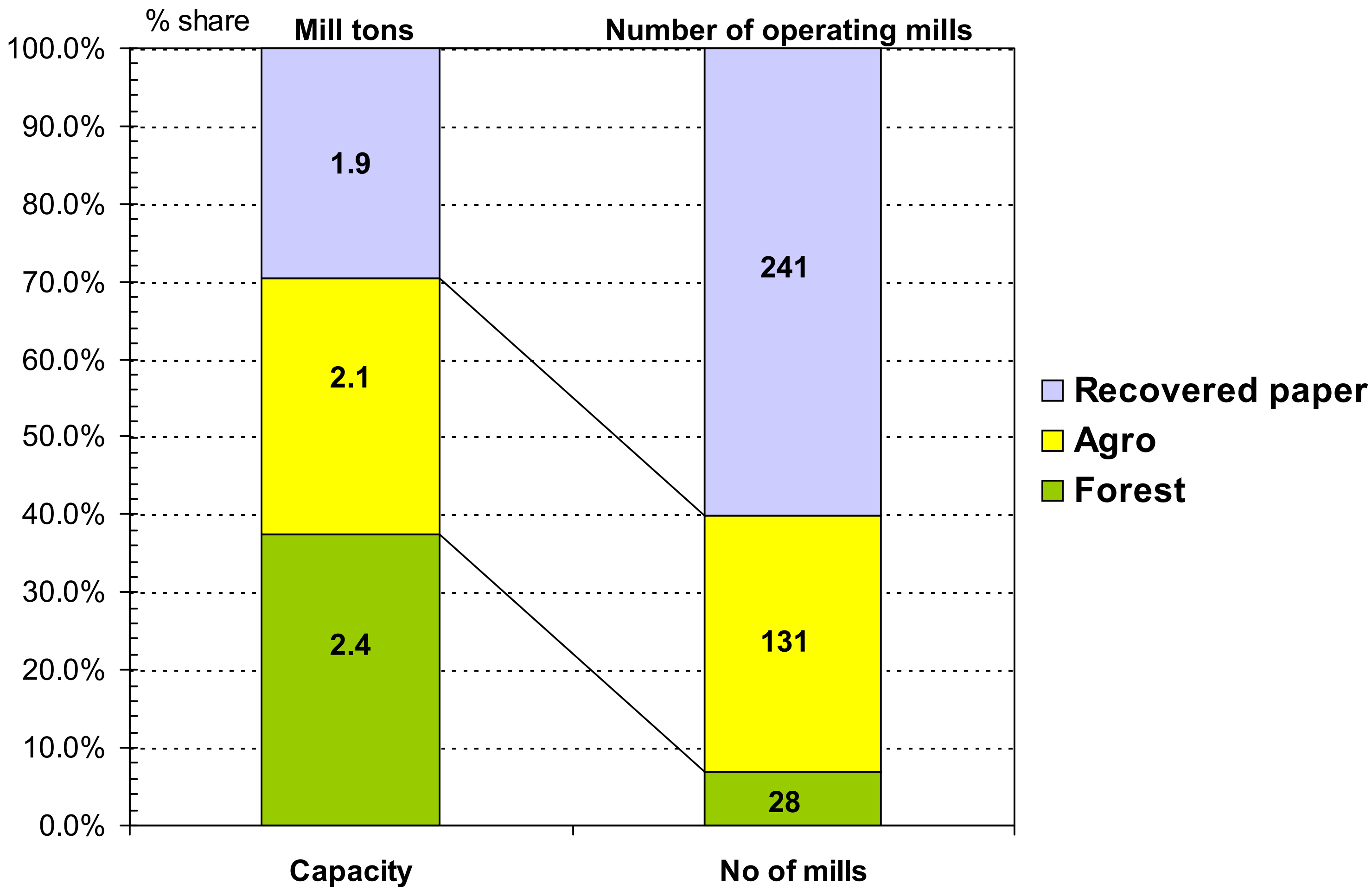
- In the 1970s excise concessions were given to small agro based mills, which resulted in a rapid increase of small mills and capacity.
- In the late 1980s the industry was in a severe oversupply situation, capacity utilisation rates being around 60 %.
- In early 1990s the government reversed the policy making large units more competitive (eg. by removing excise concessions from agro based mills).
- Today the installed capacity is over 6 million tons, of which about 1.1 million tons is idle.

Paper capacity and production in India 1950-2000



Structure of Indian Paper Industry

Production capacity is almost equally divided into three main fibre groups, but less than 10 % of mills are forest based



Paper mill structure in India 2001

There are over 500 paper mills in India. Most of the mills are small, only 34 mills have a capacity of over 33 000 tons. The Indian paper machines are mostly small units. In an international comparison, even the largest machines are medium-size, as large-scale machines are today in the range of 400 000-600 000 t/a, and have a trim width up to 10 metres.

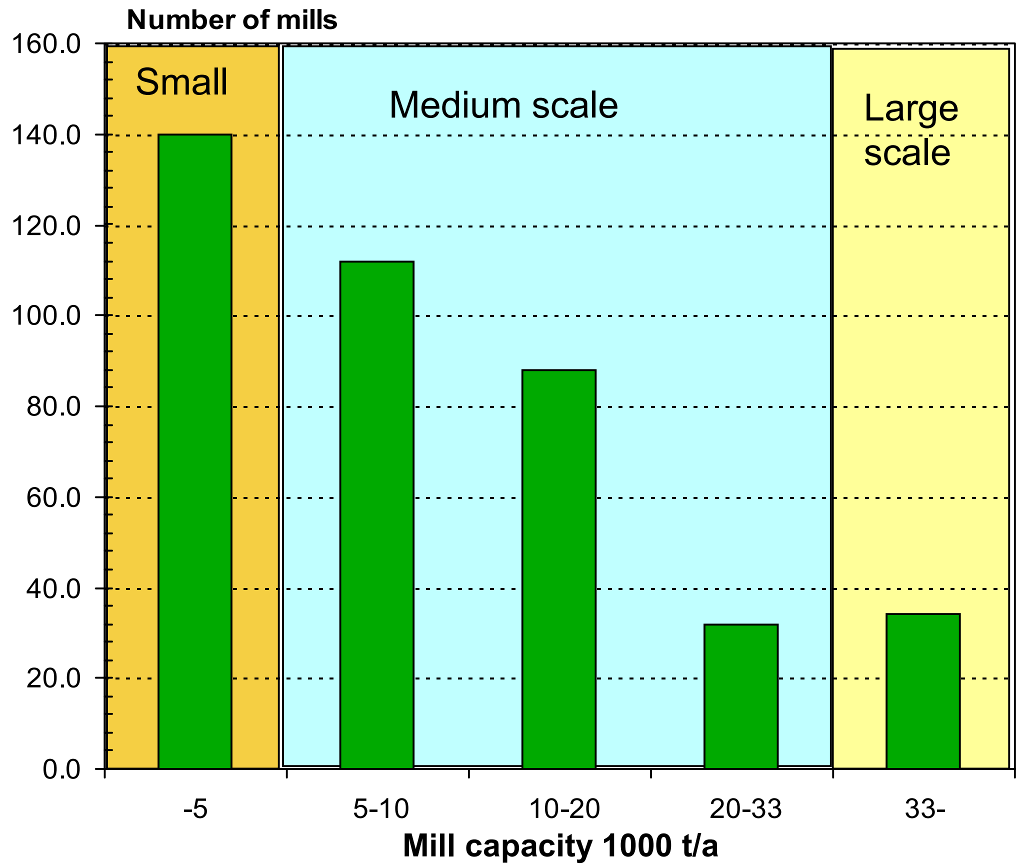
The following parameters are illustrative of the Indian paper industry:

The average capacity of paper machines is about 14 000 t/a

Most of Indian paper machines have a trim width from 1.5 to 3.5 m

There are only 9 paper machines with trim width of 5 m or more

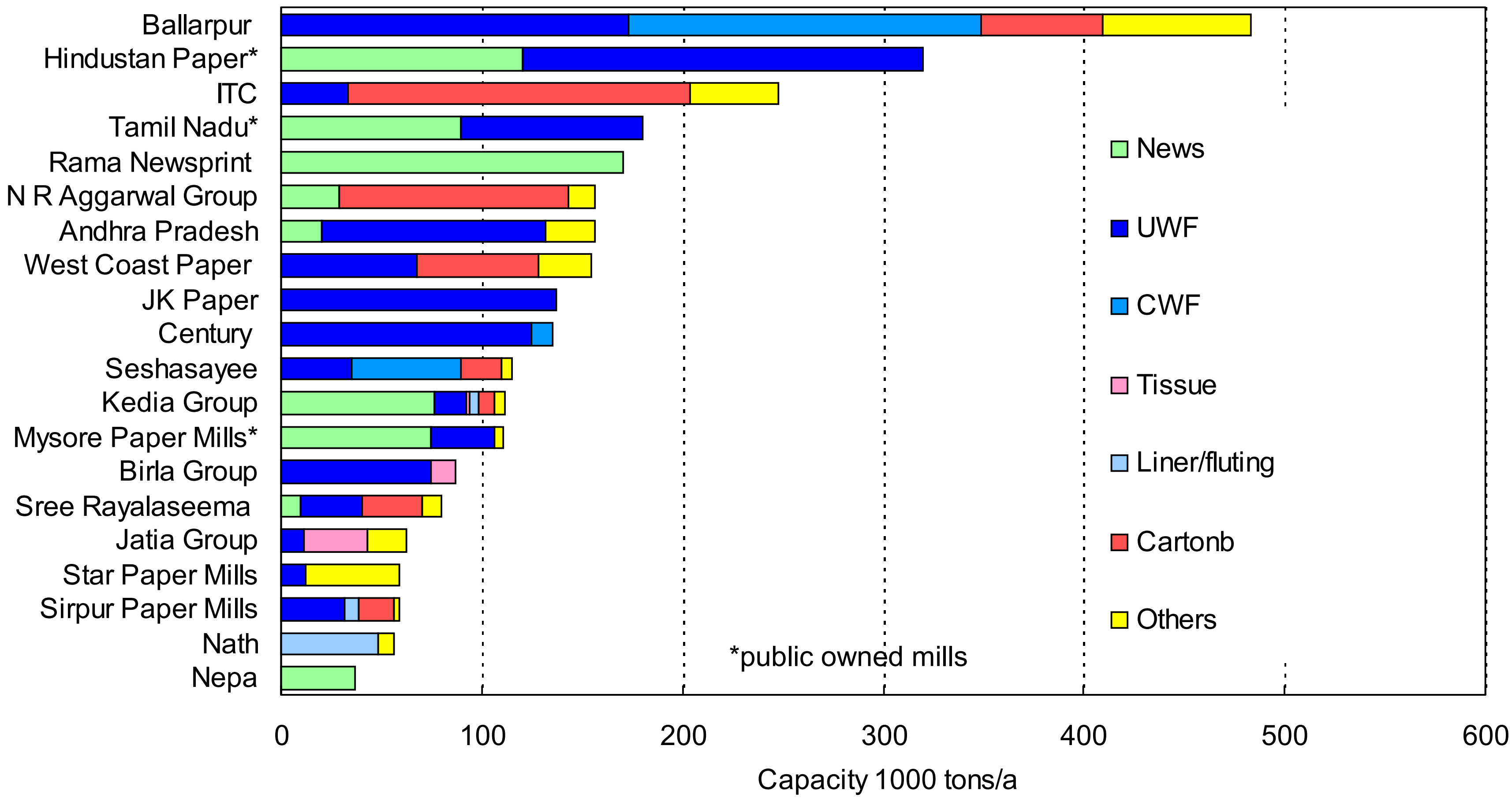
Only 14 machines have capacities 50 000 t/a or more



Major paper producers in India 2002

Project Number 52A0087

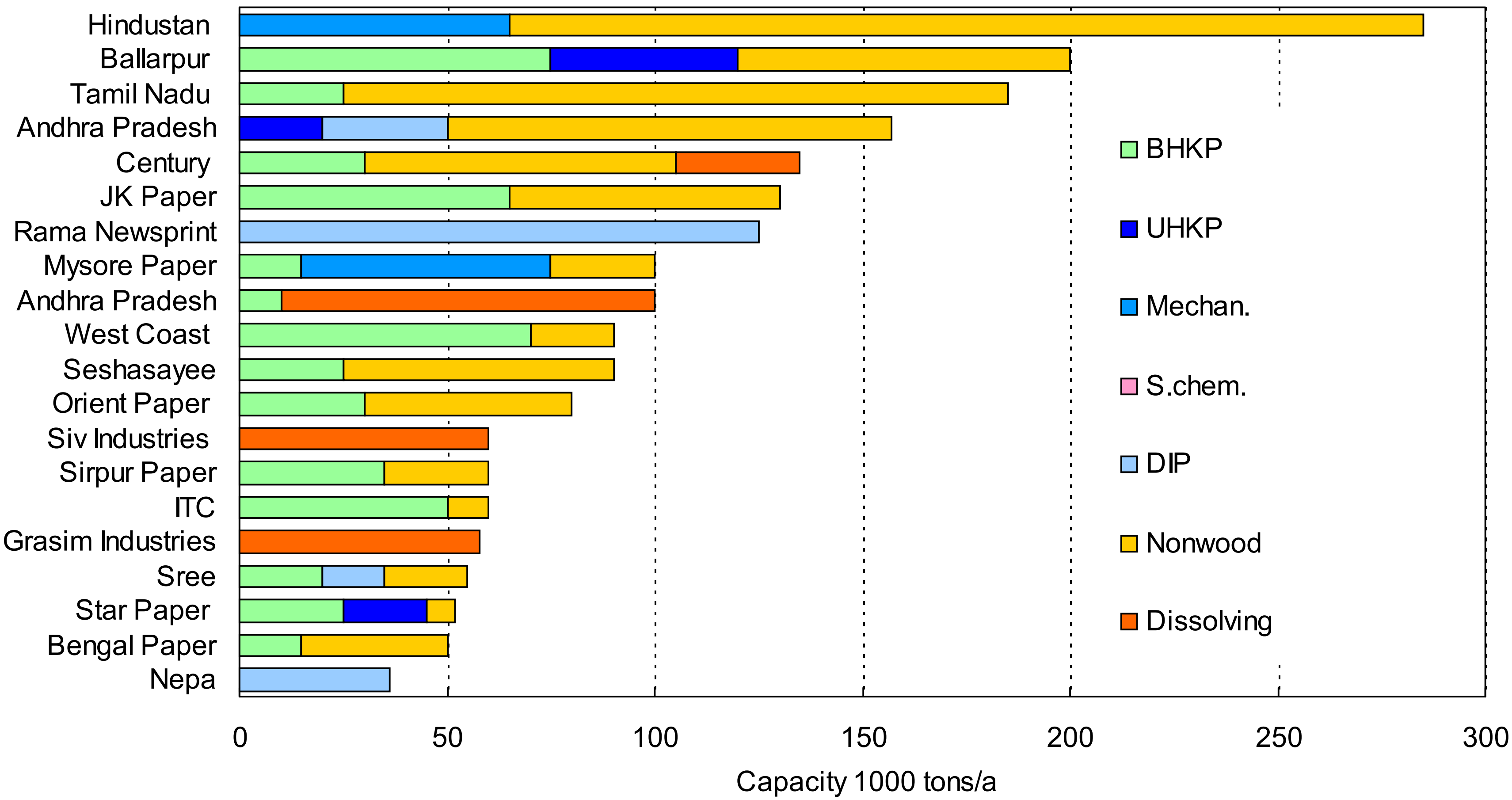
The biggest producers focus on printing and writing papers, newsprint and cartonboards



Major pulp producers in India 2002

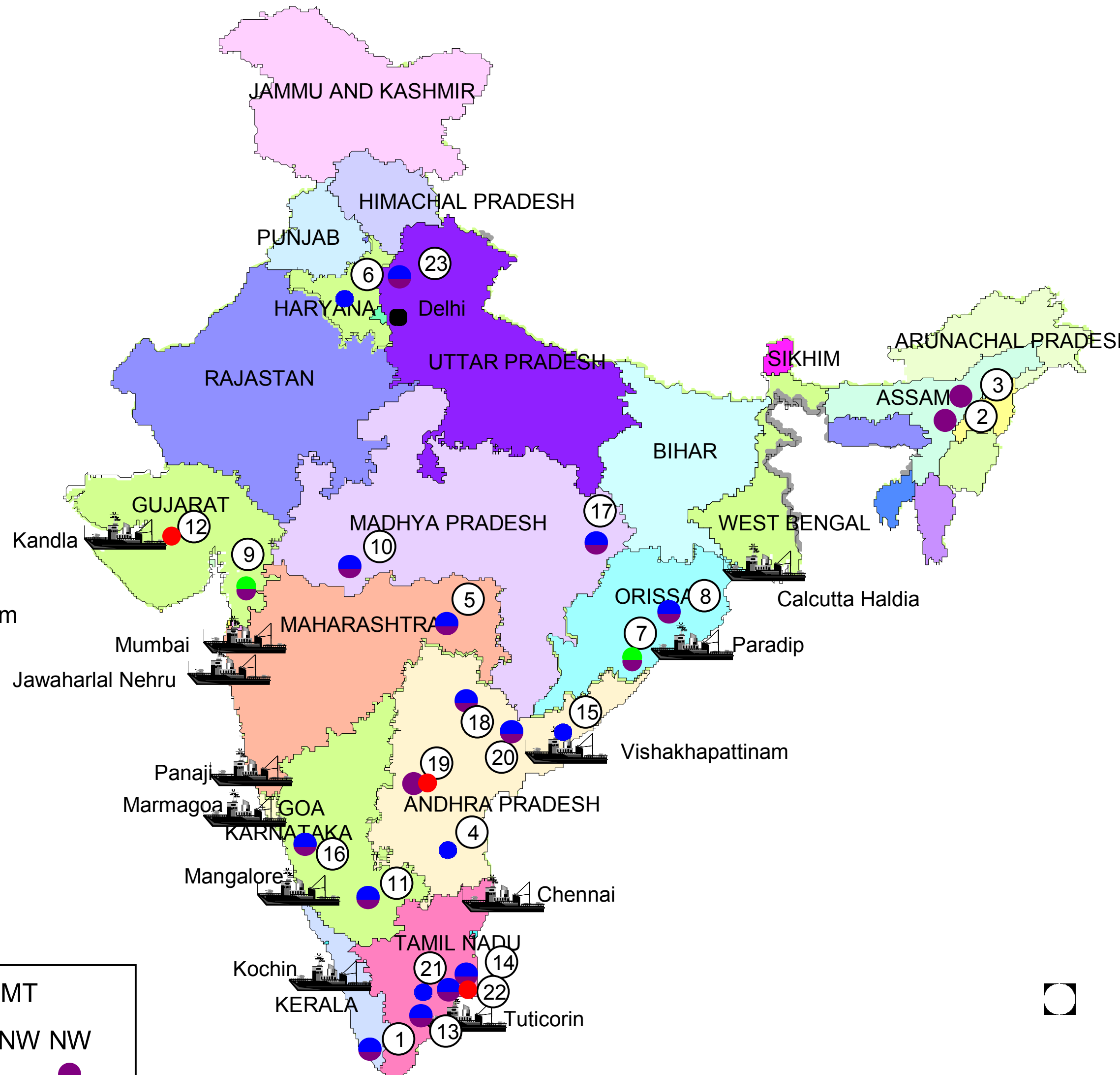
Project Number 52A0087

The biggest wood based mills of paper grade pulp include Rama Newsprint, Ballarpur, Mysore and Hindustan. Andra Pradesh is the biggest dissolving pulp producer.



India - Resource Map

1 Hindustan - Kottayam
2 Hindustan - Cachar
3 Hindustan - Kajag Nagar
4 Ballarpur - Kamalapuram
5 Ballarpur - Ballarshah
6 Ballarpur - Yamunanagar
7 Ballarpur - Jeypore
8 JK Paper - Jaykapur
9 JK Paper - Fort Songadh
10 Nepa - Nepanagar
11 Mysore - Bhadravati
12 Rama Newsprint - Magdalla Port
13 Seshasayee - Erode
14 Tamil Nadu - Kagithapuram
15 Andhra Pradesh - Rajahmundry
16 West Coast - Dandeli
17 Orient Paper - Amlai
18 Sirpur - Sirpur
19 Coastal Papers - Kadiam Mandalam
20 ITC Bhadrachalam - Sarapaka
21 Siv Industries - Mettupalayam
22 Sree Rayalaseema - Kurnool
23 Star Paper Mills - Saharanpur



Map legend

Ports

Manufacturing assets 0-1.5 MM GMT

HWD SWD RCF SWD/NW HWD/NW NW

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Industry structure in India

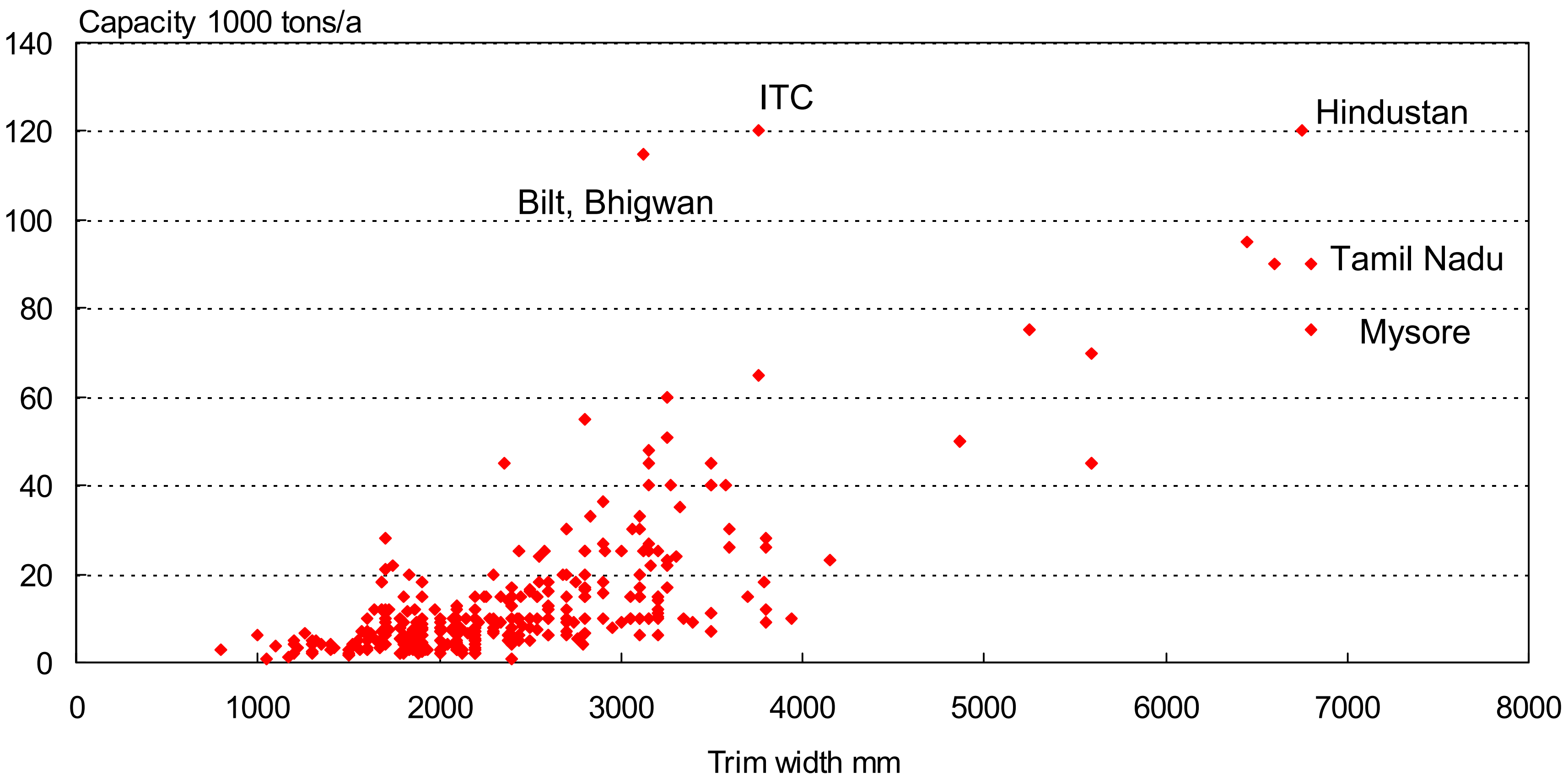
The Indian paper machines are mostly small units. In an international comparison, even the largest machines are medium-size, as large-scale machines are today in the range of 400 000-600 000 t/a, and have a trim width up to 10 metres.

The following parameters are illustrative of the Indian paper industry:

– The average capacity of paper machines is about 14 000 t/a
– Most of Indian paper machines have a trim width from 1.5 to 3.5 m
– There are only 9 paper machines with trim width of 5 m or more
– Only 14 machines have capacities 50 000 t/a or more

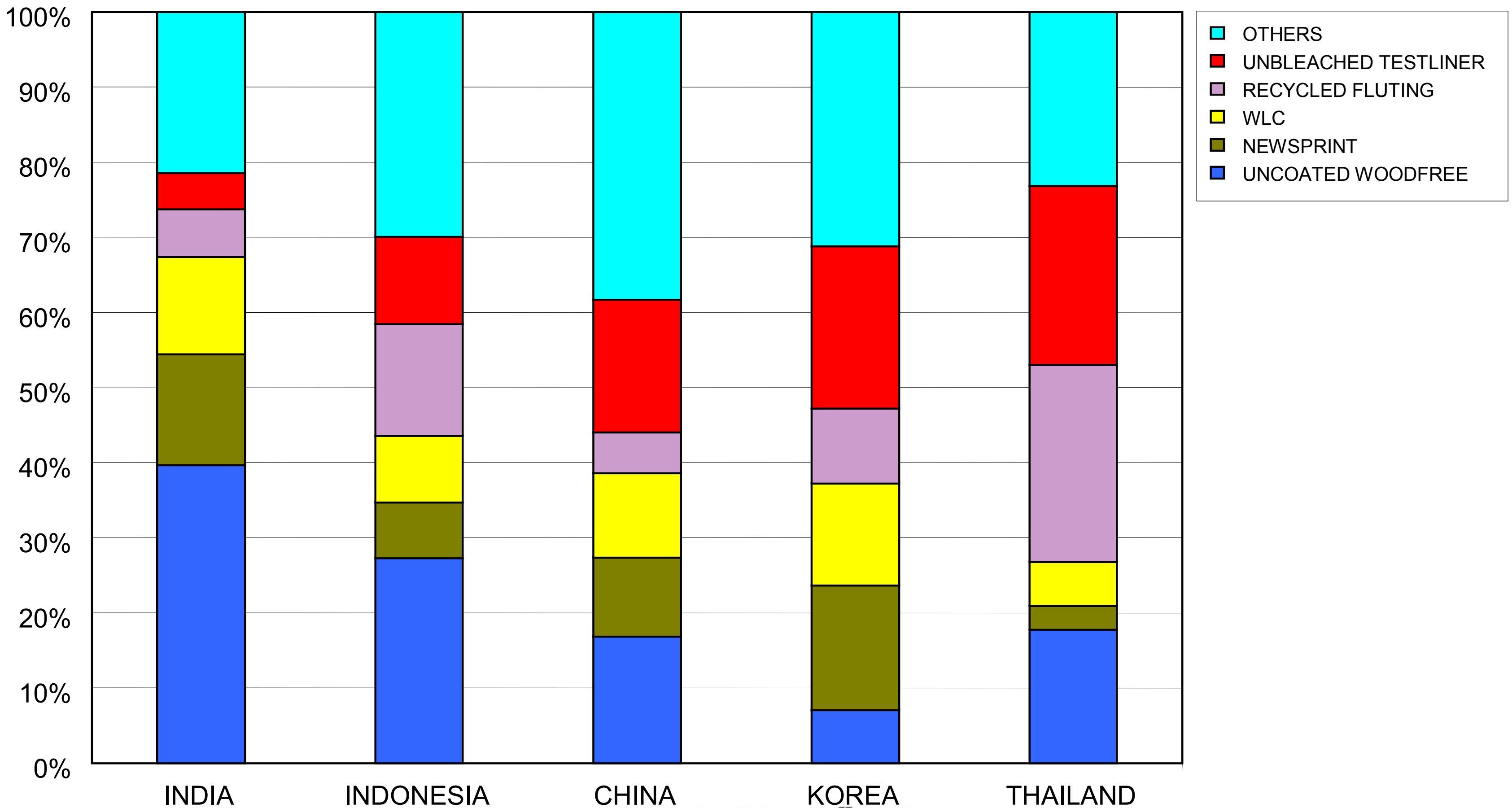
Paper machines in India 2002

Most Indian paper machines have a trim width less than 3 metres



Paper capacity structure vs. region

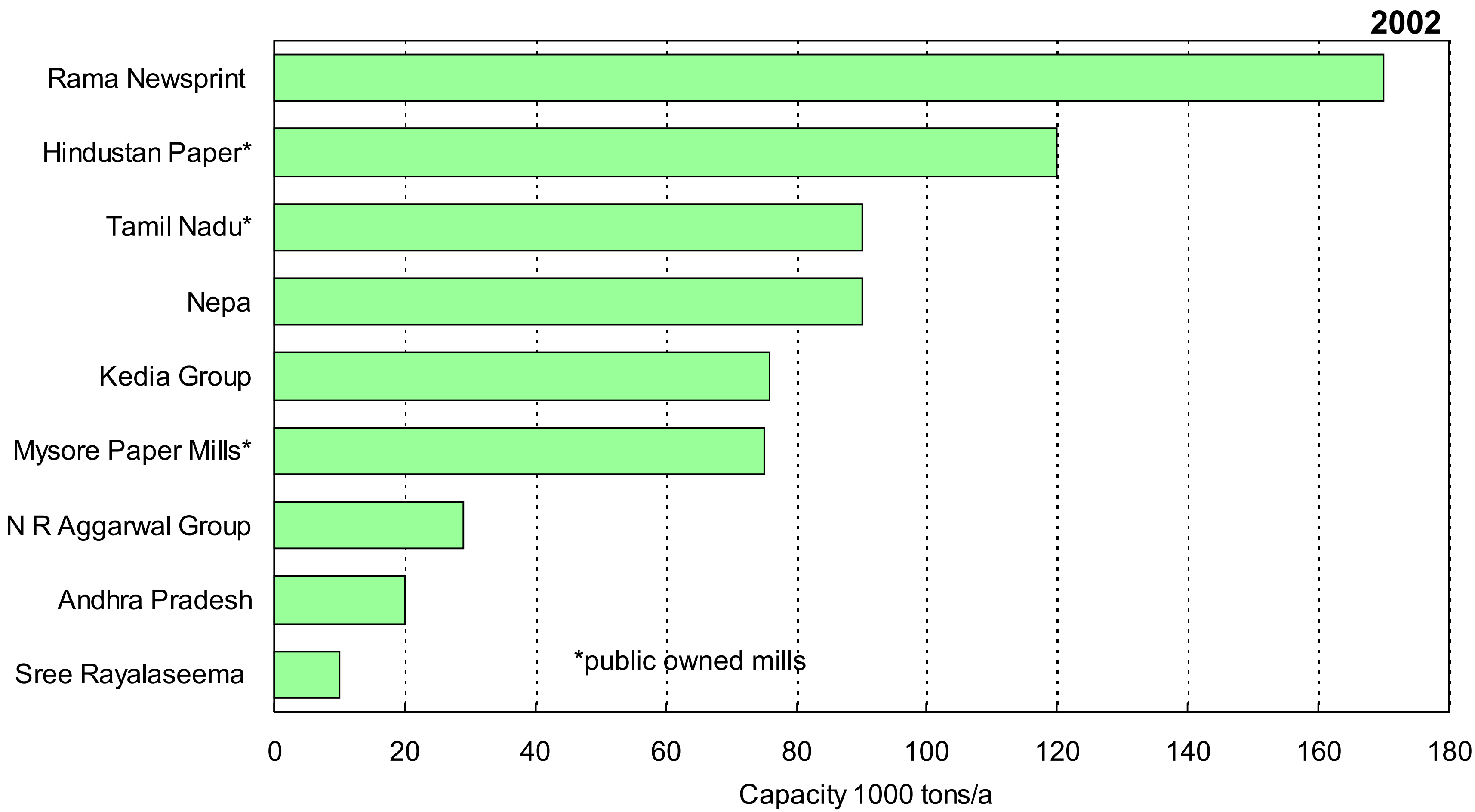
The share of so called culture papers (newsprint + printing and writing paper) of total paper capacity in India is twice that much as in the other major Asian countries. Correspondingly, the share of packaging grades is low. This is largely market driven distribution, but also wood-free paper sector is the one for which the local raw material base fits best, which again, in high import duty environment becomes important.



Major newsprint producers in India

Project Number 52A0087

Rama Newsprint and Hindustan are the leading newsprint producers



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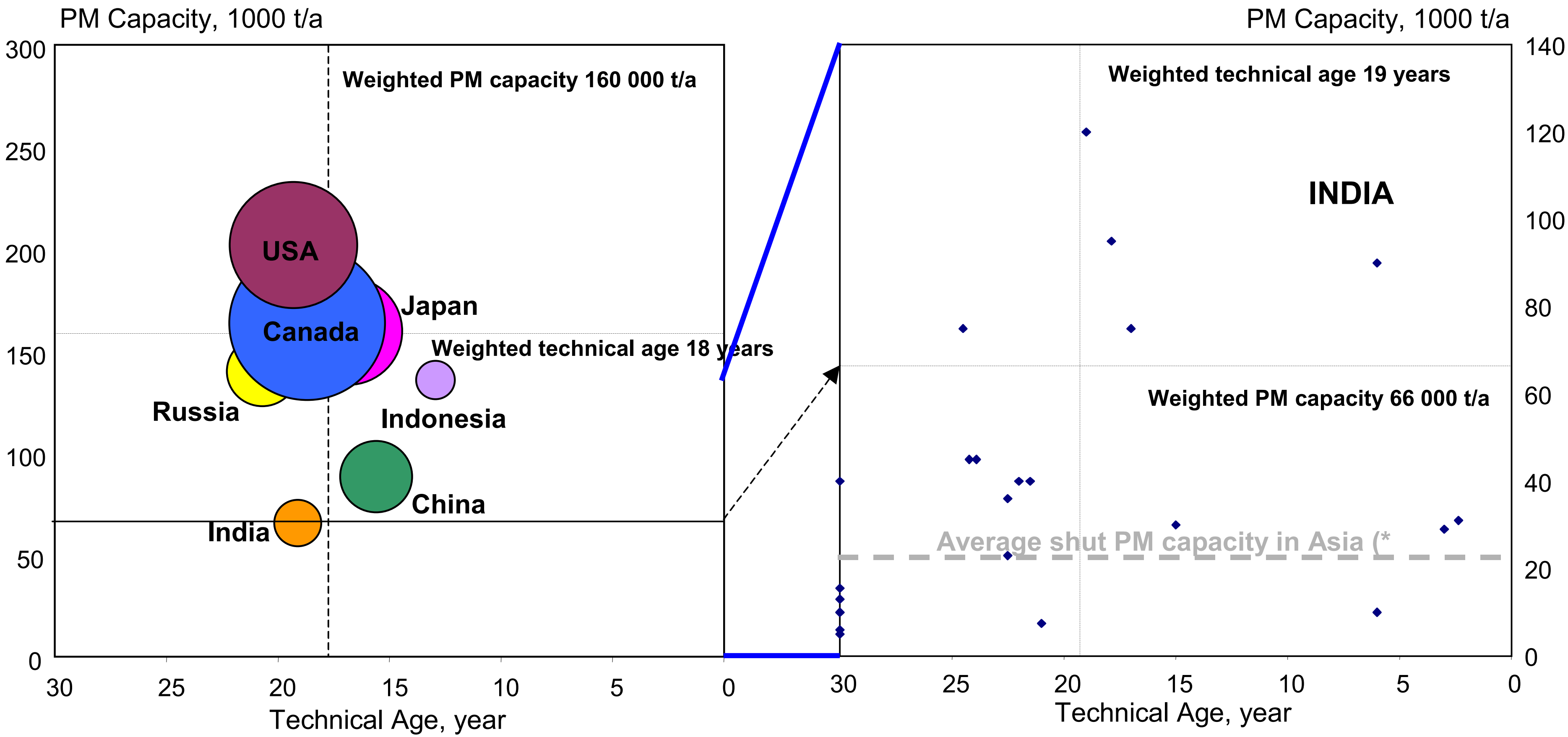
Industry structure - newsprint

Most of Indian newsprint machines have capacity below 50 000 t/a, and in a market open for international competition it is hardly justified to invest in any significant amount in that scale machines to maintain the quality and condition. Average size of shut newsprint machines in non-Japan Asia has been about 20 000 t/a.



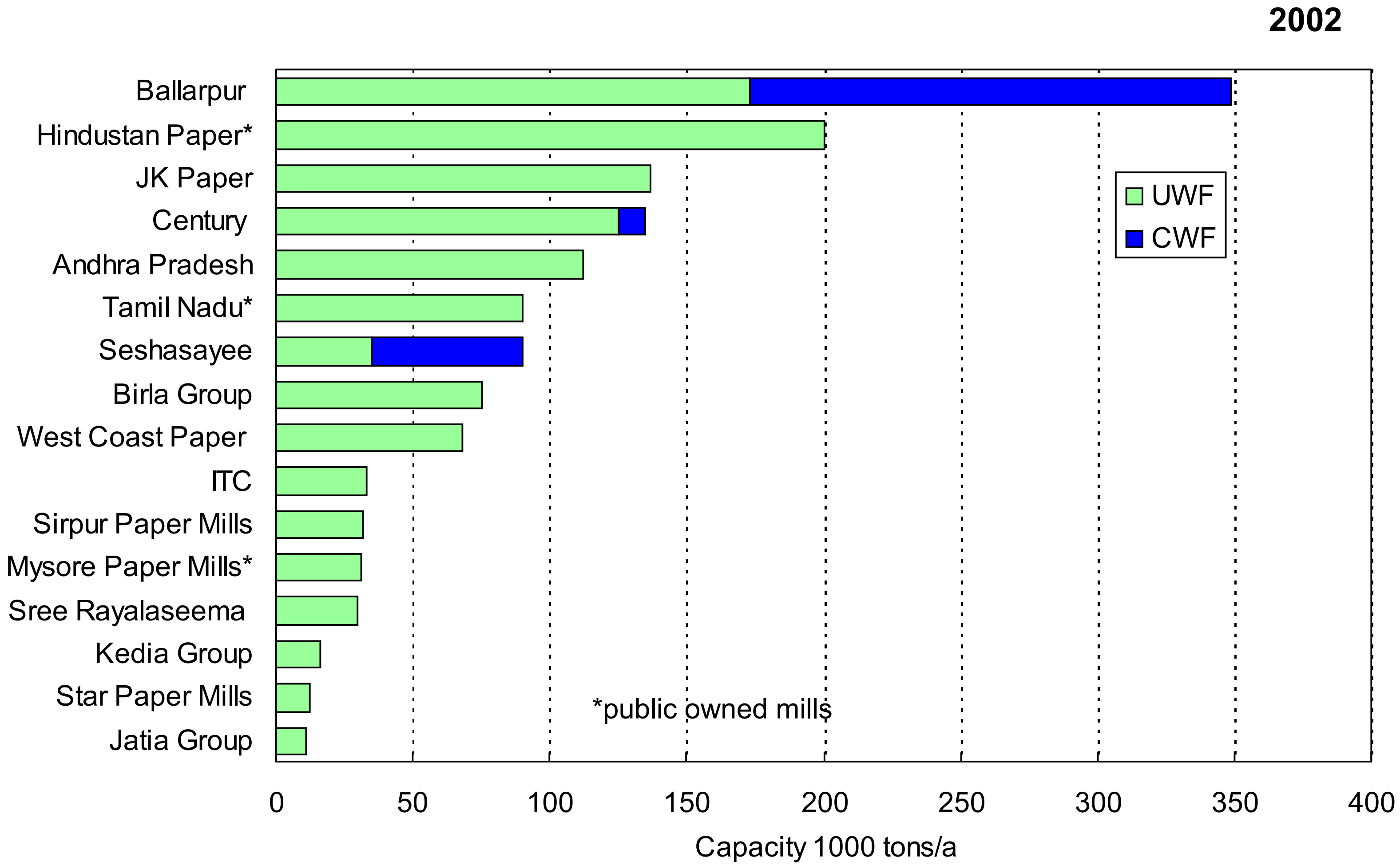
*) excluding Japan

Newsprint – backward and forward linkages

Pulping	Papermaking	Publishing/printing
Europe		
Mainly integrated with mechanical pulp or DIP	Cross border ownership linkages common	Private and generally no linkages with paper industry, although long term delivery contracts are common
China		
Mainly integrated with mechanical pulp or DIP	Mainly state owned, Pan Asia Potential is an exception (Hansol, Korea)	Publishers state controlled, no integration with paper mills
India		
Integrated with non wood, mechanical pulp or DIP	Biggest producers state owned, no foreign ownership. *Privatisation and finding foreign investors are potential development options*	Private, not integrated with paper mills.

Major woodfree pr/wr producers in India

Ballarpur is the leading woodfree printing and writing paper producer



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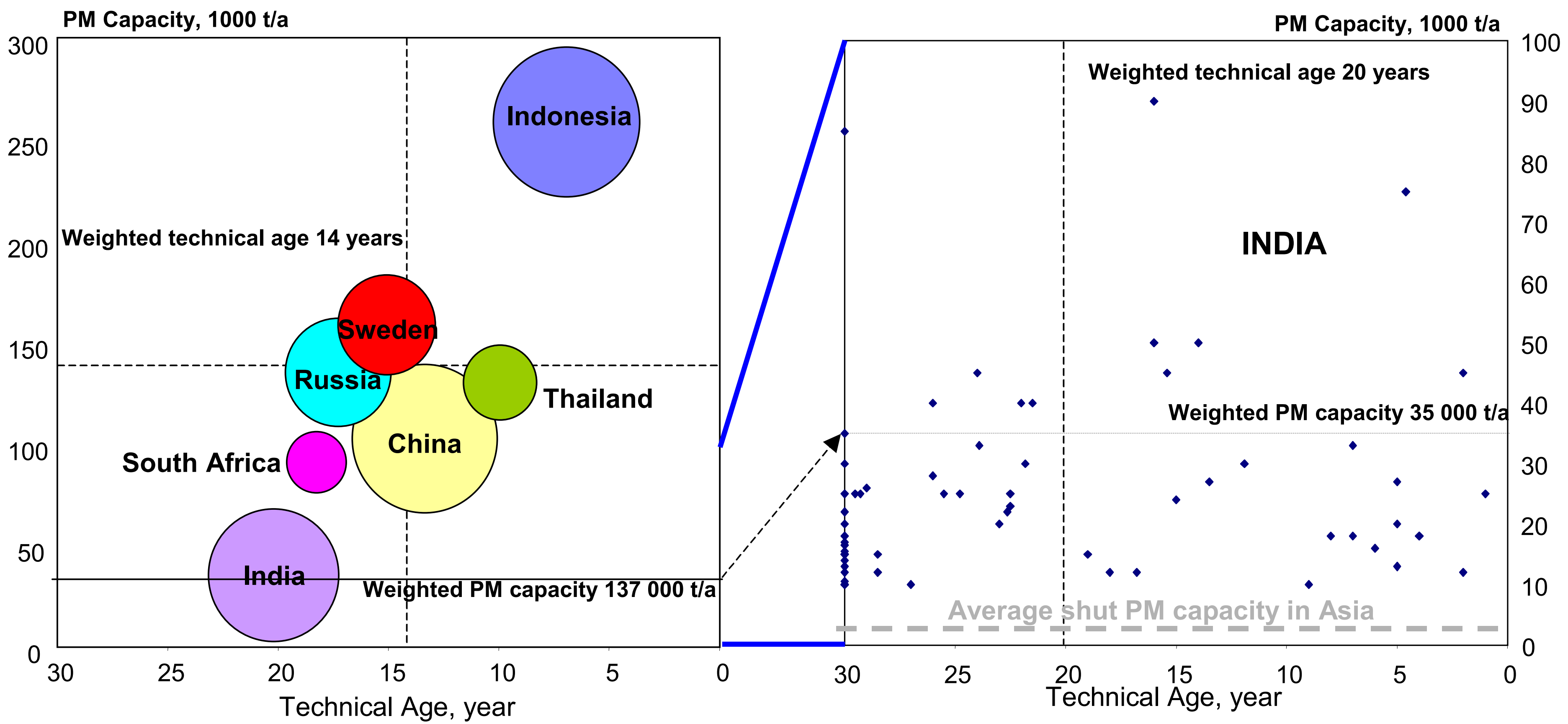
Printing and writing industry structure

Printing and writing paper sector in India is mostly (90%) of uncoated woodfree paper. Therefore the comparison is made between uncoated woodfree production in different countries. There are few reasonable size machines in India, but most of the capacity comes from small scale units. In the neighbouring Asian countries this type of small machines are all suffering from heavy price competition from recent massive increase of capacity in Indonesia.



WF printing/writing

Project Number 52A0087

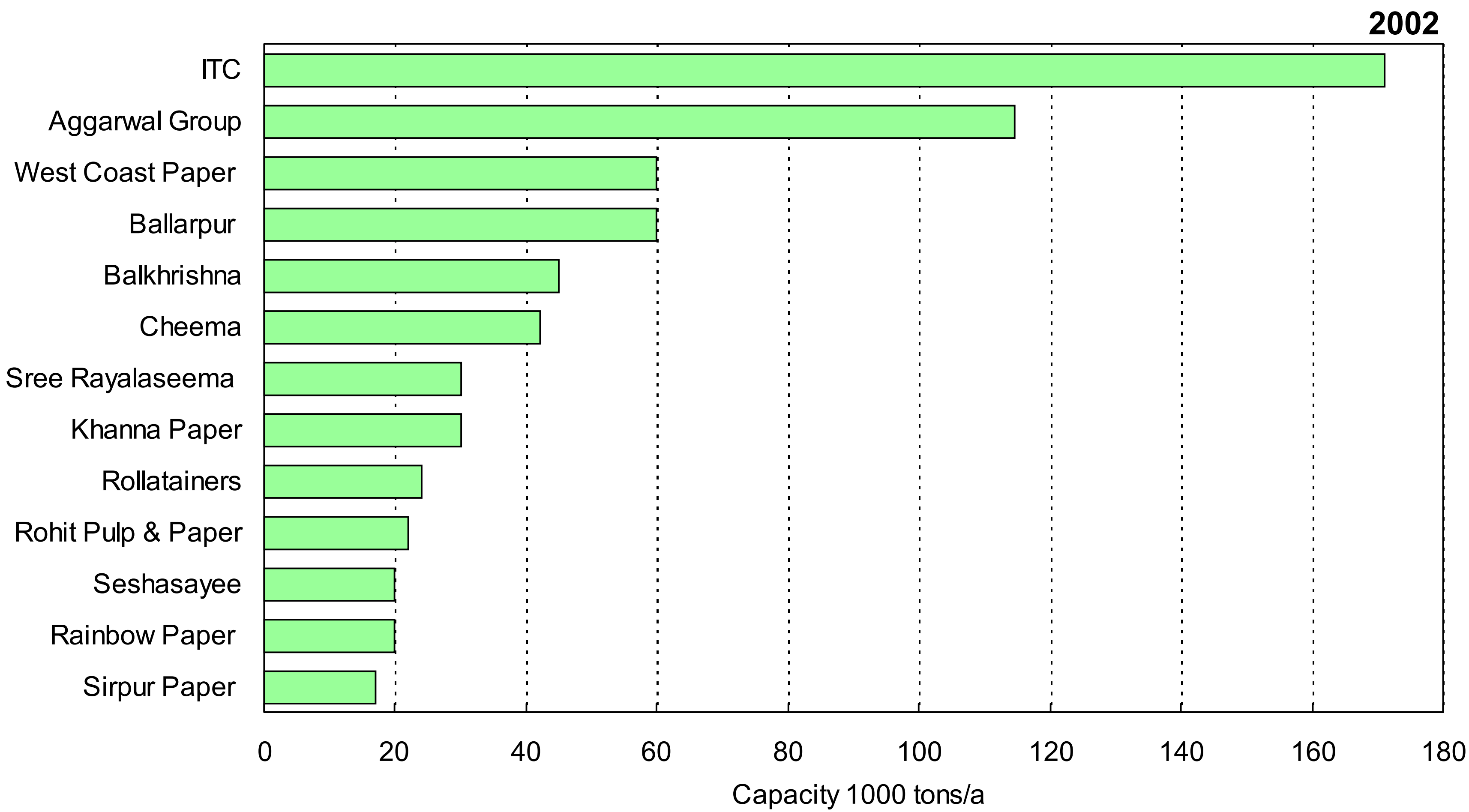
Backward and forward linkages

Pulping	Papermaking	Distributors/merchants	Printers/converters
Europe			
Large mills integrated with chemical pulp	Cross border ownership common	Some producers have own merchant network	Integration with notebook, envelope, etc. converting is common. Long term delivery contracts with biggest printers.
China			
Large mills based mainly on purchased pulp (partly captive from Indonesia), non wood common in small mills	Foreign ownership common in large mills (APP, UPM, Stora-Enso)	Several independent merchants and sub-merchants	Some integration with notebook conversion, printers operate mainly independently.
India			
Biggest producers are integrated with chemical/non wood pulp + use market pulp	No foreign participation *Foreign investments with captive pulp supplies could be a development option*	Mainly independent merchants and sub-merchants	Converting/printing done mainly independently, stand alone coaters and sheeters are common in India. *Own converting of eg. notebooks could be increased*

Major cartonboard producers in India

Project Number 52A0087

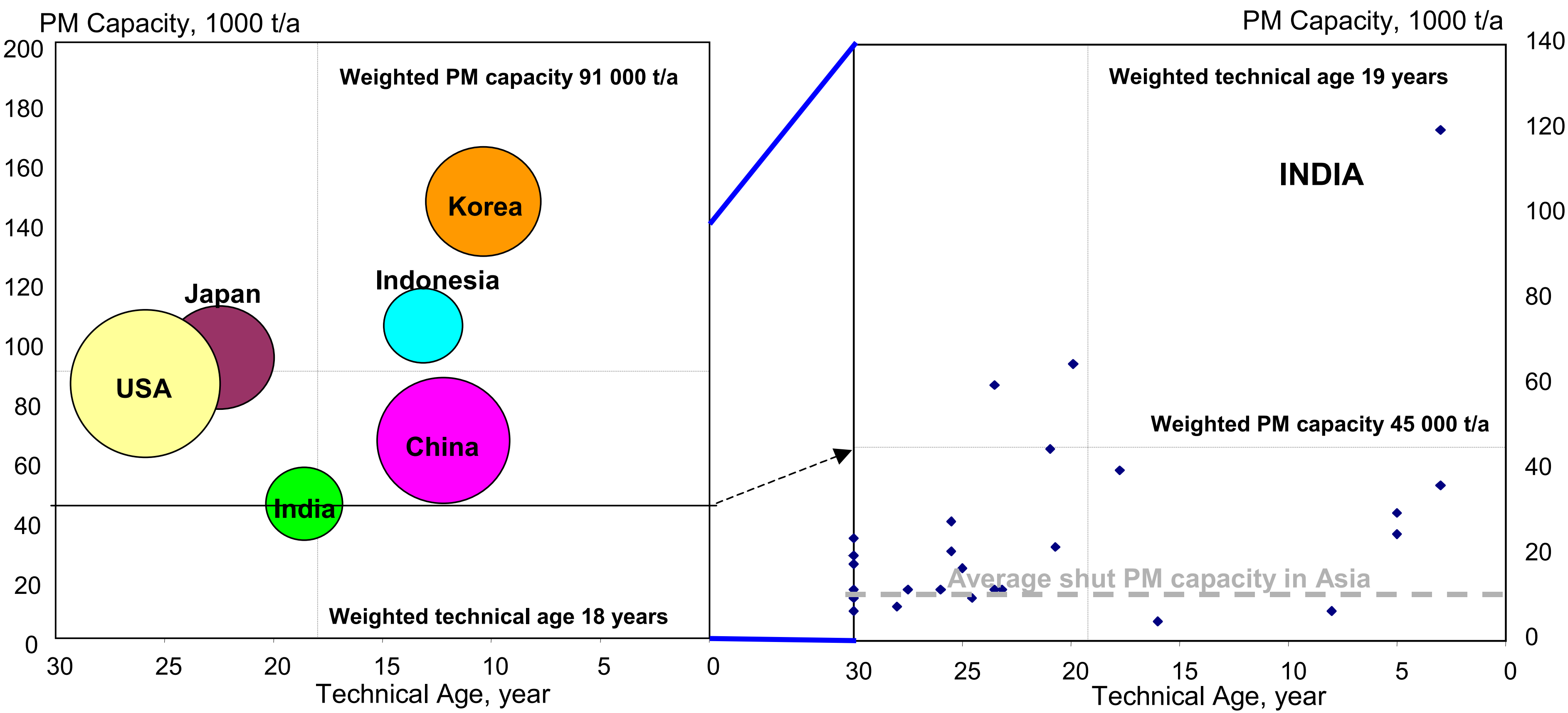
ITC is the leading producer of cartonboards in India



Cartonboard industry structure (= WLC)

Project Number 52A0087

Indian cartonboard sector is well represented by white lined chipboard. In this grade group the Indian Industry compares well in the international comparison, even if there are a number of very small production lines..



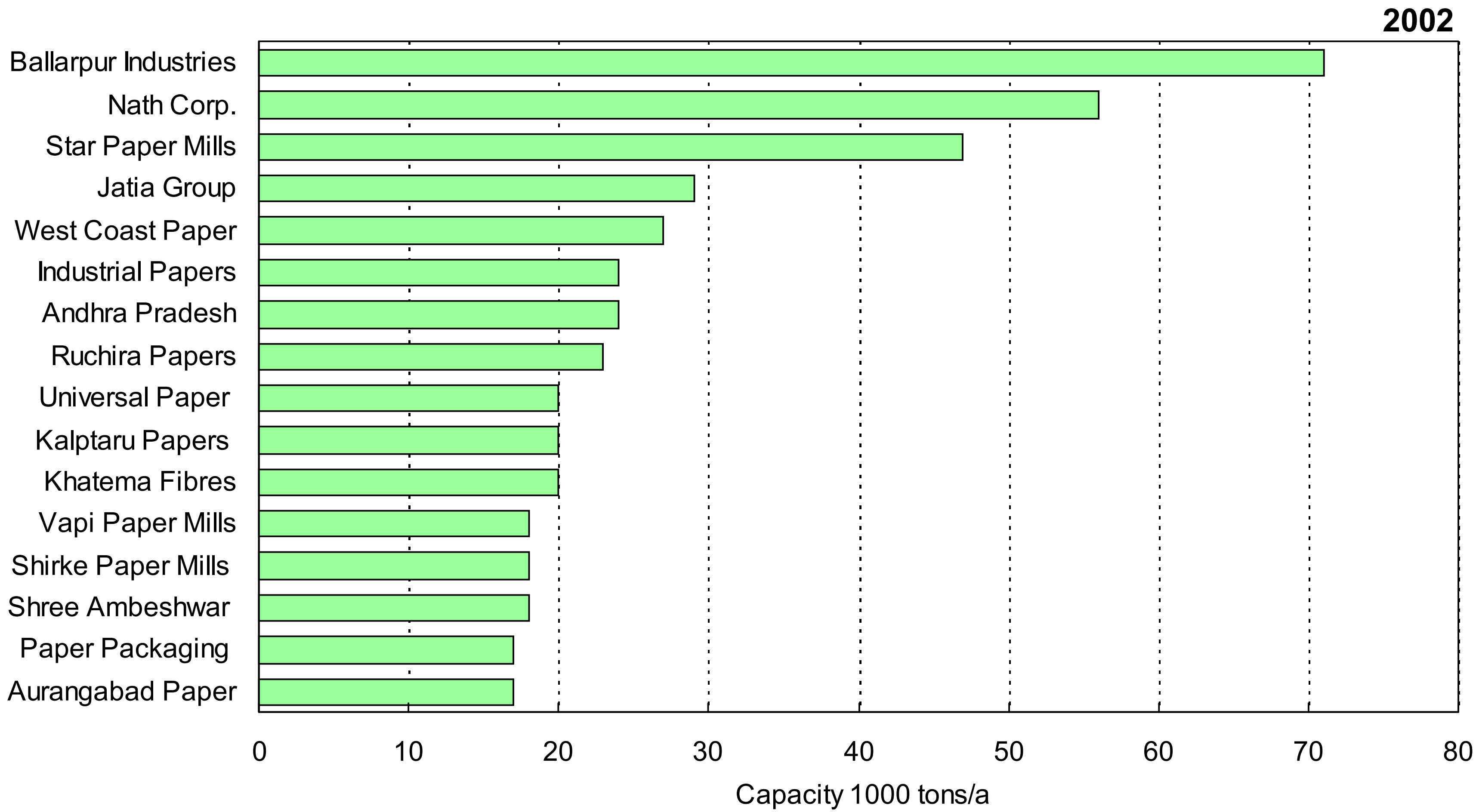
Containerboard

Backward and forward linkages

Pulping	**Papermaking**	**Corrugated converting**
Europe		
Kraftliner and NSSC fluting mills integrated with pulp, others use recycled fibre	Cross border ownership linkages common	Forward integration and cross border ownership common
China		
Mainly recycled fibre based	Some foreign participation (Rengo, Sonoco)	Foreign participation increasing rapidly (SCA/Weyerhaeuser, APP, Rengo, Smurfit-Stone, etc.)
India		
Mainly recycled fibre based	Small scale, fragmented industry *Restructuring needed, possibly with foreign participation*	Mainly small scale independent converters *Restructuring, forward integration possibly foreign investments needed*

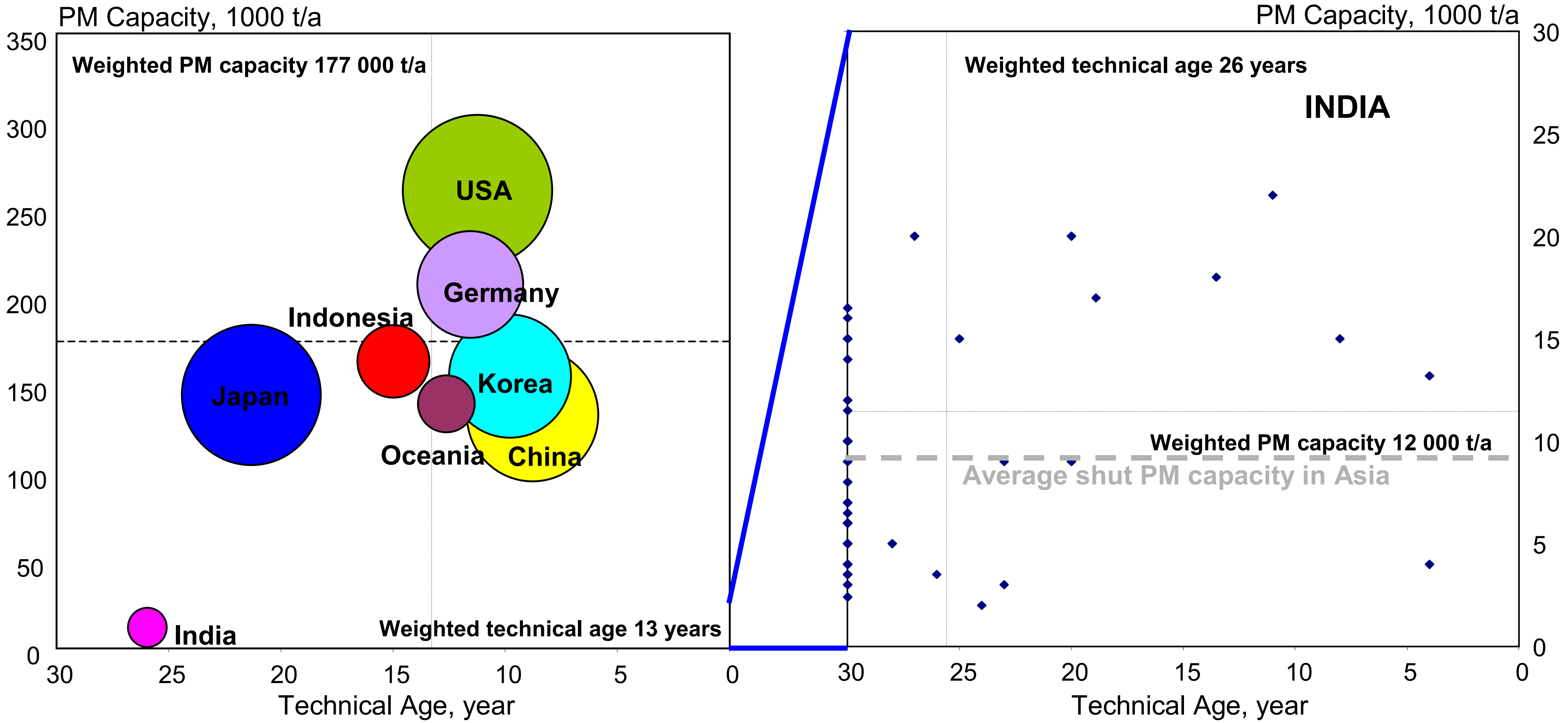
Major containerboard/kraft producers in India

Ballarpur, Nath and Star Paper are the leading producers of kraft/containerboard. There is a lot of swing capacity between kraft papers and containerboard



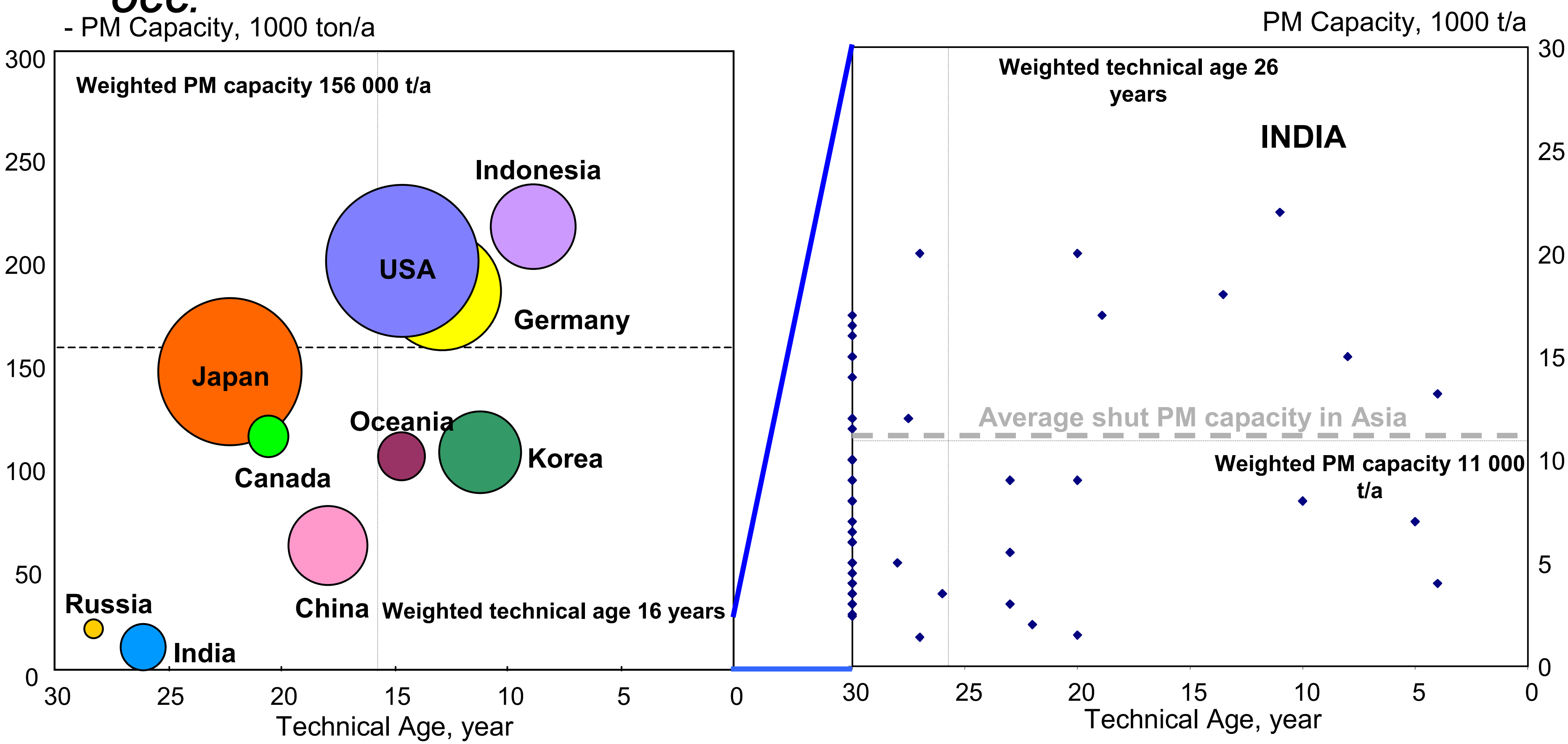
Containerboard industry structure (Testliner)

Testliner and recycled fluting cover most of Indian corrugating raw materials grade group. Indian corrugating sector is underdeveloped. Besides market factors, also the lack of domestic long fiber raw materials has been hampering the development, but situation is the same in all South Asian countries. All machinery is of very small scale and nothing much has been built over the last 20 years.



Containerboard industry structure (Fluting)

Fluting (recycled) and testliner industry is logically very similar. In this grade group it is possible to maintain production with fairly moderate quality based on small old equipment and low quality raw materials also, especially when the corrugating industry is not developed either. There is no single reasonable capacity machine dedicated to produce testliner or fluting based on imported OCC.



Cartonboards

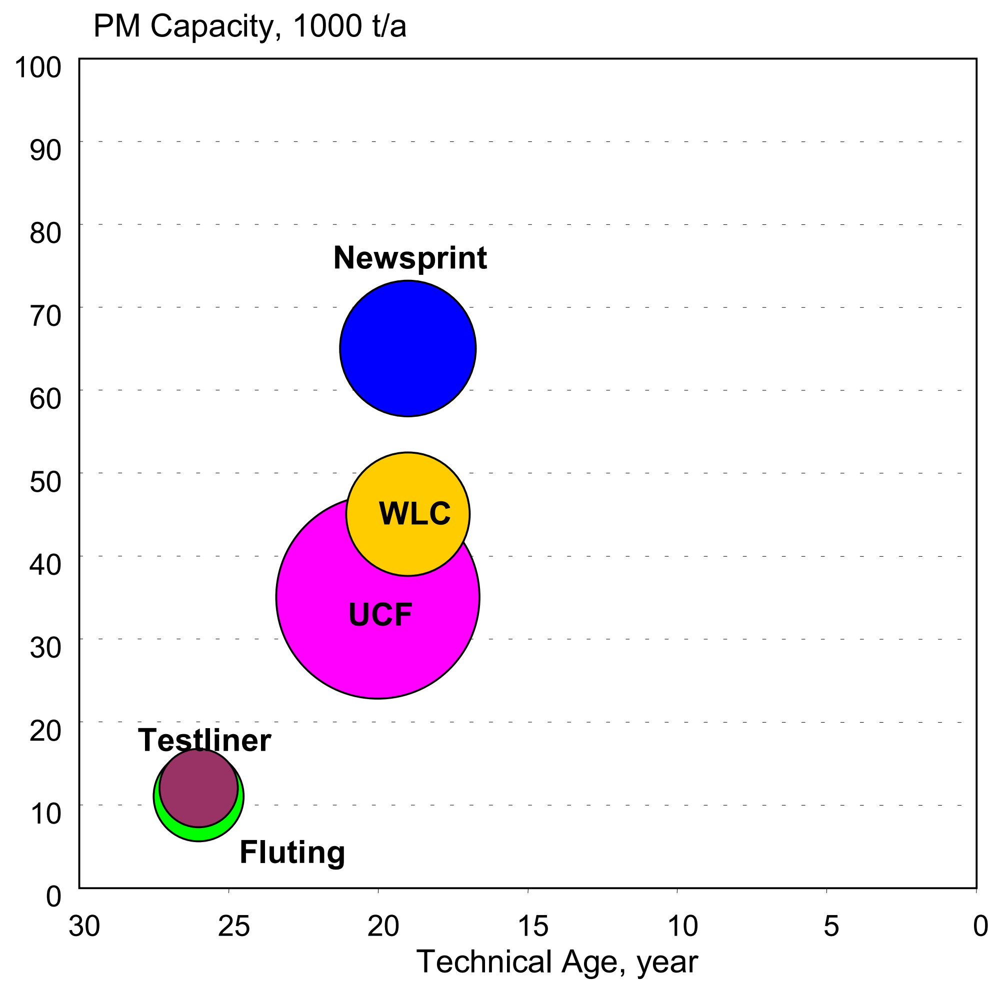
Backward and forward linkages

Pulping	Papermaking	Cartonboard converting
Europe		
Virgin fibre based board mills (SBS, FBB, SUS) are integrated with pulp, others use waste paper + market pulp	Cross border ownership linkages common	Forward integration to folding carton converting and cross border ownership common
China		
Main producers use market pulp (partly captive from Indonesia) and waste paper, some integrated pulp.	Biggest cartonboard producer Ningbo is owned by APP. Chinese cigarette industry owns some cartonboard producers.	Cartonboard converters operate mainly independently
India		
Partly integrated with pulp, board making is mainly based on waste paper	ITC is the leading producer, owned by cigarette factory. Several small producers. *Opportunities for high quality coated boards + liquid packaging board in the long term*	Mainly small scale independent converters *Restructuring, forward integration and foreign participation (high quality converting)*

Asset quality by grade comparison – India

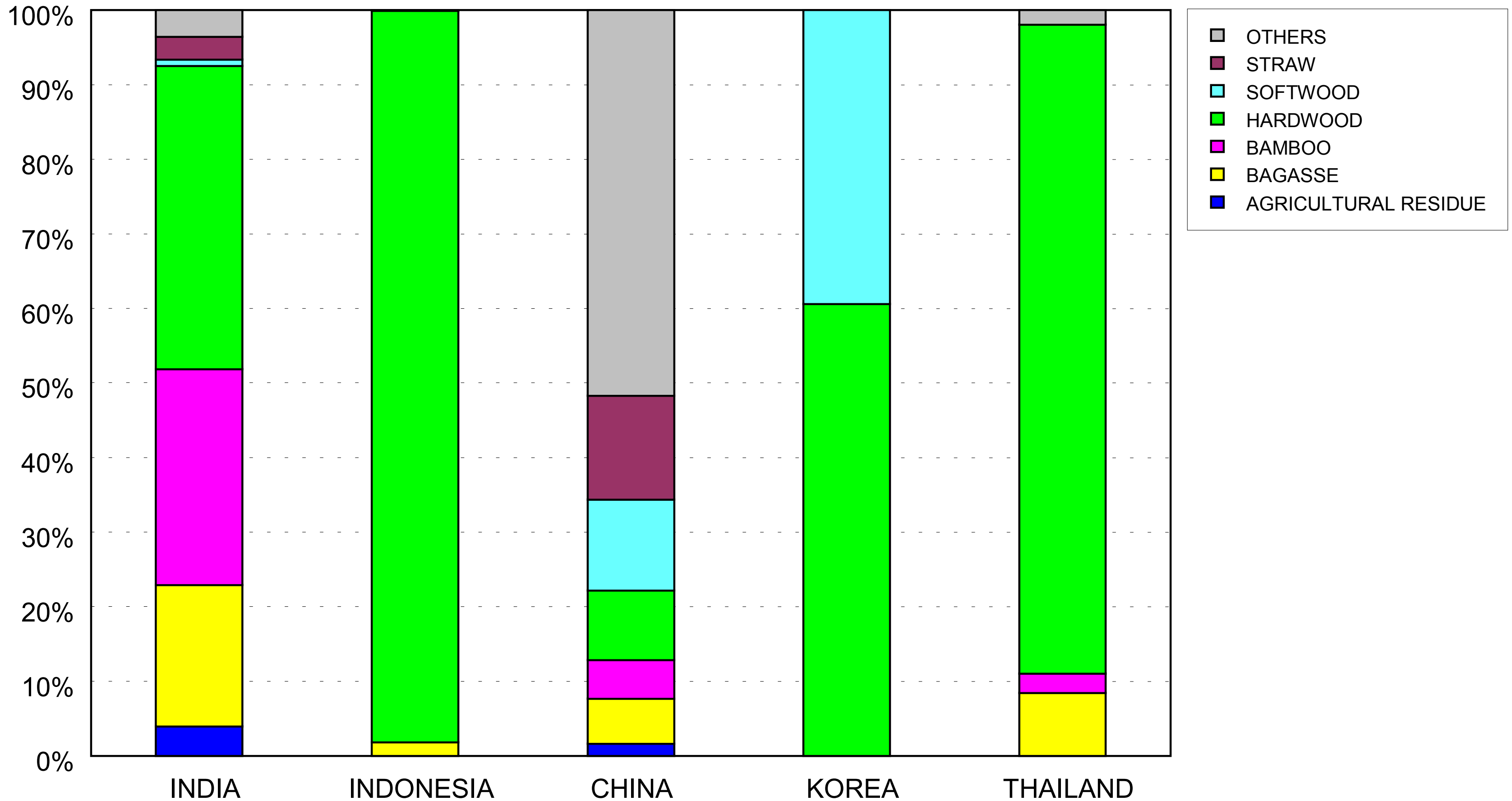
The newsprint, printing and writing sector and cartonboard have much better production structure than containerboard raw materials.

Reading/education, growth of office papers, pharmaceutical packaging, tobacco industry and luxury item packaging are the key drivers of this situation.



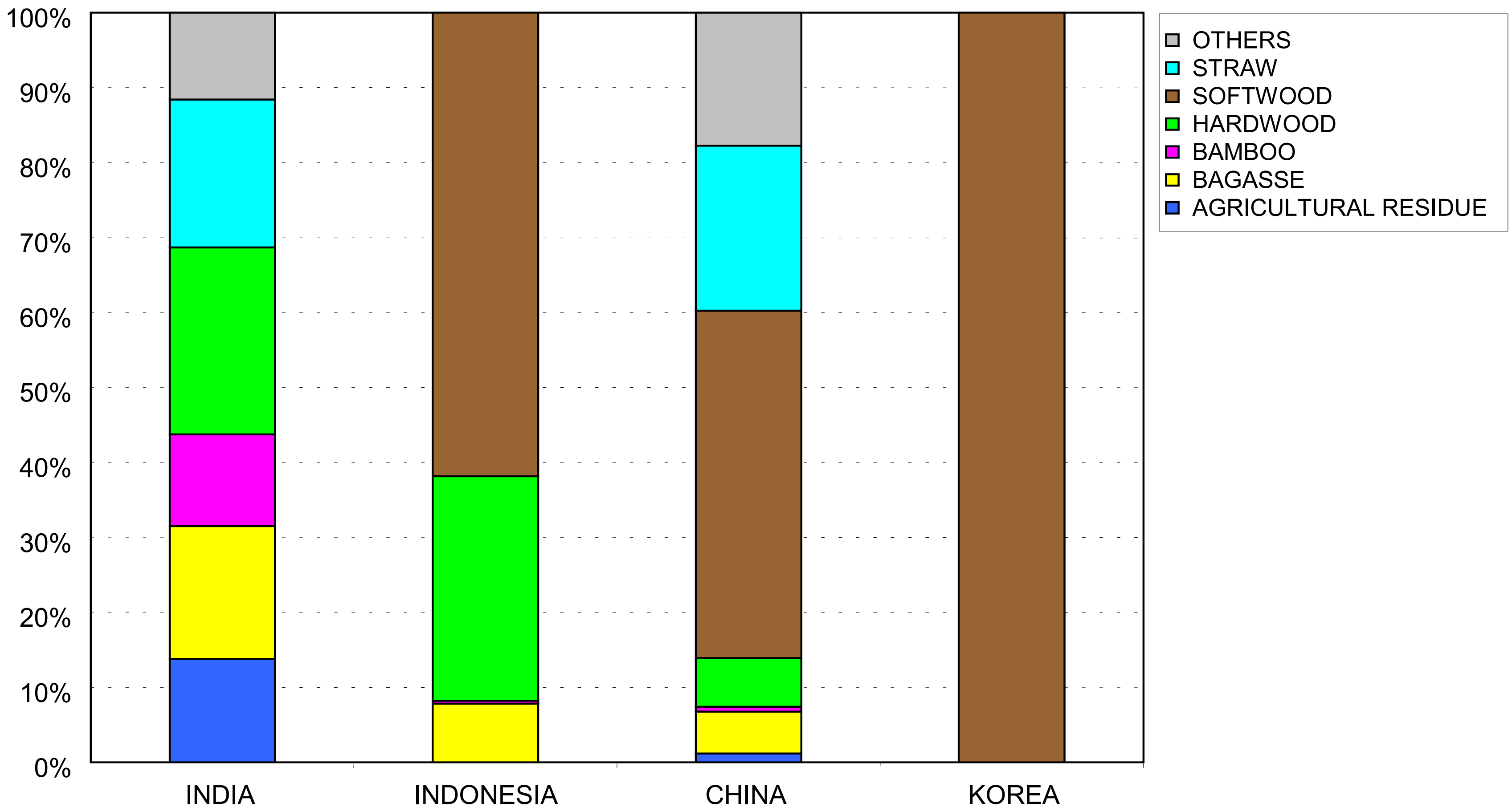
Bleached pulp fiber structure

In India, Bamboo is an important fiber raw material covering about 30% of raw materials for bleached pulp manufacture. Out of important producing countries, only in China it is of any significance, there its share is about 15%. Total hardwoods cover about 40% of fiber raw materials, and it is a mix of eucalyptus and species of varying quality hardwoods. Usage structure reflects well the difficult situation in fiber availability.



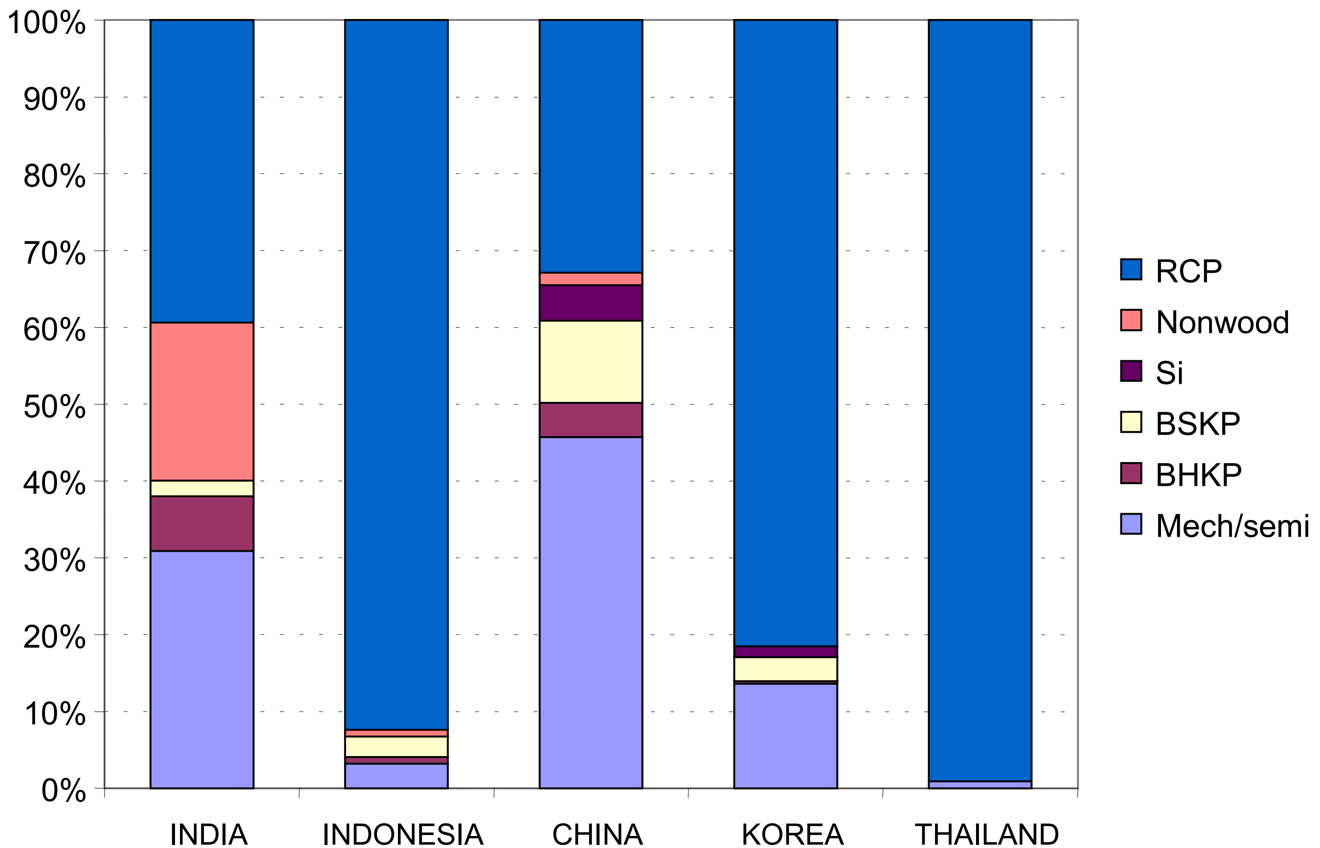
Unbleached pulp fiber structure

In India, softwoods are not used for chemical pulping, while it is the typical fiber raw material for unbleached pulp even in Asian countries. However, the production volume of unbleached pulp in Asia is very low. Taking into account the low volume, the Indian situation is very fragmented.



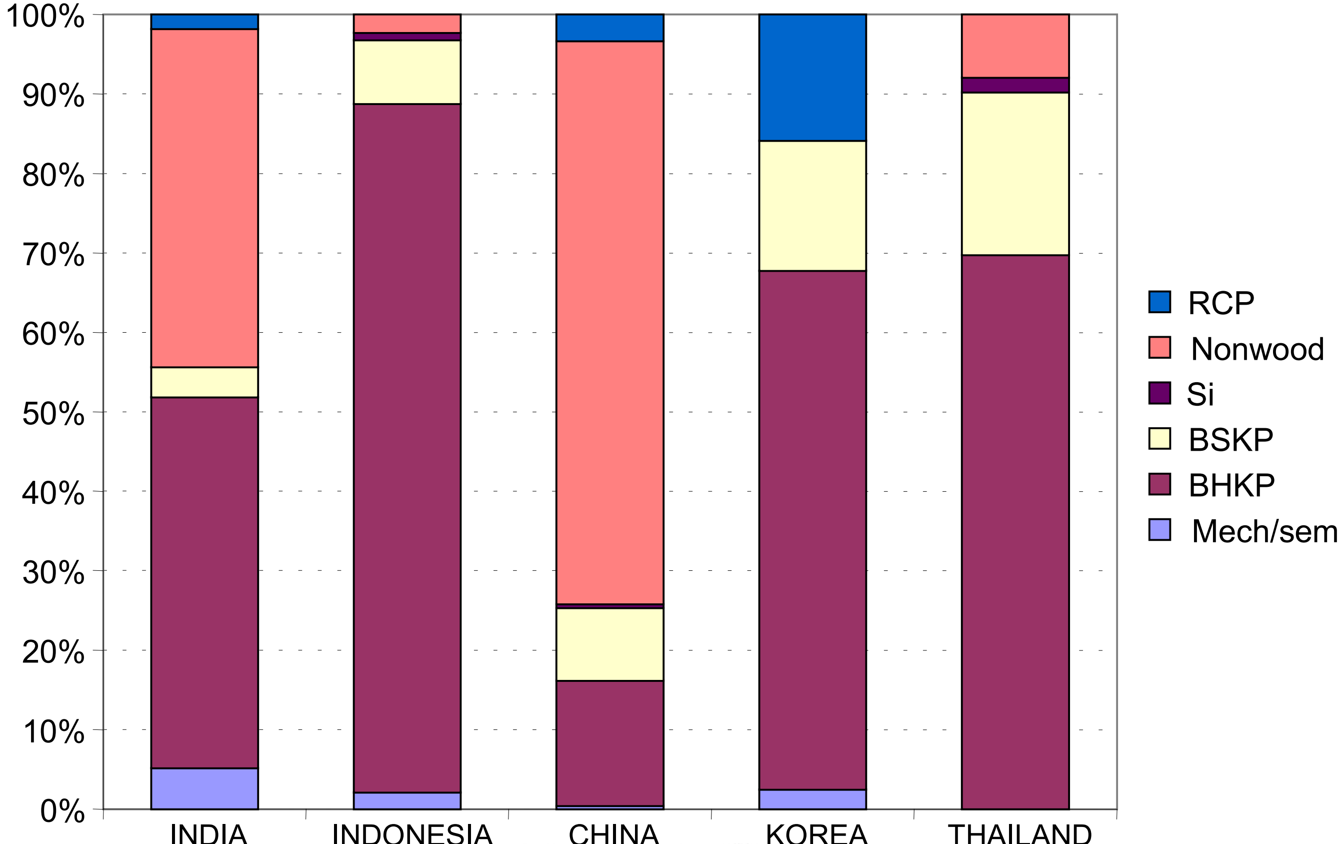
Newsprint fiber structure

The estimated fiber structure in India for newsprint manufacture shows similar pattern as that for China. Indonesia, China, Thailand and Korea import ONP. India has been using a lot of non wood pulp.



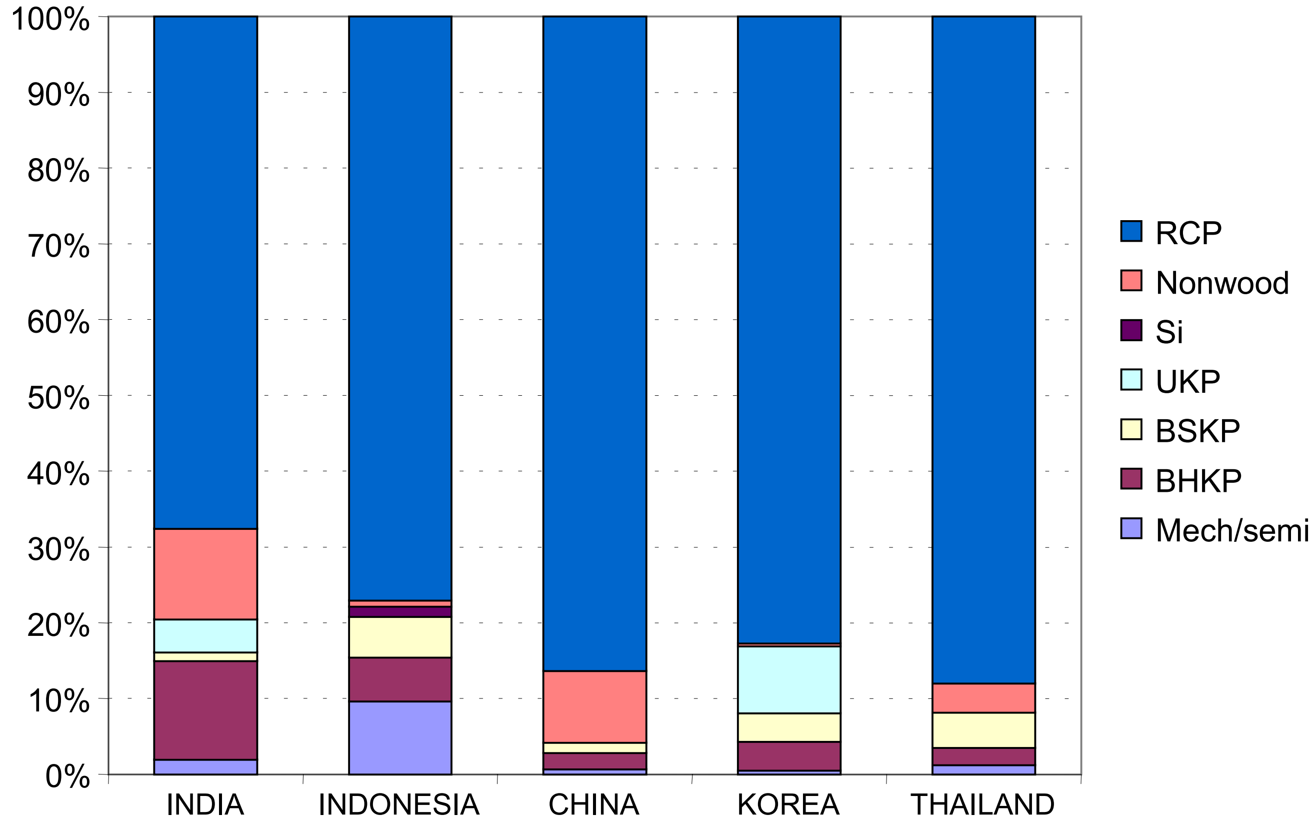
Woodfree paper fiber structure

Both in India and China non-wood fiber forms a significant component of the estimated wood-free paper furnish. In China the uncoated segment is divided into large non-wood based, low price segment, and into internationally comparable segment based on wood pulp. In the exporting neighbouring Asian countries the fiber furnish is wood pulp based and especially in Indonesia is focused in minimizing the use of BSKP which needs to be imported, while BHKP is based on domestic raw materials.



Cartonboard fiber structure

In all countries compared, the estimated fiber furnish for cartonboard is very similar. This is in line with the fact that the industry age and scale are of fairly comparable level, too.



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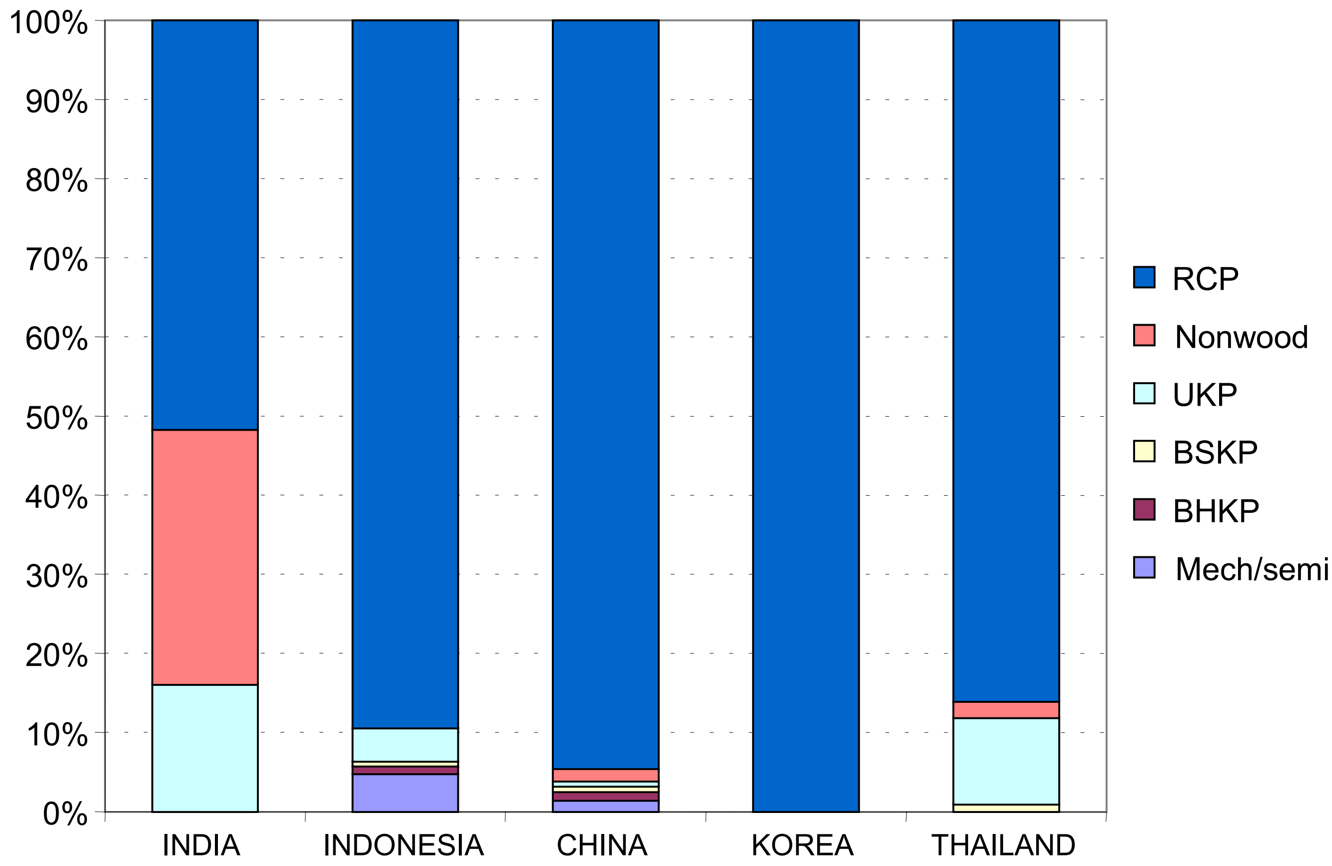
Containerboard fiber structure

Project Number 52A0087

In India, the containerboard sector is undeveloped and fragmented, and the same applies to fiber usage.



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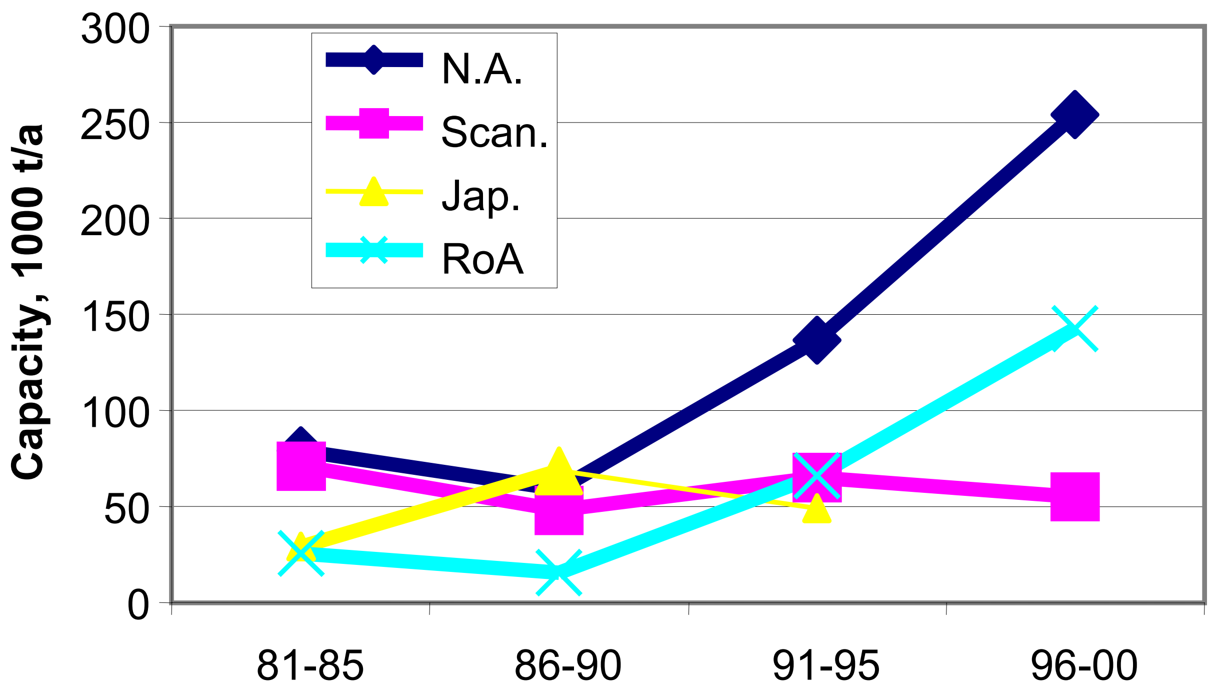
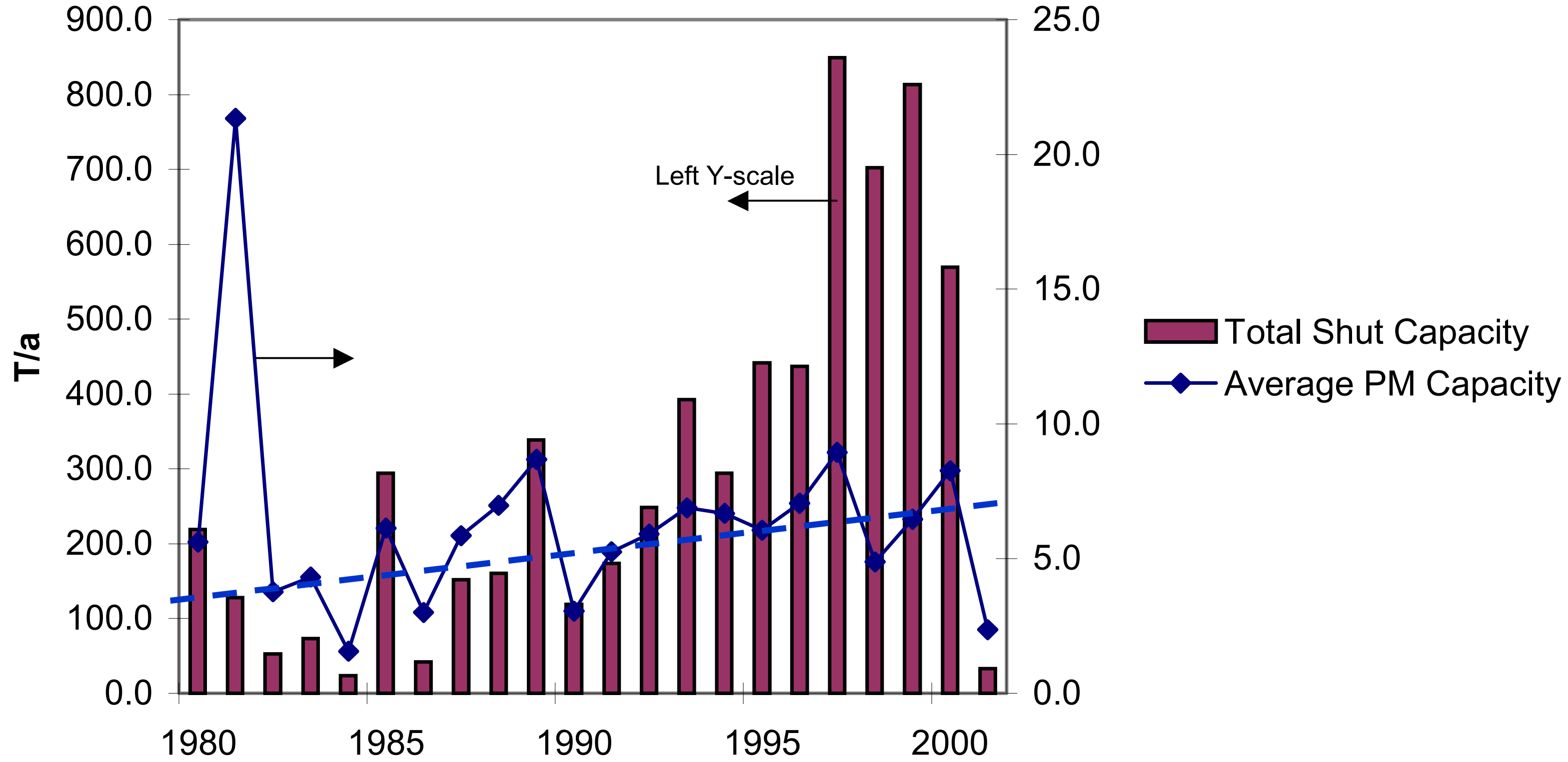
Permanently shut chemical pulp lines

The average size of permanently shut pulp lines has been very low in Asia (other than Japan) until 1990s. Now it is equally high there as in other regions. The closures are generally dictated predominantly by capital efficiency rather than fixed operating costs. Modernization of facilities costs about the same everywhere, and the push to global quality standards and environmental requirements is getting more on the same level.



Permanently shut paper machines in Asia

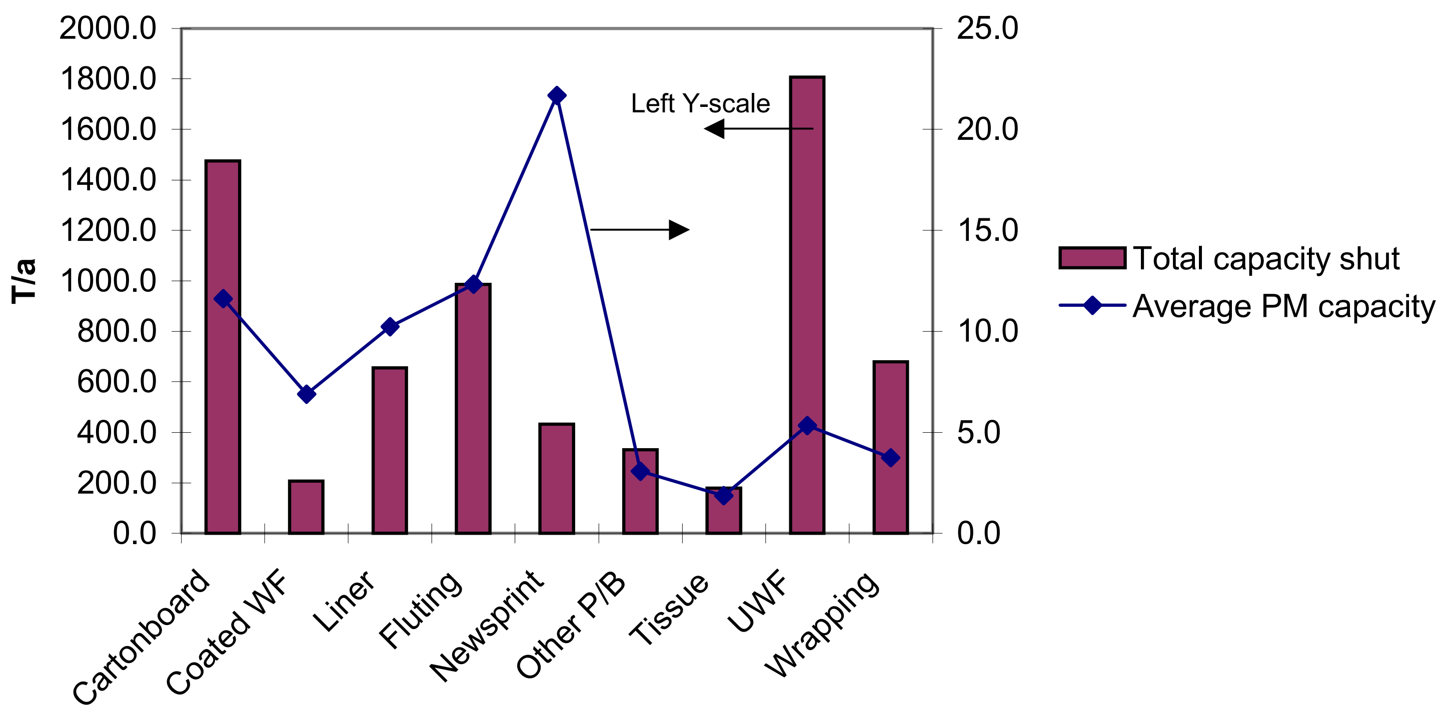
The average size of permanently shut paper machines in Asia excluding Japan has been about 5 000 t/a. The development shows slight increase, see the graph below. The graph contains all grades including machines producing specialty paper grades. In commodity grade production, the level of capacity of paper machines shut / exited is higher.



Shut paper machines by grade

The average size of permanently shut paper containerboard and cartonboard machine in Asia excluding Japan has been about 10 – 12 000 t/a during the period 1980 - 2001. Correspondingly in newsprint grade this capacity has been 22 000 t/a.

In tissue, and specialties, such as uncoated wood-free specialty, so called 'other paper and board, and in wrapping production, smaller capacity has proved still to be possible, and therefore the average shut capacity has been much lower, from 2 000 to 5 000 t/a.



Changing capacity structure - newsprint

Capacity structure 1980

Grade/ Country	Number of paper machines and capacity (1000 t/a) - 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - No.	Cap.
Newsprint										
Finland					4	285	10	1325		
Sweden			1	40	2	140	12	1739		
Germany			1	30	2	155	3	371		
United States			9	320	11	844	24	3188	2	405
China	31	306	3	99						
Indonesia										
India	7	59	3	115						
Thailand										

Capacity structure 2002

Grade/ Country	- 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - No.	Cap.
Newsprint										
Finland							1	110	6	1385
Sweden							5	720	8	1895
Germany			2	80	2	150	4	630	4	1135
United States			1	45			17	2585	15	3535
China	20	217	11	357	9	526	7	1008		
Indonesia			3	100	2	185	1	115	1	220
India	11	108	9	313	4	335	1	120		
Thailand							1	120		

In Asia, the number and the share of newsprint machines has increased significantly.

After 1980 China, Indonesia, India and Thailand have build up 11 new machines with a capacity over 100 000 t/a.

Changing capacity structure – Unc. WF

Uncoated woodfree printing and writing paper

Capacity structure 1980

Grade/ Country	Number of paper machines and capacity (1000 t/a) - 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - 300 No.	Cap.	300- No.	Cap.
Uncoated woodfree												
Finland	2	9	3	115	3	195	1	100				
Sweden	13	115	3	102	1	70	2	250				
Germany	46	358	11	305	2	155	3	375				
United States	126	1148	120	3481	38	2518	15	1915				
China	549	2147	7	158	1	50	1	100				
Indonesia	18	164										
India	**119**	**827**	**14**	**362**	**1**	**70**						
Thailand	18	127	2	40								

Capacity structure 2002

Grade/ Country	Number of paper machines and capacity (1000 t/a) - 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - 300 No.	Cap.	300 - No.	Cap.
Uncoated woodfree												
Finland	1	2	2	58			1	175	3	695	1	350
Sweden	5	53	4	102	1	85	2	335	3	645		
Germany	18	112	11	351	3	170	4	555	2	475		
United States	49	460	44	1291	36	2574	24	3253	12	3030	5	1620
China	421	2021	32	850	2	100	1	100			1	350
Indonesia	16	138	6	187	3	175			3	670	3	1090
India	**116**	**1007**	**30**	**872**	**7**	**435**						
Thailand	20	155	6	173	1	92			1	250		

The share of over 200 000 t/a machines has increased significantly, especially in Indonesia

Changing capacity structure - cartonboard

Capacity structure 1980

Grade/ Country	Number of board machines and capacity (1000 t/a) - 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - No.	Cap.
WLC, FBB, SBS										
Finland	2	34	5	200	3	210	1	105		
Sweden	2	20	6	187	1	65	4	420		
Germany	3	47	8	244	3	210	2	245		
United States	9	115	52	1769	26	1738	20	2590	2	560
China	54	373	4	130	3	150	1	100		
Indonesia	4	51	1	20						
India	17	193	3	71	1	65				
Thailand	5	61	2	55						

Capacity structure 2002

Grade/ Country	- 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - No.	Cap.
WLC, FBB, SBS										
Finland					4	232	6	865	1	215
Sweden					1	60	4	565	1	215
Germany					4	240	4	645	2	480
United States	4	48	20	740	30	1913	20	3000	9	2250
China	50	429	12	397	16	975	8	1015	2	440
Indonesia	2	20	10	332	1	50	2	270	2	440
India	16	193	12	347	2	125	1	120		
Thailand	3	37	5	161						

Today, all cartonboard machines less than 50000 t/a have disappeared from Europe and the USA.

The share of over 200 000 t/a machines is already 15%.

The trend is towards bigger machines also in Asia. China and Indonesia have four cartonboard machines over 200 000 t/a.

However, most of the changes have happened in the size group 50-200 000 t/a – 25 new machines.

Also India has one over 100 000 t/a PM

Changing capacity structure

Project Number 52A0087

Recycled liner and fluting

Capacity structure 1980

Grade/ Country	Number of board machines and capacity (1000 t/a) - 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - 300 No.	Cap.	300 - No.	Cap.
Recycled liner & fluting												
Finland												
Sweden	1	6	1	40								
Germany	15	193	26	783	6	460	2	215	1			
United States	8	77	17	521	5	365	5	590				
China	156	895	13	354	1	51	1	120				
Indonesia	5	30	1	25								
India	75	564	1	20								
Thailand	8	50	1	30	1	60						

Grade/ Country	- 20 No.	Cap.	20 - 50 No.	Cap.	50 - 100 No.	Cap.	100 - 200 No.	Cap.	200 - 300 No.	Cap.	300 - No.	Cap.
Recycled liner & fluting												
Finland			1	45								
Sweden					1	85						
Germany	4	49	8	270	11	813	7	1065	9	2105	2	625
United States	3	34	7	257	13	887	15	2237	7	1610	9	3165
China	122	821	25	750	10	626	11	1300	3	650	1	400
Indonesia	5	40	11	346	3	225	4	555	2	440	2	710
India	81	638	2	40								
Thailand	6	45			5	320	7	850	3	670		

The number of recycled liner & fluting machines has increased from 263 to 303 in China, Indonesia, India and Thailand.

The share of over 50 000 t/a machines has increased from 1% to 16%. Today, there are three machines over 300 000 t/a.

India has 83 machines, mainly small with a capacity up to 20 000 t/a.

Paper projects in India

Decided projects are small considering the size and growth of the market

Company	Mill	Grade	Capacity change	Year	Remarks
			1000 t/a		
Sirpur Paper Mills	Sirpur	Newsprint	25	2002	New PM
Tamil Nadu	Pugalur	Unc. WF	25	2002	PM1 rebuild
West Coast Paper Mills	Dandeli	WLC	35	2002	New PM
Wimco Boards	Ambarnath	WLC	16	2002	2nd hand PM from Japan
Murli Agro	Nagpur	Newsprint	28	2002	New PM, Servall
Total decided			**129**		
Titaghur (currently closed)	Mill no. 1	Newsprint	100	Planned	2nd hand PM from USA
West Coast Paper Mills	Dandeli	MG		Planned	
ITC	Sarapaka	Cartonboard	140	Planned	New PM
Madhya Desh	Saoner	Newsprint	30	Planned	New mill
Matu Newsprint	Haldia	Newsprint	100	Planned	New PM, on hold
Pragati Paper Mills	Kalambi	Newsprint	17	Planned	New PM
Total planned			**387**		

Pulp projects in India

Decided pulp projects are small considering the size and growth of the market

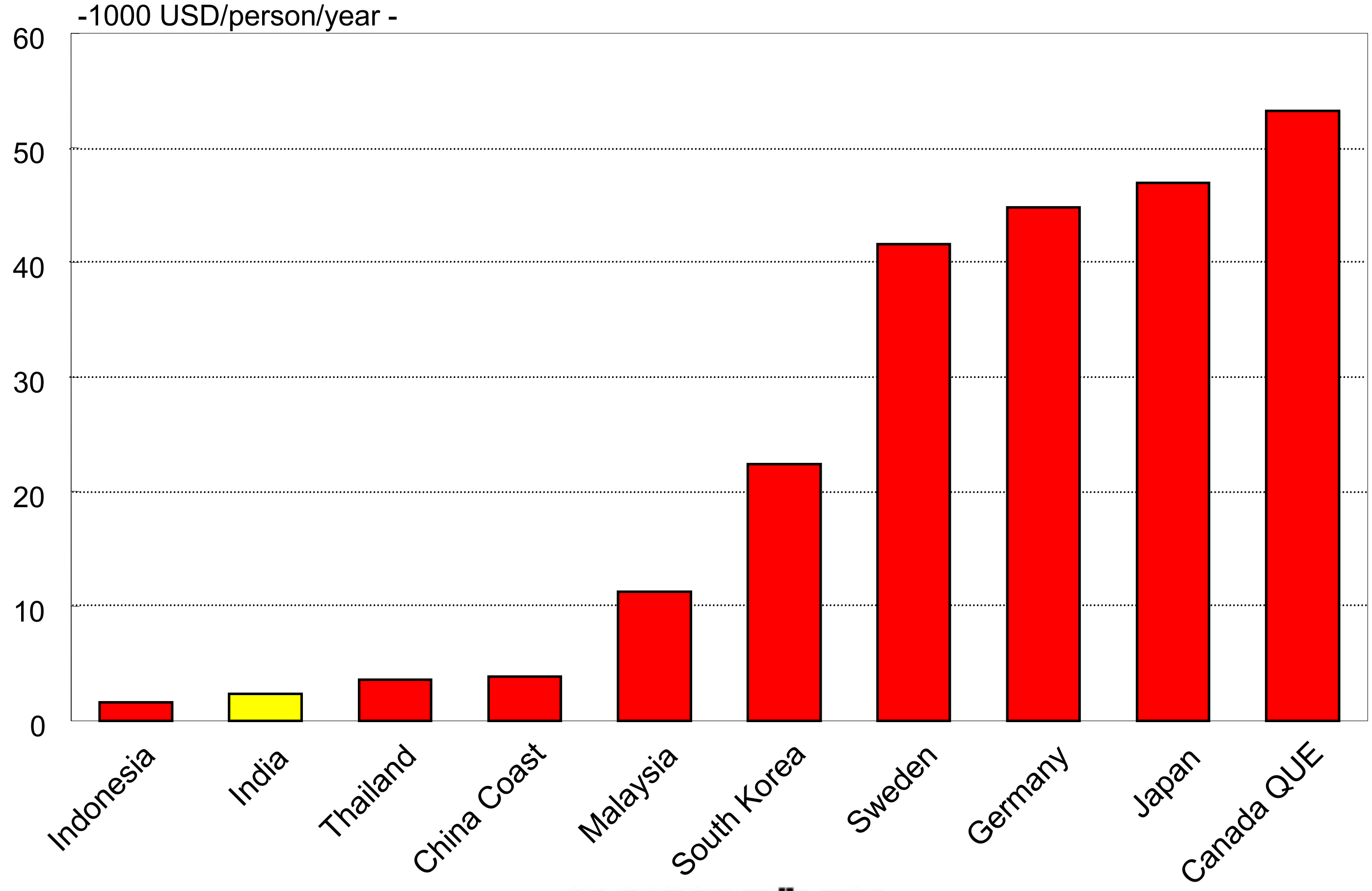
Company	Mill	Grade	Capacity change	Year	Remarks
			1000 t/a		
Hindustan Paper	Kerala	Deinked pulp	35	2002	New line
ITC	Sarapaka	Bl.sa hw/bamboo	35	2002	Newl line replaces 2 old lines
Total decided			**70**		
The Andhra Pradesh	Rajahmundry	BHKP		Planned	New line
Shiva Paper	Rampur	Bl.soda,bagasse,straw	15	Planned	New digester
Tamil Nadu Newsprint	Pugalur	BHKP	15	Planned	Expansion
Titaghur (currently closed)	Mill no. 1	Deinked pulp	100	Planned	2nd hand
Total planned			**130**		

5. Cost Position Information

Unit Cost Level

Personnel costs

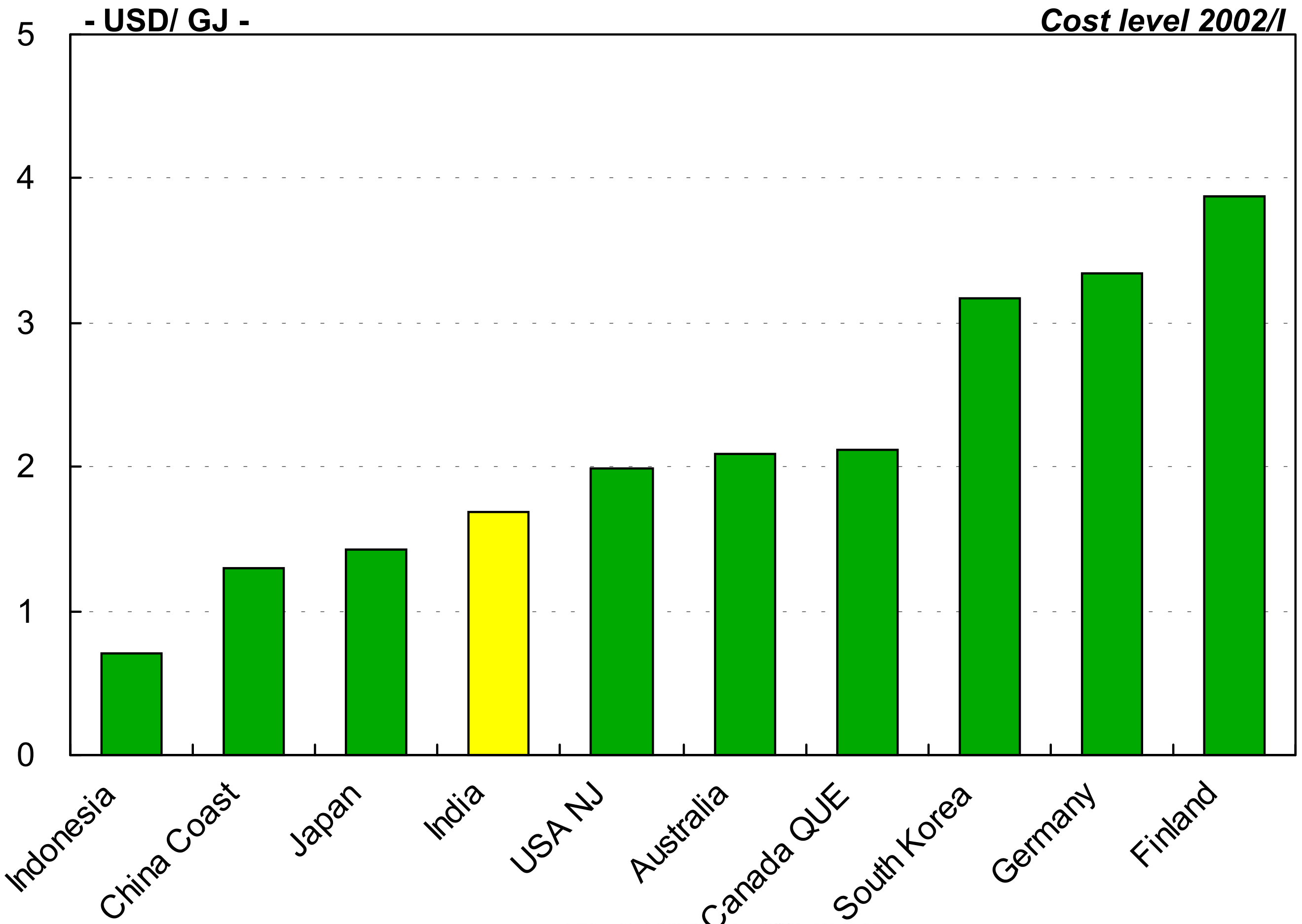
India belongs to the lowest labor cost group together with Indonesia, Thailand and China. The advantage for India in comparison to most of (South East) Asian countries is good availability of highly educated staff. For example in large Indonesian mills the cost of expatriate personnel exceeds that of local personnel.



Cost of fuels (Coal)

Project Number 52A0087

India has low cost coal, but the trade is controlled by the government. India has own coal resources like Indonesia, China USA, Canada and Australia. Japan has relatively low cost, too, but the level is explained by very efficient handling systems.



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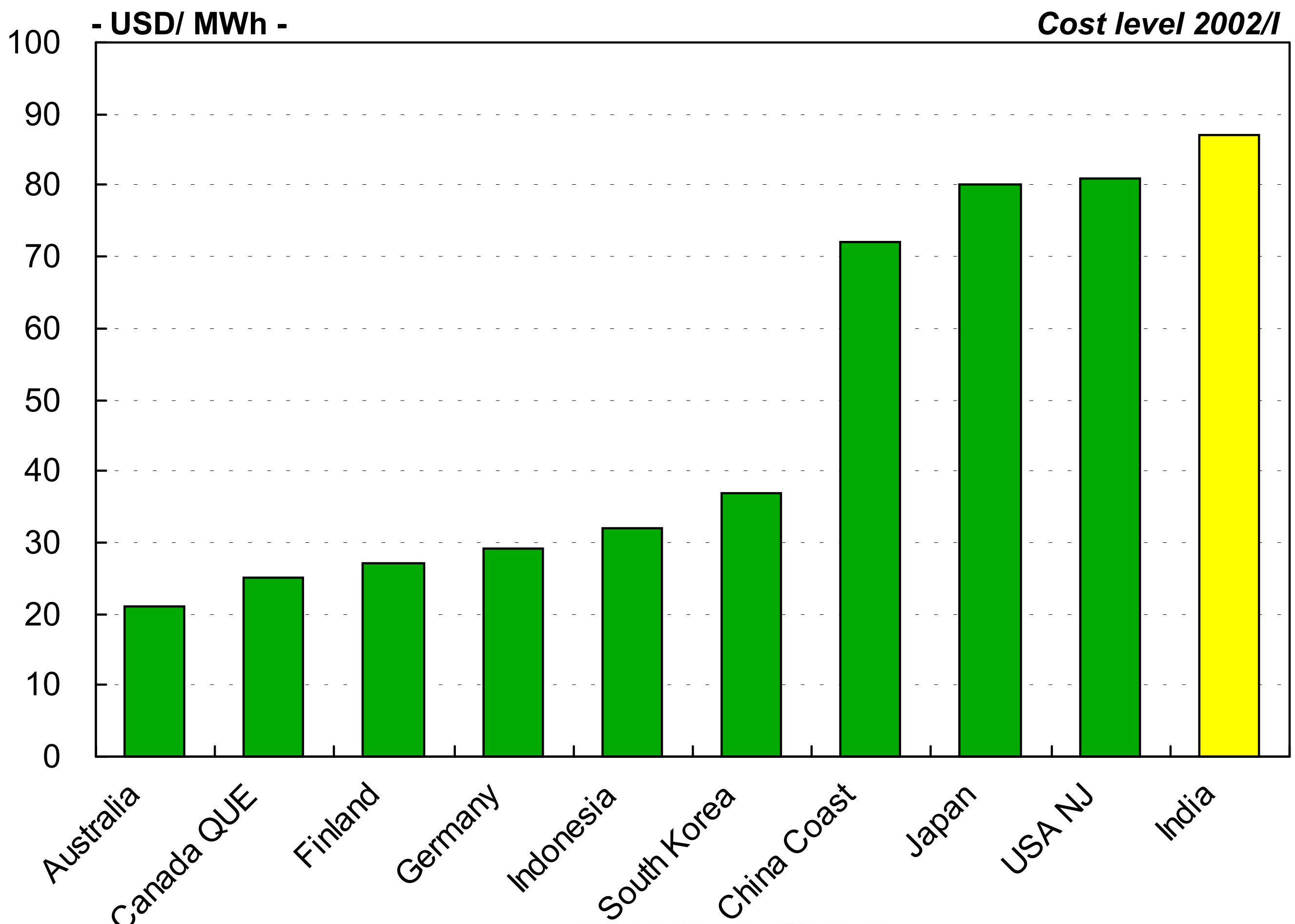
Purchased power

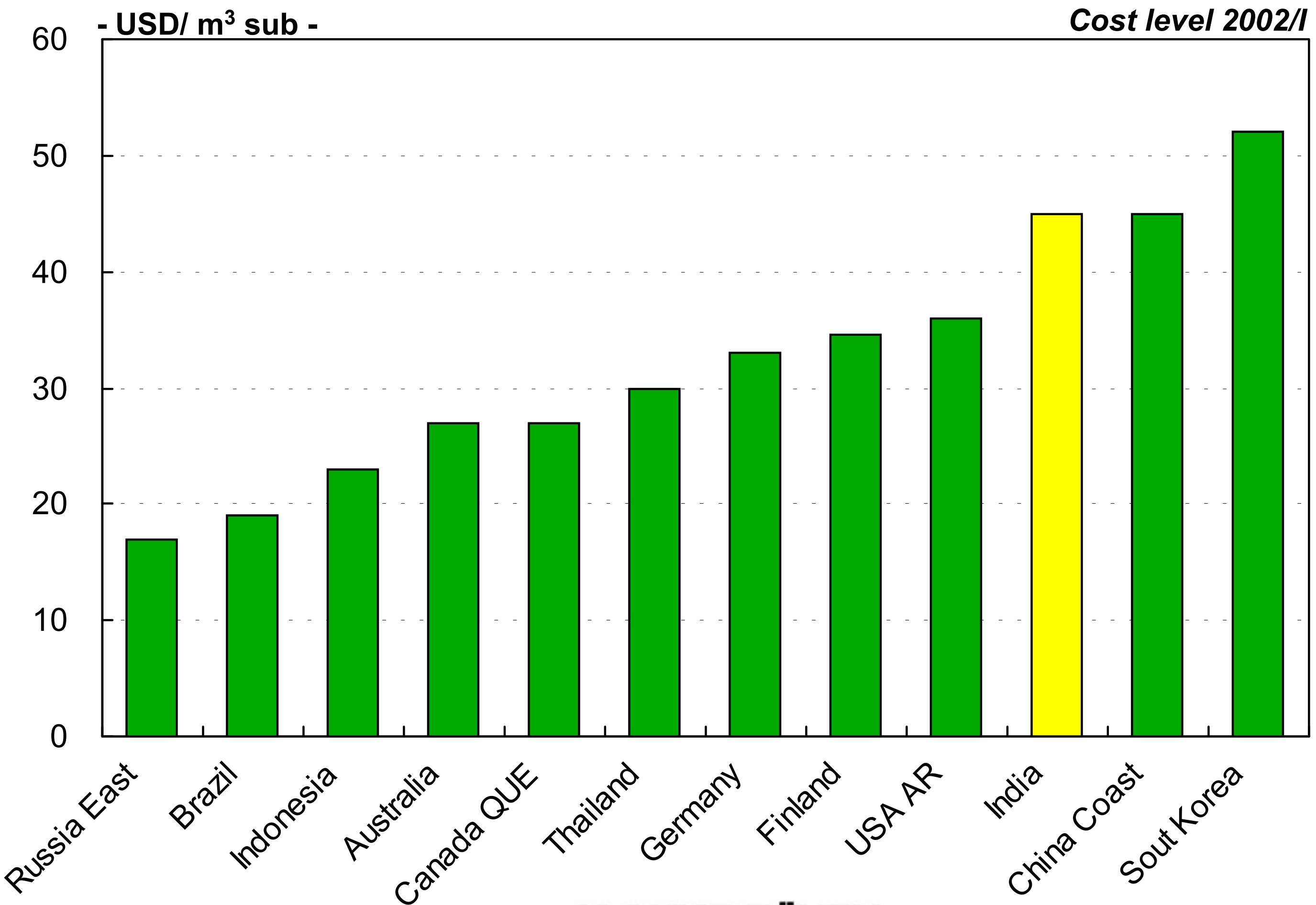
In spite of low cost of fuel, power purchased from the grid is expensive for the industry in the international comparison. Similar situation is in China and Japan, however, in Japan it is about to change when deregulation of the industry proceeds.



Hardwood

Project Number 52A0087

Mills' wood raw material basket is typically composed of mix of species due to limited availability. This tends to lead to low efficiency in processing. Wood price in India is high like in many competing countries e.g. China and Korea.



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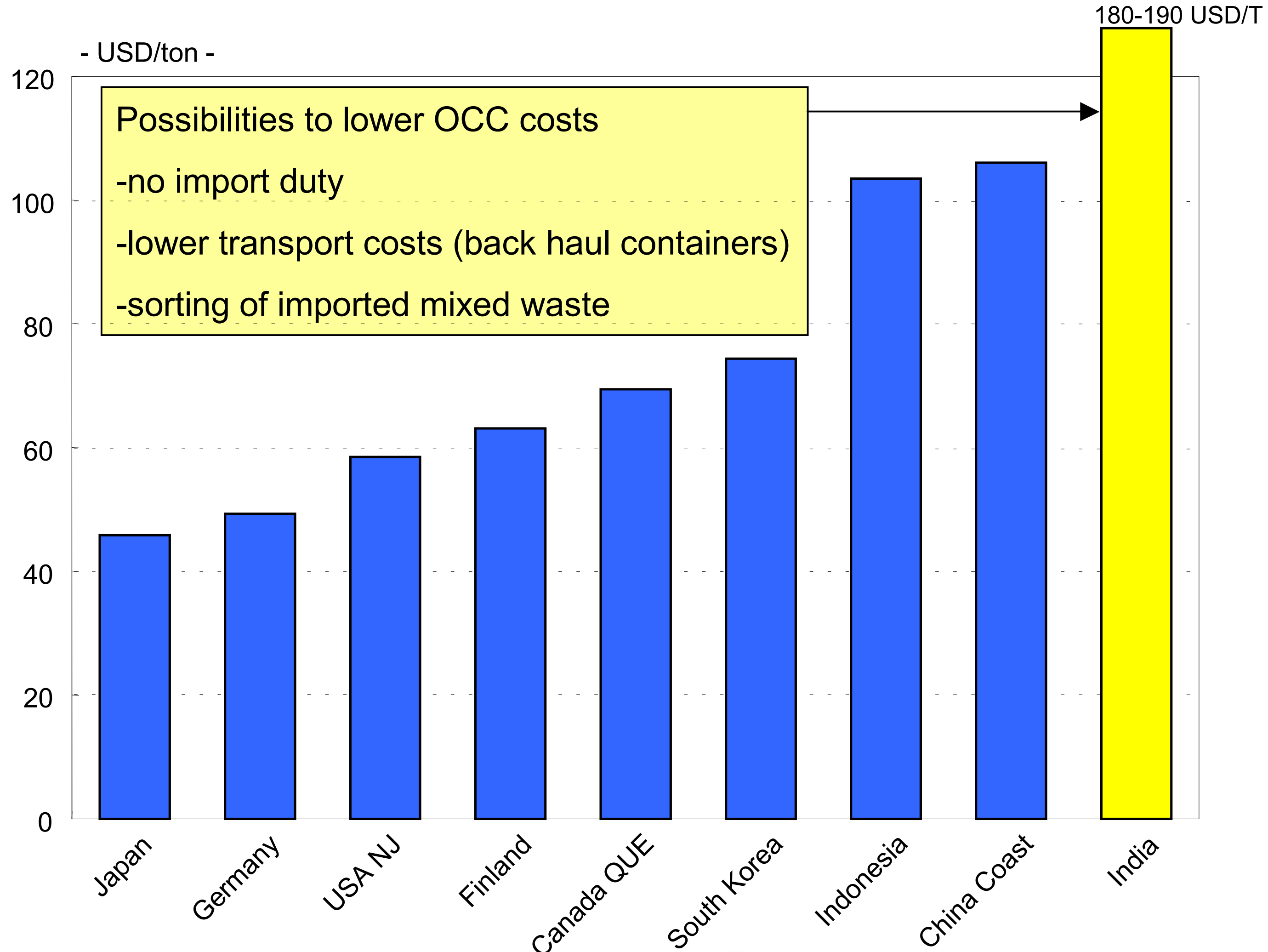
Waste paper (OCC)

OCC is expensive in India, Indonesia and China. Due to shortage of long fiber resources these countries must import OCC. Long delivery distance increases transportation costs.



Main cost drivers in India

Wood costs

Cost component	Cost drivers	Actions needed to reduce costs
Wood costs - domestic	– shortage of wood, forest economics, harvesting, transport, etc.	– increasing plantations – promote cooperation between States/Mills/Farmers
Wood costs – bamboo	– shortage of bamboo in India	– funds for bamboo regeneration and afforestation programs – imports of bamboo eg. from Myanmar
Wood costs - imported	– Japan dictates largely Asian prices	– sourcing with long term contracts – improvement of port handling equipment for wood chips

Main cost drivers in India

Waste paper costs

Cost component	Cost drivers	Actions needed to reduce costs
waste paper - domestic	– low domestic recovery for paper industry (competing uses waste paper)	– improve domestic recovery starting eg. with long term contracts with printers/converters.
Recoverd paper - imported	– international market for imported waste paper – import duty on waste paper	– global sourcing (Europe, North America, Gulf countries) – long term contracts with international merchants/exporters – sorting of mixed waste locally – mill location close to main ports – backhaul opportunities to lower transport costs – allow duty free imports

Main cost drivers in India

Agro fibres

Cost component	Cost drivers	Actions needed to reduce costs
Bagasse	– limited availability of surplus bagasse (energy use of bagasse is subsidised) – seasonal variations – transport costs – environmental investments	– revision of energy subsidy policy for bagasse – backward integration to sugar cane production (option for some mills) – mill location close to raw material – mill scale big enough so that proper effluent treatment is viable
Straw	– availability is good, but storage costs are high due to short harvesting season + transport costs – environmental investments	– mill location close to raw material – mill scale big enough so that proper effluent treatment is viable

Main cost drivers in India

Other costs

Cost component	Cost drivers	Actions needed to reduce costs
Energy costs	– coal availability – inefficiency of steam generation (eg. due to coal quality) – enrgy prices from grid vary by State – high energy consumption due to old/obsolete machinery	– Government energy policy – Co-generation at pulp mills (modern pulp mill is self sufficient in energy) – mill modernisation – exploitation of alternative energy sources (eg. wood residues like bark).
Chemical costs	– domestic availability (basic chemicals available in India) – imports of speciality chemicals – lack of chemical recovery at smaller mills	– promote foreign participation to chemical industry to improve quality and know how – lower duties for paper industry chemicals – mill modernisation – some mills have bacward integration with caustic soda and chorine production
Water costs	– vary by State – high water consumption due to old/obsolete machinery	– Government policy on water – mill modernisation
Labour costs	– India has a cost advantage, but labour costs will rise in line with the overall economic development	– Increasing automation – Modernisation of machinery

Cost Position

JPC Approach

- In the cost competitiveness analysis the current cost competitive position of main Indian producers has been compared to relevant Asian and European producers in following grades
  - Std. newsprint
  - Uncoated and coated woodfree
  - Testliner
  - White lined chipboard (coated duplex board)
- In addition, the Indian pulp manufacturing costs in DIP, BHKP, CTMP and agro fibres has been analysed
- The cost analysis includes also estimation of new hypothetical producers in India. The assumption for these calculations are

		News	UWF	CWF	Board
Production	t/a	**189 600**	**189 200**	**255 900**	**269 800**
Concept					Liner/fluting
Imported ONP/OMG	DIP	100 %			
Imported OCC					100 %
Indian euca etc. plantation	sa		80 %		
Imported SW kraft			20 %		
Filler addition	GCC		20 %	8 %	
Coating totally				40 %	

JPC Approach (cont.)

- The cost structures of the analysed producers have been estimated with the Cost Competitiveness Model developed by Jaakko Pöyry Consulting Oy. The estimation is based on the technical analysis of the mill and on the economic analysis of the region in which the mill is situated. A description of the methodology is presented in Annex I.

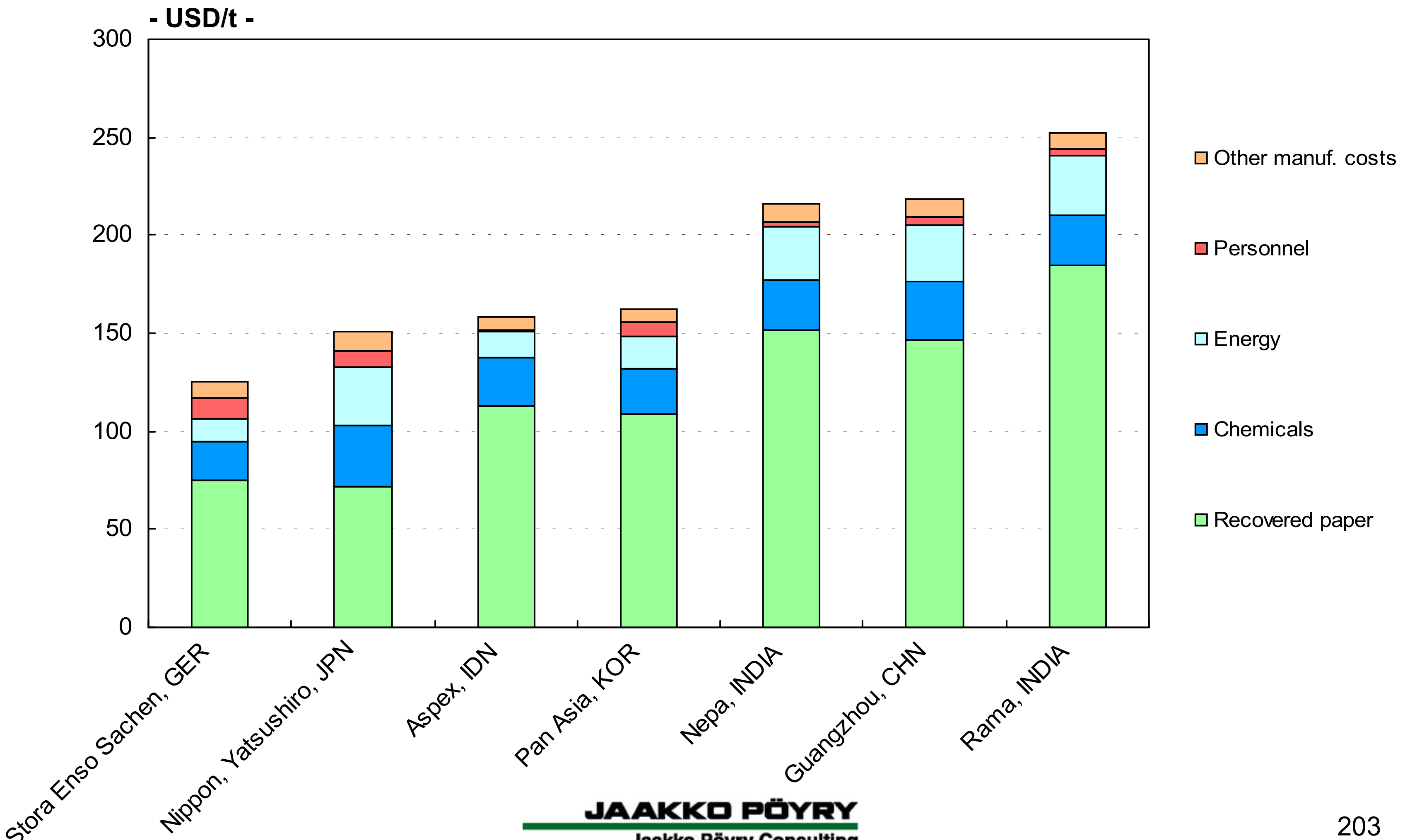
- The price level applied to the analysis is the first quarter of 2002 and the analysis is carried out by applying March 2002 (1 USD = 48,7 INR) exchange rates. The prices are regional average unit prices collected form publicly available sources, so this reason there are differences to the actual prices that separate mills are paying.

Pulp manufacturing

Slush pulp cost comparison - DIP

Project Number 52A0087

Low cost of local waste paper in North and Southeast Asia is responsible to the low cost of slush pulp. Indian and Chinese producers lose their competitiveness due to high import duty for waste paper and local transportation.



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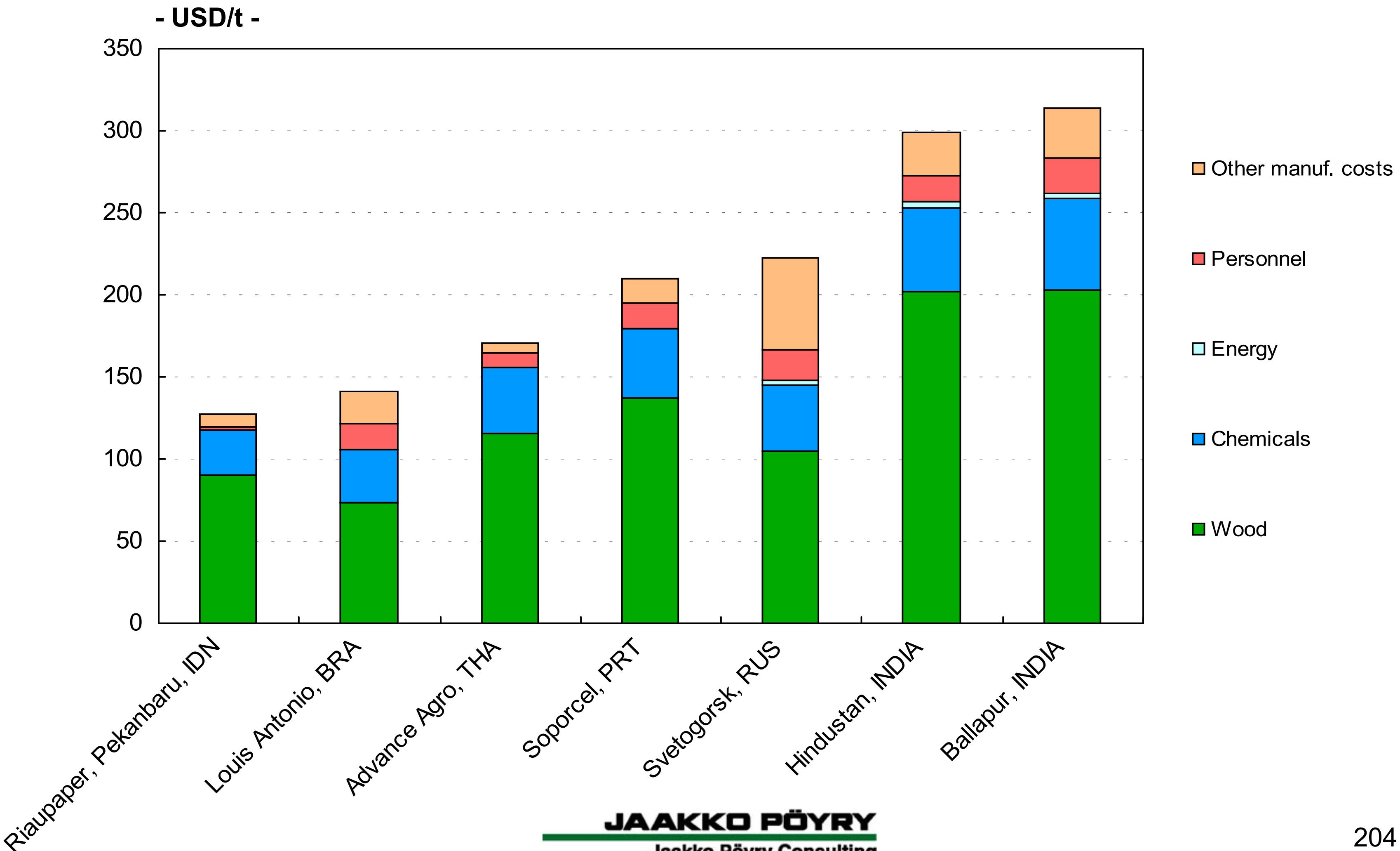
Slush pulp cost comparison - BHKP

Indian producers suffer from high cost of wood and chemicals. Besides inefficient use of manpower raises higher fix costs compared to other Southeast Asian producers.



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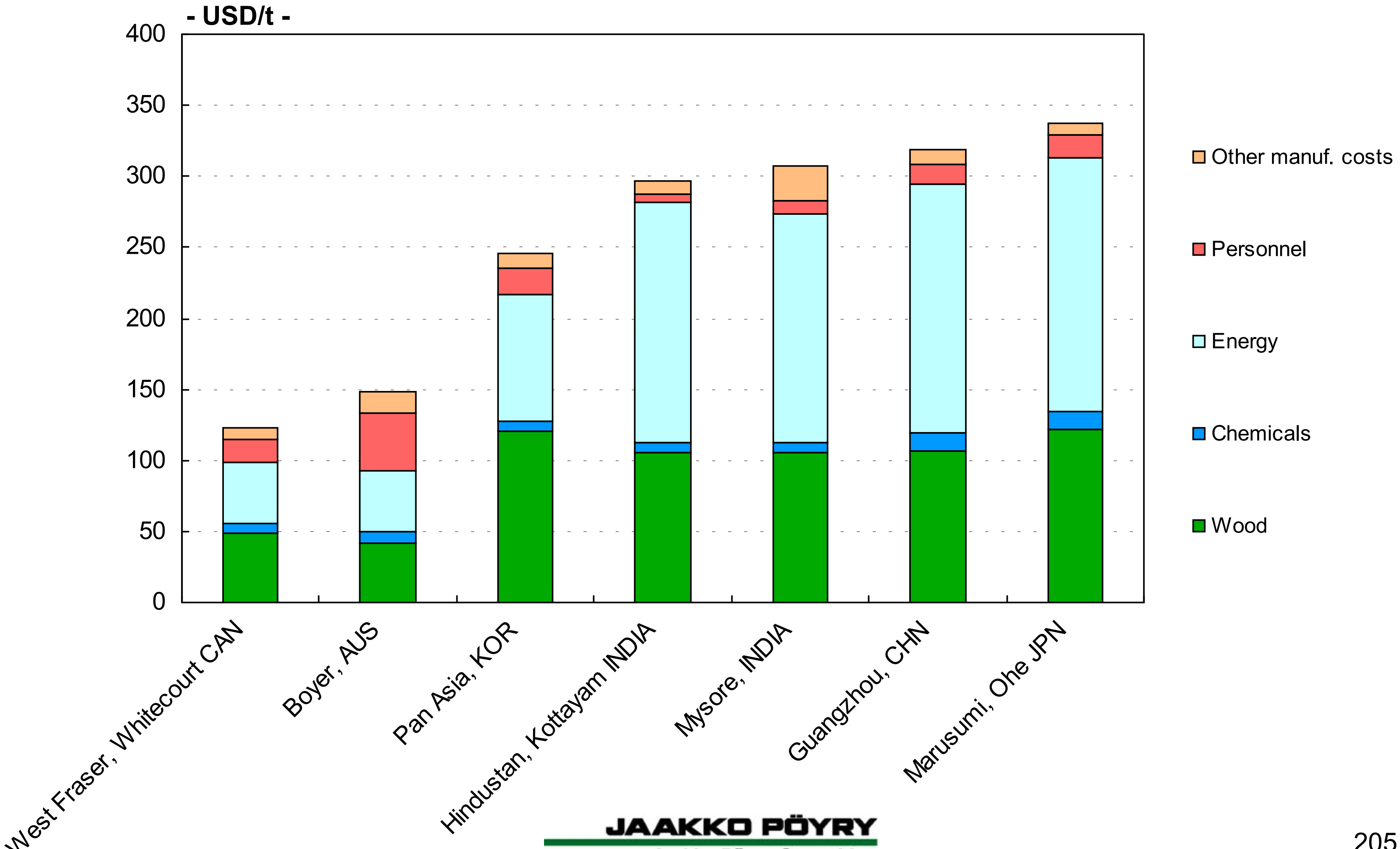
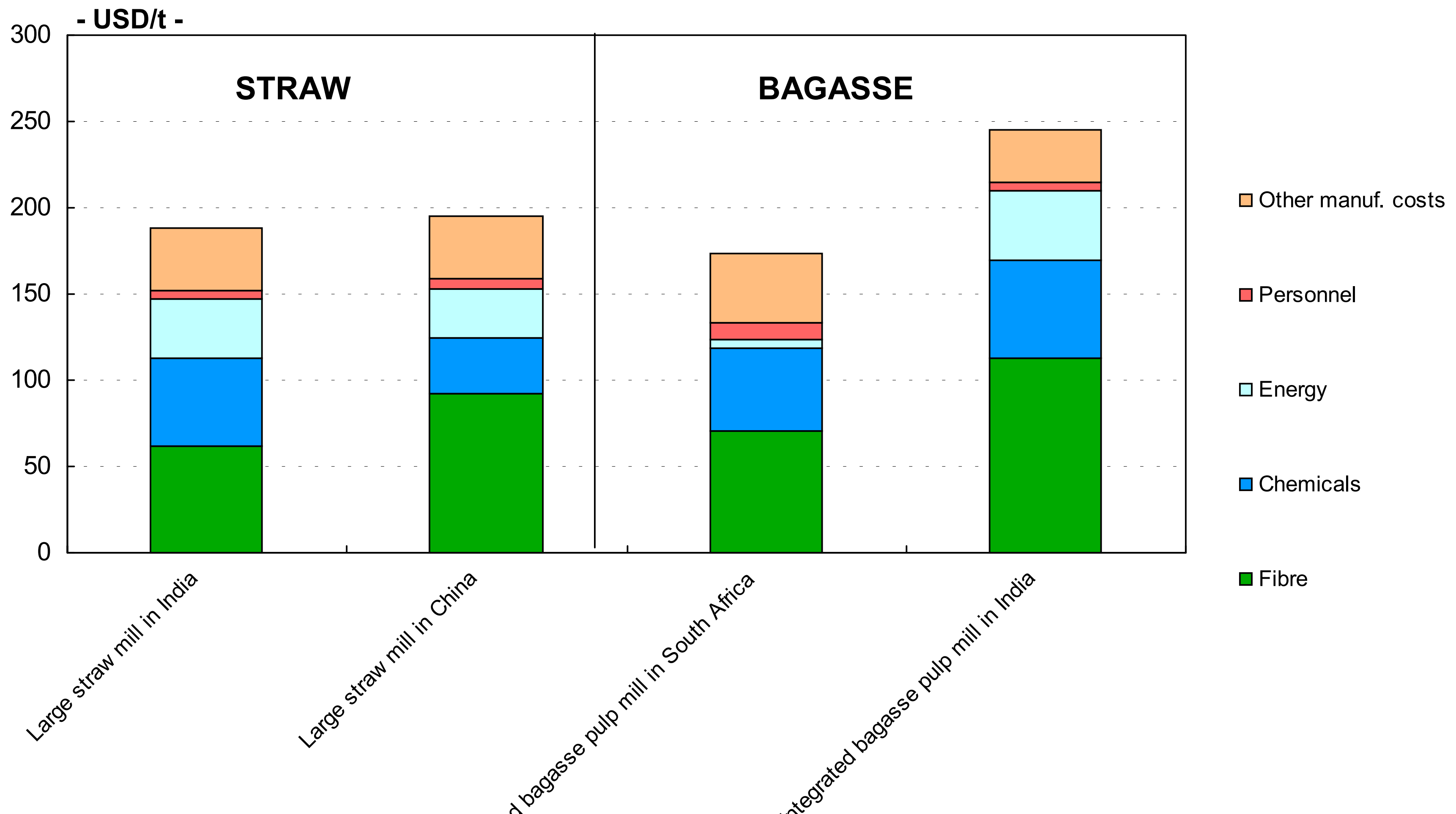
Slush pulp cost comparison - CTMP

In CTMP production the cost level of Indian producers is at the same level with other Asian countries with high wood prices.



Slush pulp comparison – Agro fibres

The Indian straw pulp production costs are at the same level with Chinese mills. In bagasse the variation are great.



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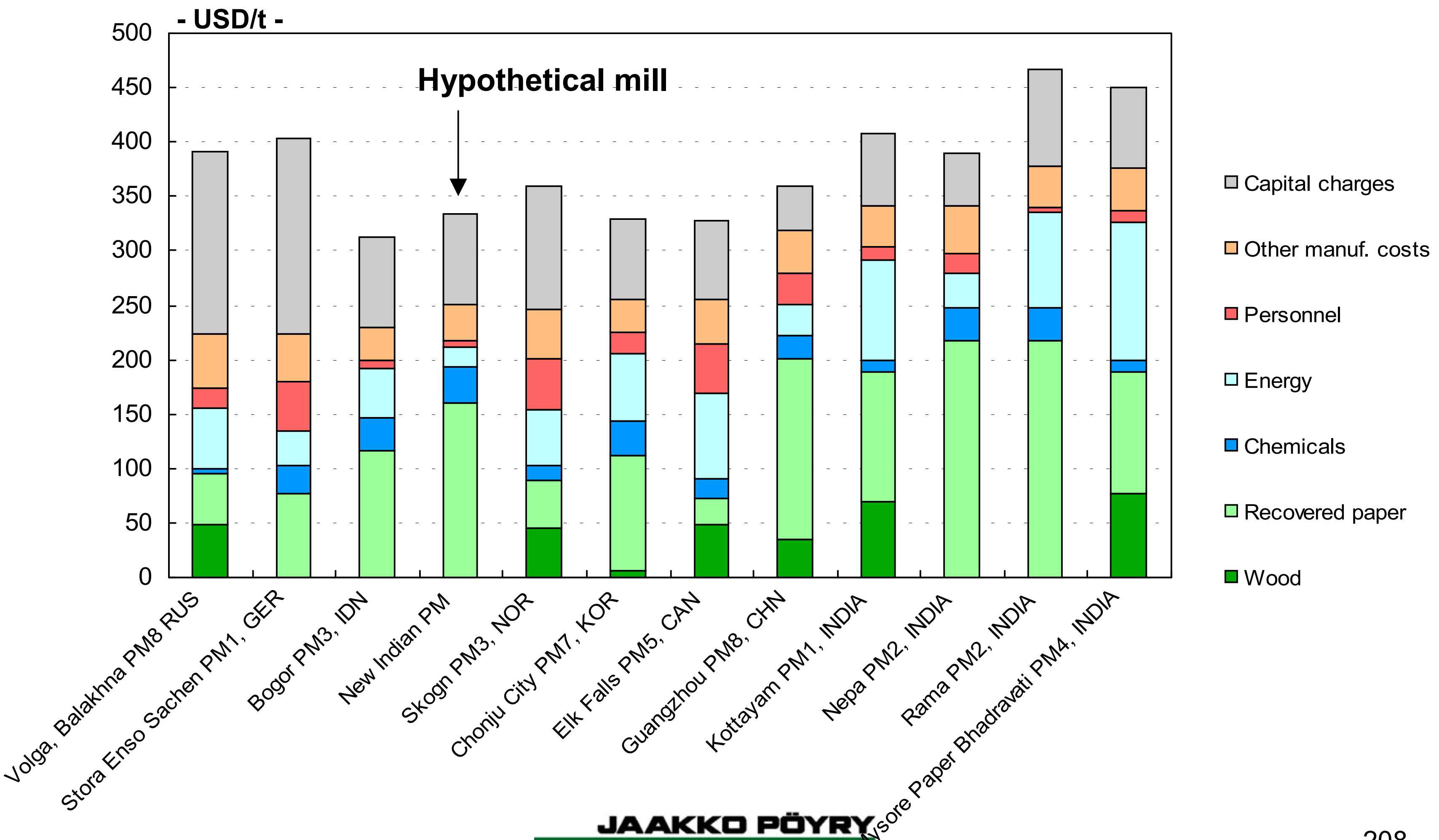
Newsprint

Jaakko Pöyry Consulting

Comparison of cost components - Newsprint

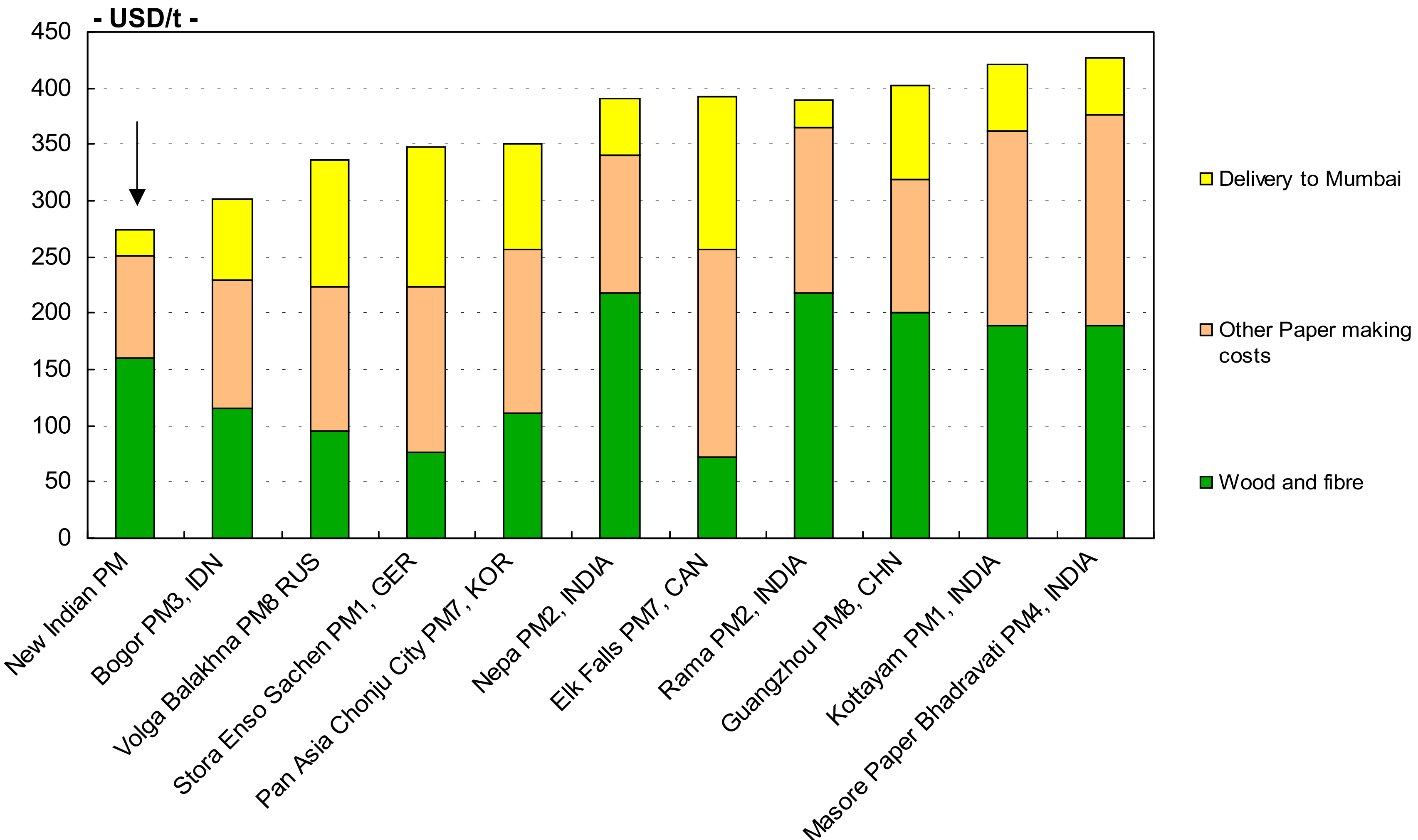
The manufacturing costs of Indian newsprint mills are high mainly due to the wood and fibre prices. A new large scale newsprint machine using 100 % of DIP in its furnish would be competitive. The capital charges of Indian PMs are typically low.



Delivered cost of newsprint to Mumbai

Project Number 52A0087

The high fibre costs weaken the cost competitiveness of Indian newsprint producers even at their home market. A new PM near New Delhi would how ever be very competitive.



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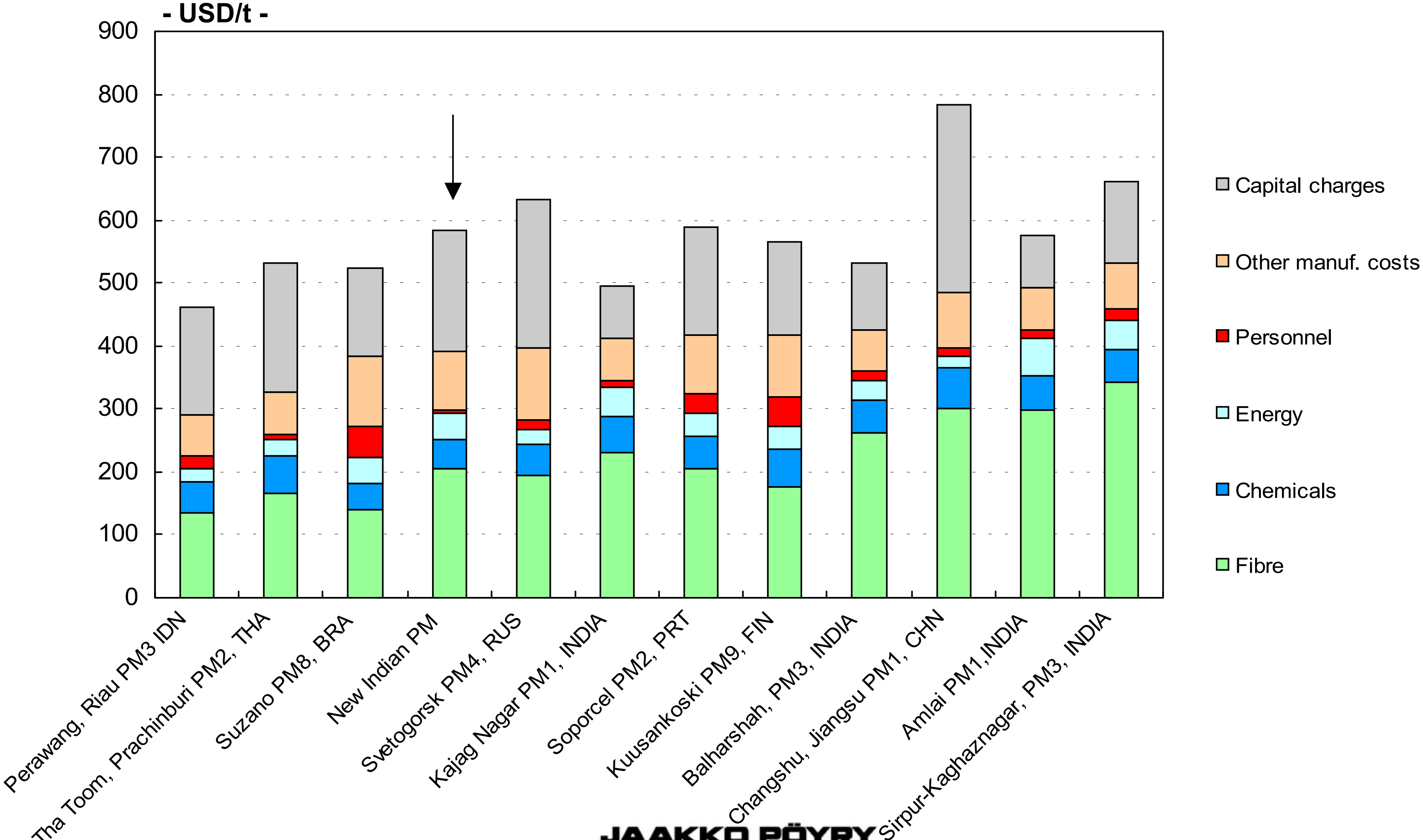
Printing and writing papers

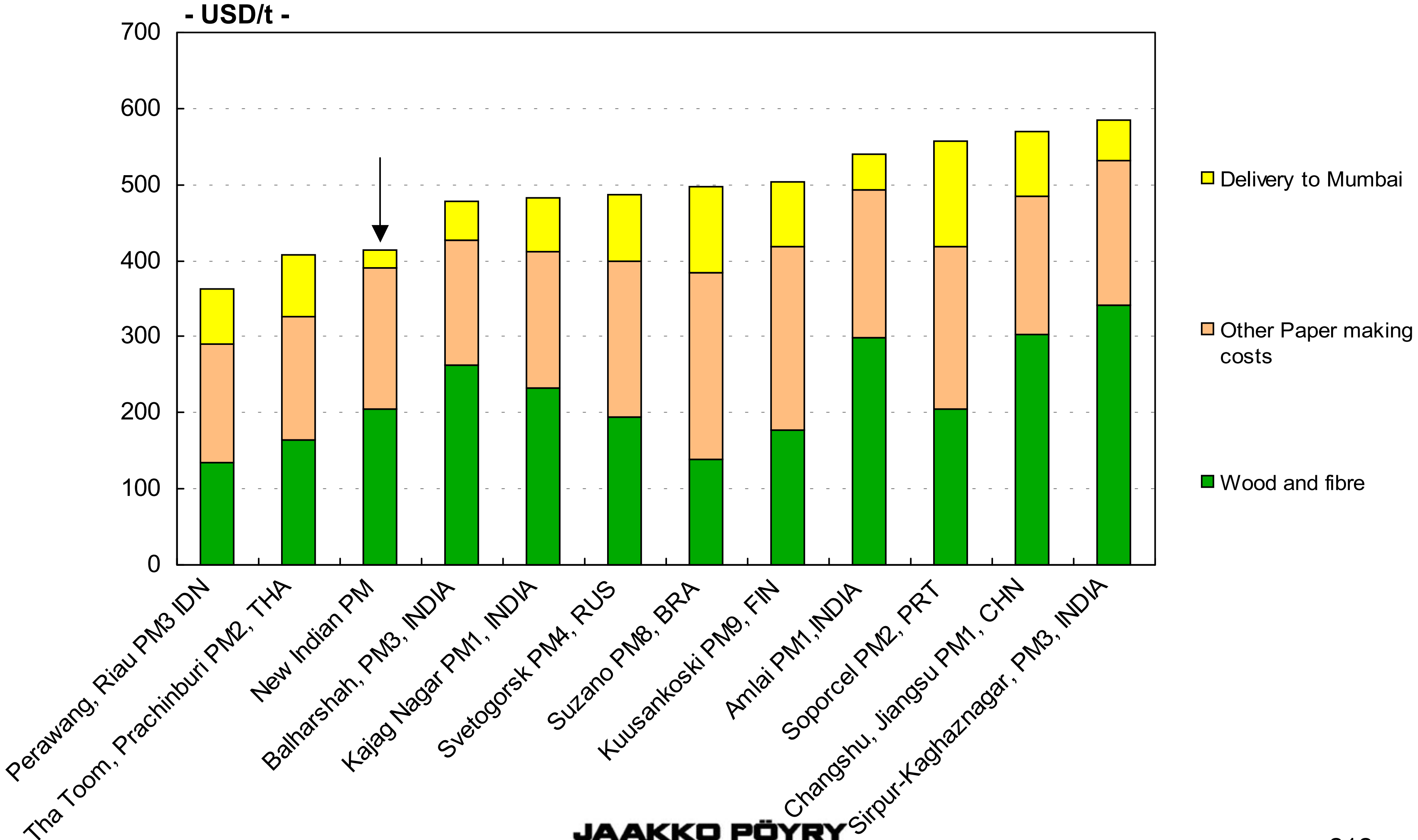
Comparison of cost components - UCWF

The manufacturing costs of the largest Indian fine paper machines are at competitive level, however, the quality is not comparable. A new PM integrated to BHKP production and producing international quality would be competitive in India.



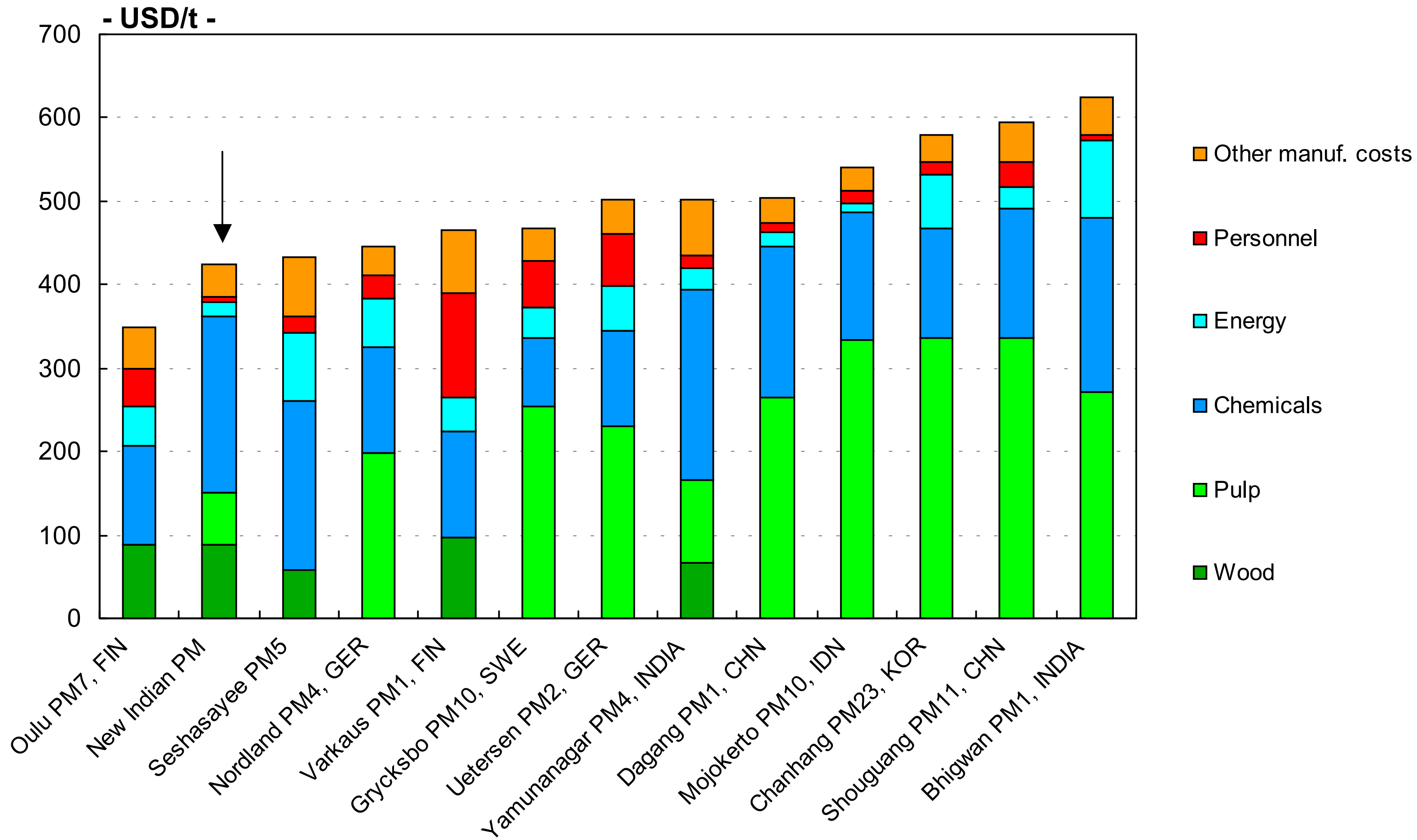
Delivered cost of UCWF to Mumbai

The currently the Indian producers are cost competitive in their home markets against other than South East Asian competitors. A new modern Indian PM could compete also with them.



Comparison of cost components - CWF

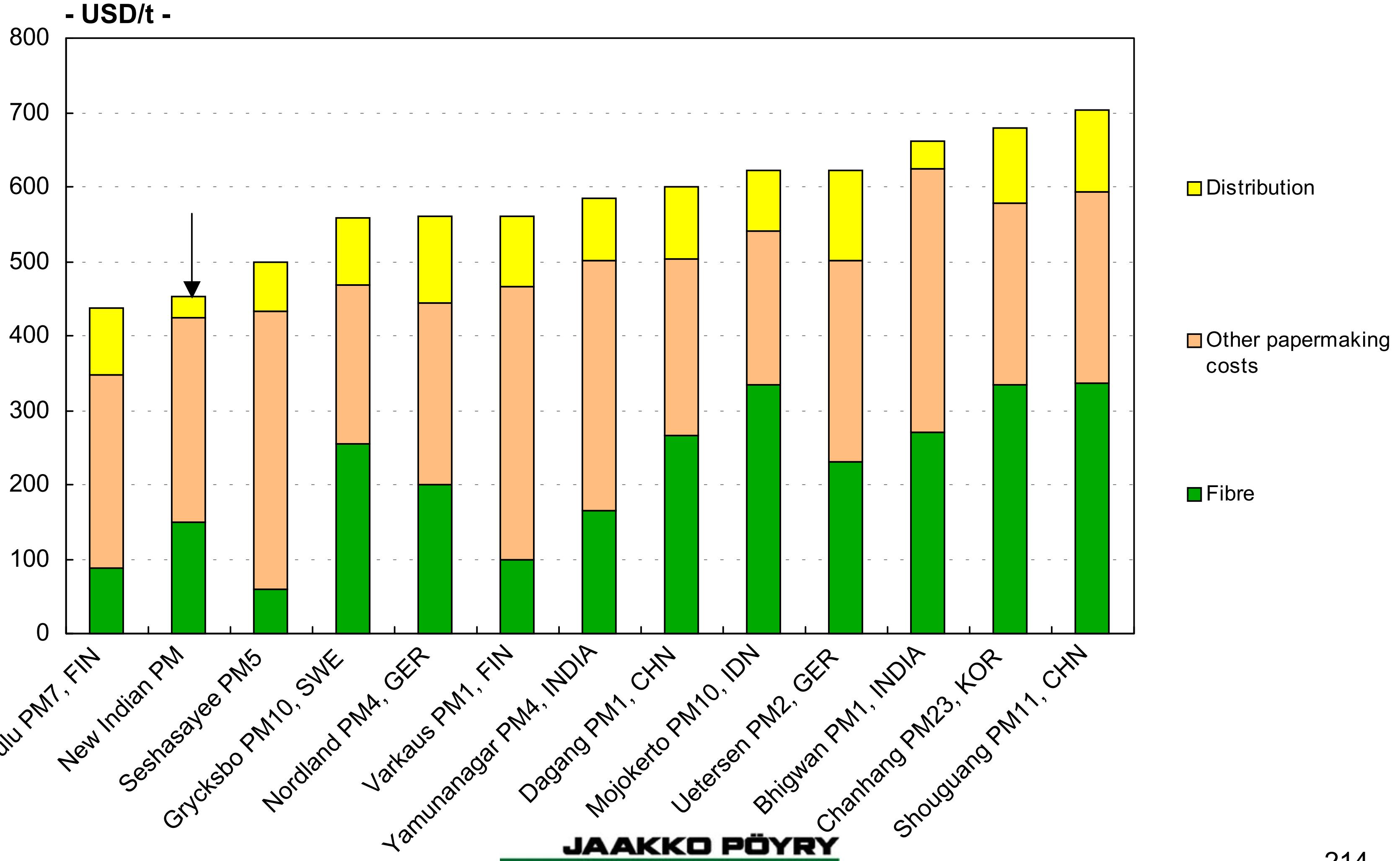
The largest Indian CWF machine is cost competitive on manufacturing cost basis. However, there are significant differences in quality.



Delivered cost of CWF to Mumbai

Project Number 52A0087

The largest Indian CWF machine is cost competitive at home markets. A new modern PM would be very competitive.



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Packaging boards

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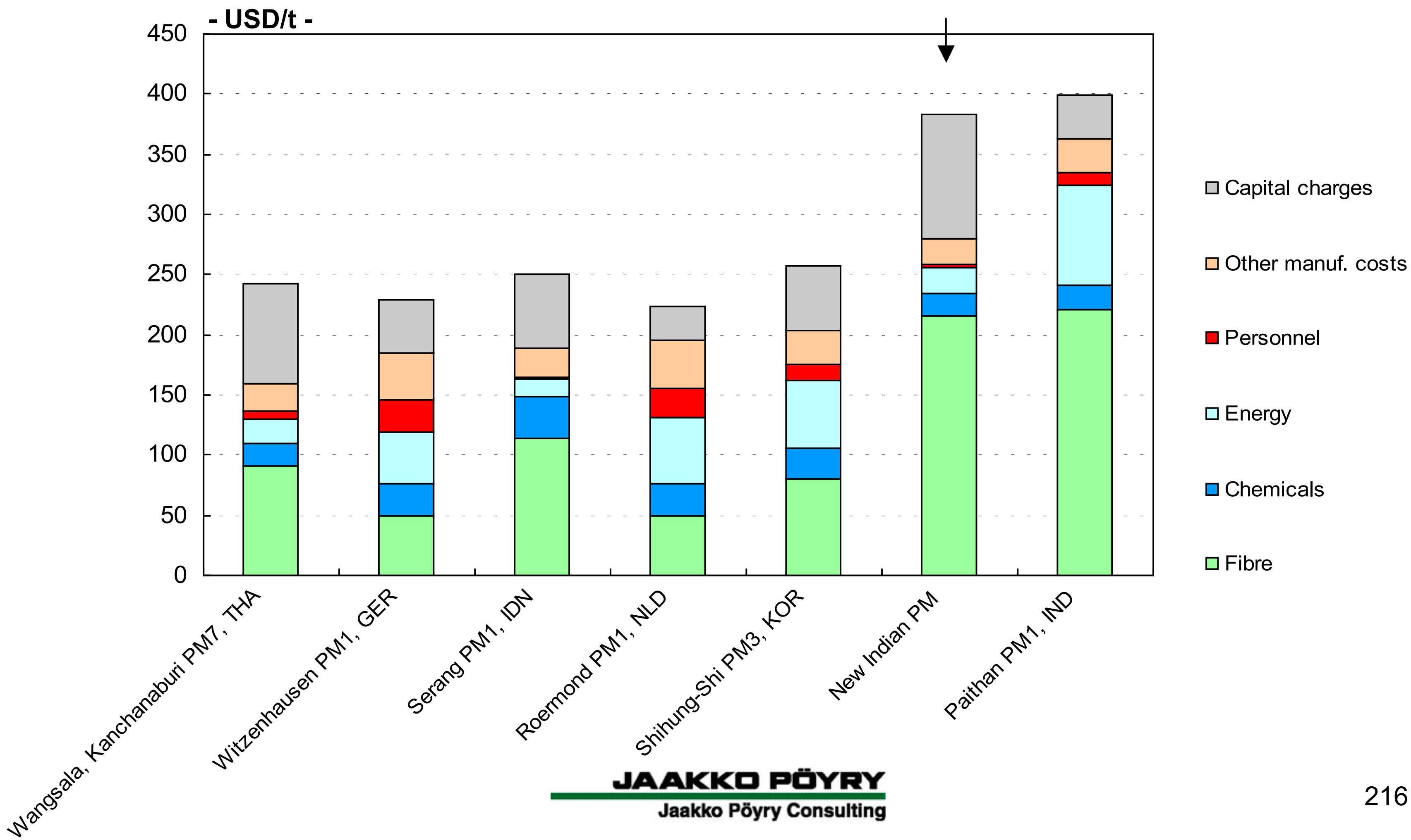
Comparison of cost components - Testliner

The high OCC and mixed waste price weakens cost competitiveness of most Asian producers. The Indian testliner machines are very small and even the largest one (Paithan PM1) is fairly inefficient. With the current OCC sourcing and pricing even a new large machine would not be competitive.



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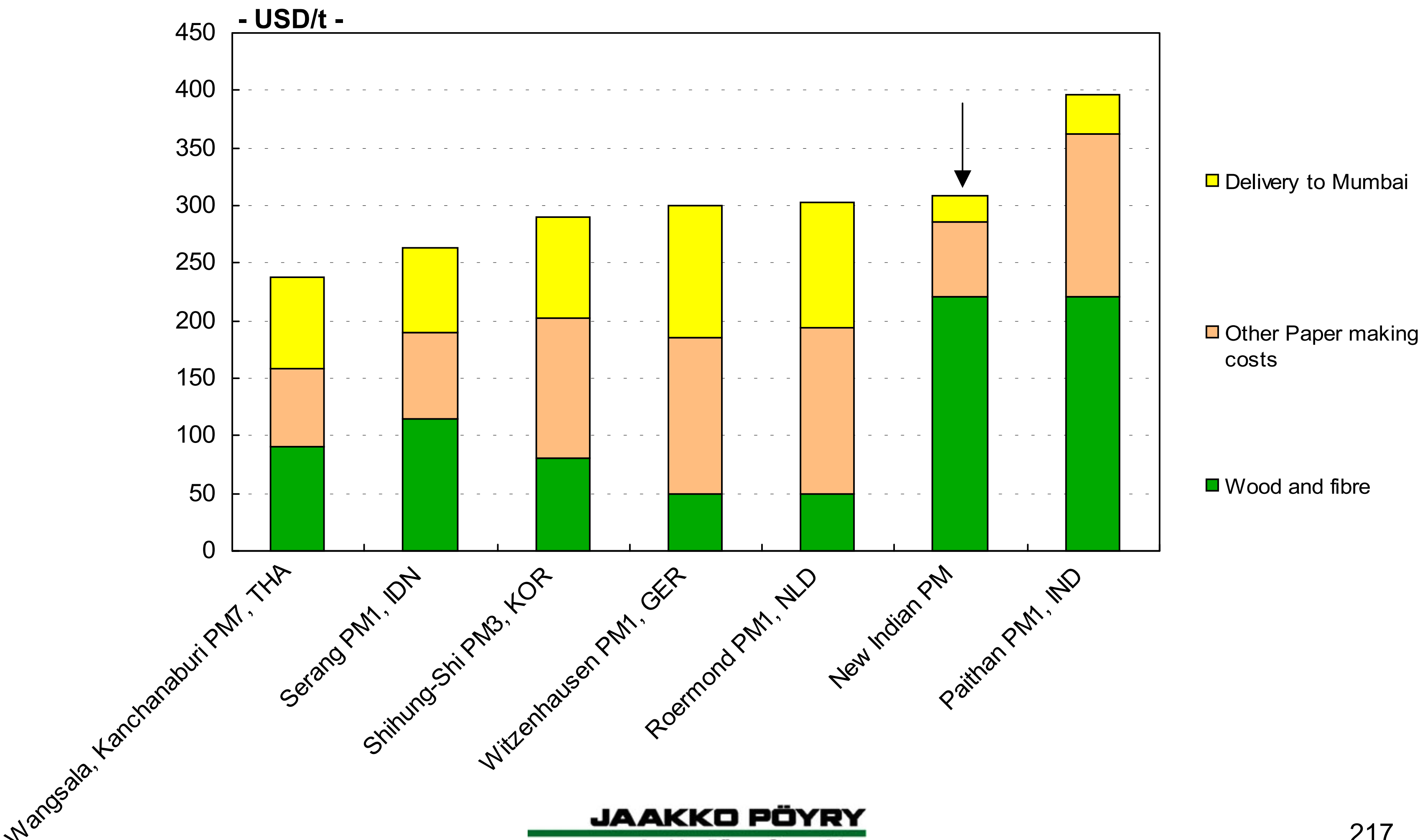
Delivered cost of Testliner to Mumbai

Project Number 52A0087

High cost of raw materials combined with small scale production make the estimated cost level of the selected Indian mill fairly high in spite of transport cost advantage.



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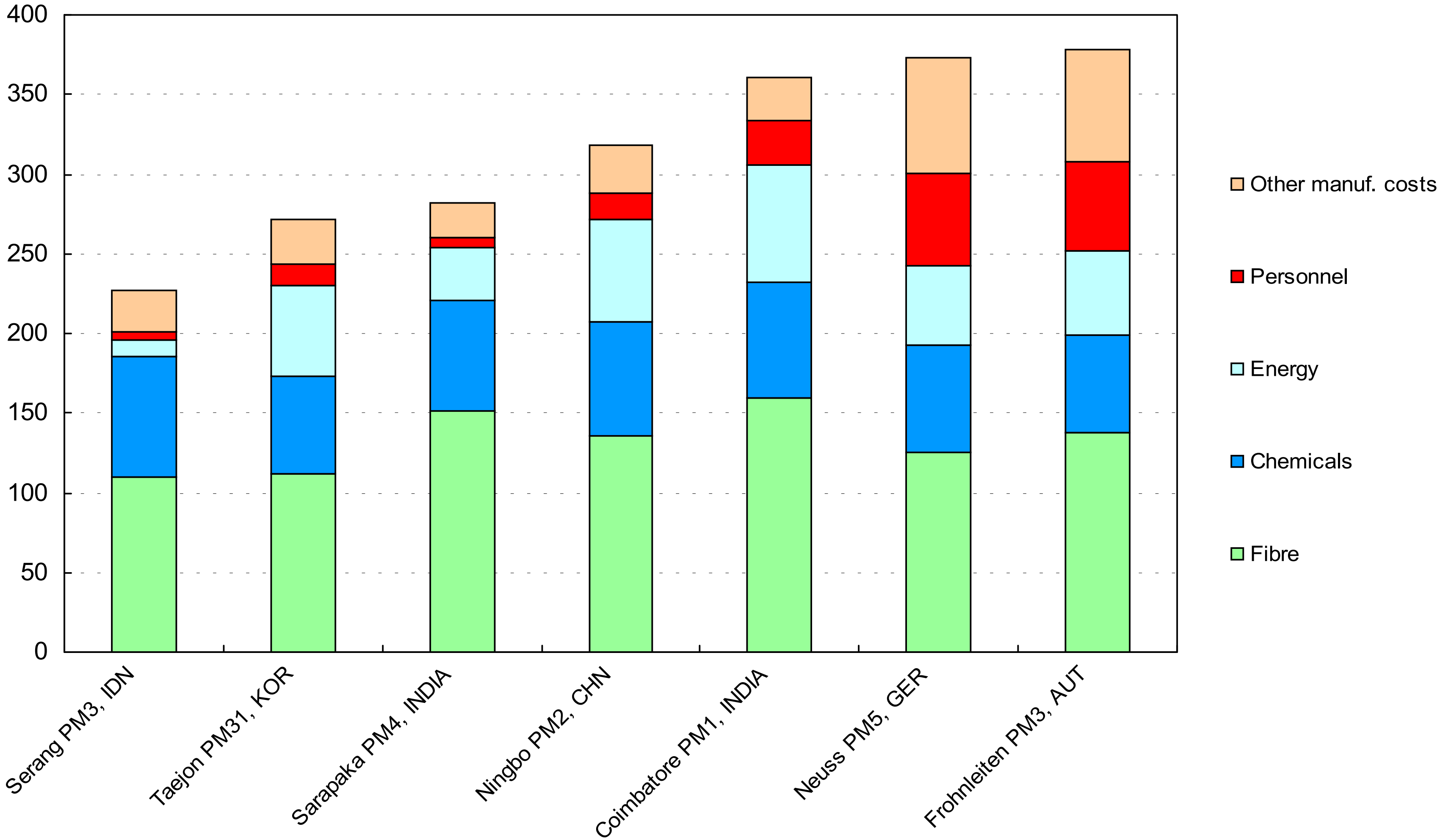
Comparison of cost components - WLC

The largest Indian board machine (ITC's Sarapaka BM4) is relatively competitive on manufacturing costs basis.



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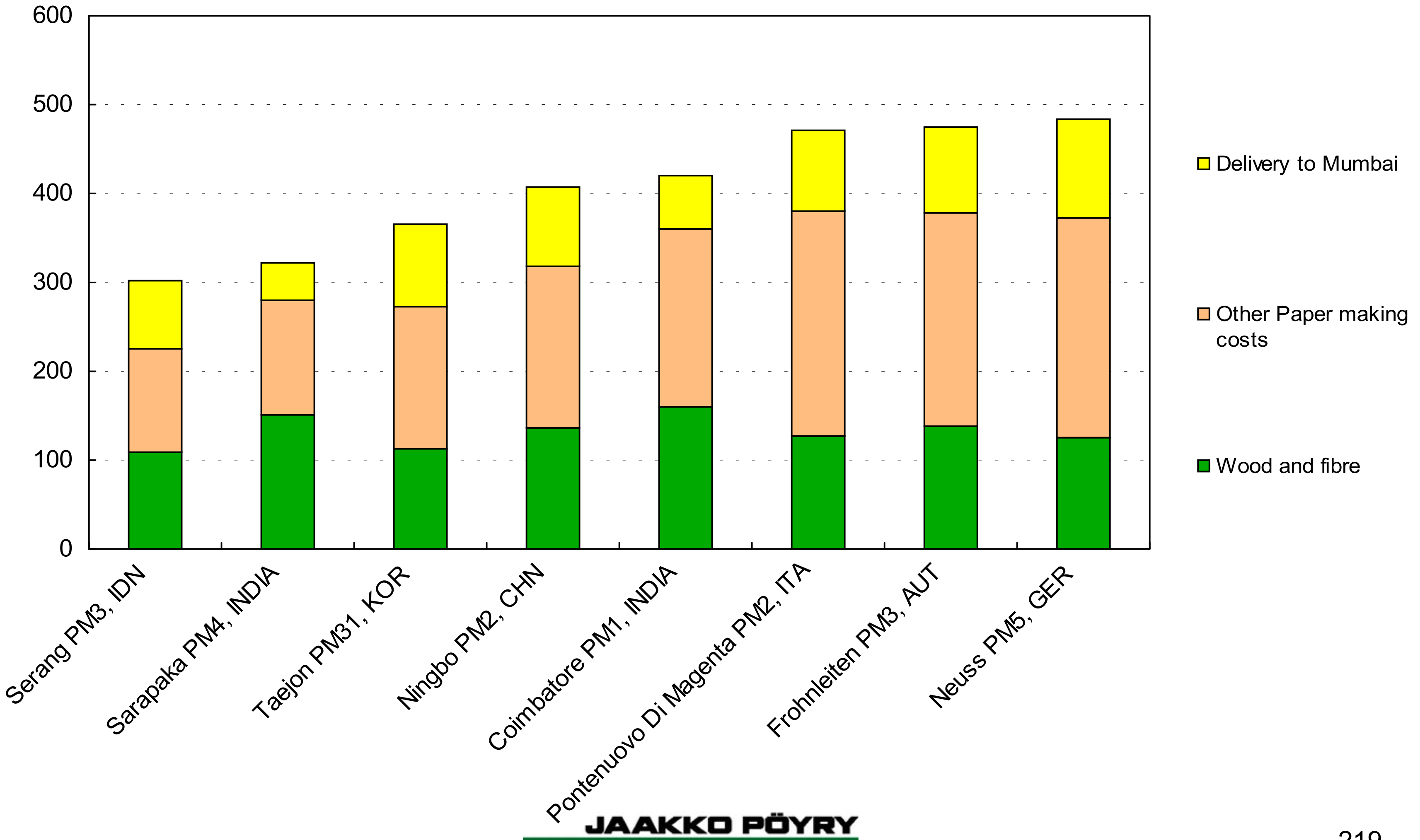
Delivered cost of WLC to Mumbai

The best Indian mill reaches low cost level as a result of low processing costs. The mill is integrated, and purchases wood and waste paper, while most of the competitors buy bleached chemical pulp and waste paper.



Conclusions – Cost competitiveness

Cost competitive positioning

Integrated pulp production

- **Kraftpulp pulp** production is fairly expensive in India compared to other South East Asian countries. This is mainly due to the following reasons
  - Expensive wood prices due to the high demand compared to the limited supply
  - Small inefficient production lines
- **Deinked pulp** is also very expensive in India as waste paper has to be imported due to the lack of own collection system
- **Agro fibre**

  There is a great variation in manufacturing costs depending on the mill and the region. The best mills are competitive.

Cost competitive positioning

Newsprint and printing & writing papers

- The cost competitiveness of Indian newsprint mills suffers from both small machines size and high fibre costs. Furthermore the high purchased power prices weaken their cost competitiveness.
- The high manufacturing costs overturn the location advantage even in the Indian market and thus the cost competitiveness of Indian newsprint industry is weak. The large and modern machines in cheaper fibre areas, like in Indonesia and Russia, and even the largest European mills are able to deliver newsprint to India with an competitive cost.
- The largest Indian uncoated woodfree machines are fairly competitive on manufacturing cost basis and in their home market. However, the quality is not fully comparable.
- In both newsprint and fine papers, the new larger scale papermachines in India would be competitive. Despite of high fibre costs, the machines would be able to reach competitive manufacturing costs due to the low fixed costs. However, own power generation facilities are a necessity for ensuring the availability of electricity.

Cost competitive positioning

Packaging grades

- The currently operating testliner machines in India are very small; the largest is only 20 000 t/a while there are several machines Asia that are larger than 200 000 t/a.
- With the current machines and high OCC and power prices, the Indian testliner industry can not compete with other Asian producers. A new modern machine with capacity of some 290 000 t/a could be competitive with different OCC sourcing and pricing policy.
- In white line chipboard production the largest Indian producers ITC's Sarpaka mill is very competitive due to the modern machine concept and low fixed costs.

6. Technology

Technology of Indian Paper Industry

Summary of Technical Recommendations

PM capacity and speed - economy of scale

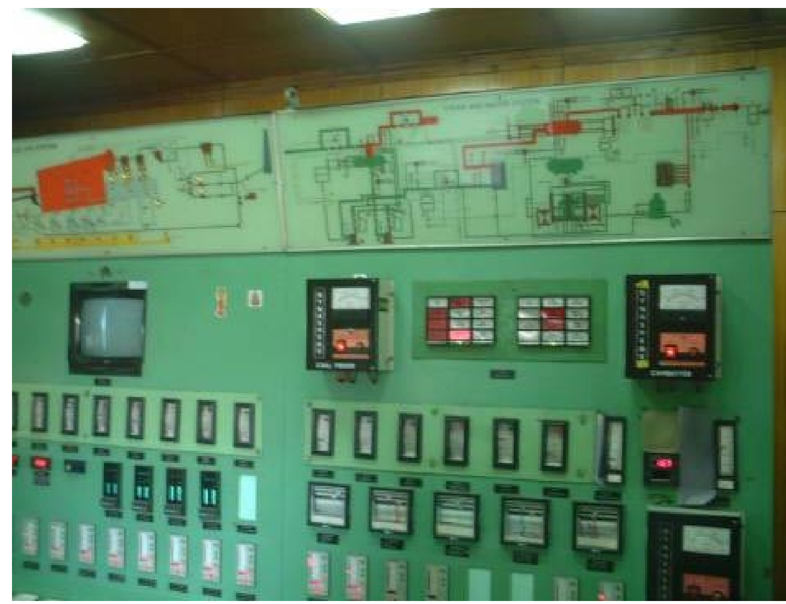
Mills and machines are relatively small in India, technology is old-dated and quality of raw materials and end products is low.

- Average and maximum mill and machine capacities are small in India. **New machines should be about 50 % of international size**.
- With bigger machines investment costs, production of utilities, effluent treatment and all fixed **costs would be lower per produced ton of paper**. Especially bigger machines can afford better automation (QCS and DCS).
- **High speed machines** (>1000 m/min) are needed for cultural papers and one-layer boards. With a higher design speed, technology and paper quality will be closer to the international standard. Machine width can be less than internationally.
- To be internationally competitive **second hand machinery should be imported selectively**.
- Machines representing old-dated technology should be **gradually shut down**.
- Mills and machines have to focus on **few grades** to be more effective This requires efficient marketing and distribution channels as well as some export.

Improvement of paper quality

Domestic raw material quality & availability (fibres, pigments and chemicals) must be improved. Level of quality control systems and automation should be better.

- The level of **quality measurement and control** should be better. Cost of automation for a small machine is almost same as for a big machine. Bigger machines can afford better quality control systems (QCS and DCS).
- Classification of products and mills should be based on the customer **requirements** and their **converting processes**. Now the thinking is based too much on raw materials and mill size.
- **Bleaching** sequences should be improved to get the standard ISO-brightness of 89 %.
- **Mills must have export** to be able to improve quality and to meet the international competition and development.
- Indian paper industry needs more **international contacts**, joint ventures, training and applications instead of 100% Indian owned companies and own R&D. Input to **R&D** should be totally (mills and CPPRI) about **1% of turnover**.
- **Internet and mobile connections** from all mills should be working.



Improving raw materials for papermaking

Domestic raw material quality & availability (fibres, pigments and chemicals) must be improved.

- **Plantation trees and recovered fibres** should be favored over the agro based fibres to be able to improve paper machine speed, runnability, product quality and competitiveness.
- The share of **hardwood sulphate pulp** and **recycled pulp** should be higher to get better paper quality and higher machine speed. Agro based fibre can be mixed up to 25 % of the fibre amount of papers and boards. Mills should be **integrates** of wood/waste and agro based pulping.
- Good quality domestic **carbonate pigment** and **synthetic size** is needed to produce white papers and cartonboards in alkaline conditions.
- The total **amount of pigments** (fillers and coating pigments) should be about double the present level in cultural papers and cartonboards.
- **Cleanliness and order** of all mills should be good to get better efficiency and product quality.

Technology Level of Indian Paper Industry

Consumption of basic inputs

Specific consumptions are always better with new, big and well working machines.

- There is always a fixed and variable part in all inputs. This is the reason that **bigger and well working machines** and mills reduce specific consumptions.
- European chemical pulp mills **produce heat** and electricity from recovery boiler. TMP plants use lot of energy but produce heat.
- **Silicate is not a problem** in wood based pulping. This is the main reason why chemical recovery is better in Europe.
- European mills run with 5 shift crews while Indian mills have only 3 shift crews. In spite of this difference, **personnel productivity** in European mills is 10-40 times as high as in India. Automation and machine size have the greatest impact on this difference.

Input per net ton of paper	Top mills in India	Top mills in Western Europe
Heat GJ/t	15 - 30	4 - 8
Electricity kWh/t (excl. pulp mill)	800 - 1500	400 - 800
Water m^3/t	25 -150	5 - 40
Chemical recovery, %	88 - 94	95 – 98
Productivity tpa/person	25 - 300	800-3500
Personnel man-hours/t	10 – 100	0.5 - 2

Global technology trends

Main Drivers	Key issues	Technology
COST	**Exploit advantages of scale (higher paper machine speed)**	**New former designs** **New press section designs** **New drying section designs**
	Invest efficiently	New approach flow designs On-machine coating and calendering New drying technology
	Improve productivity	**New process concepts** **Automation and control**
QUALITY	**Improve quality**	New headbox, former and surface treatment designs Calendering and winding Fibres, pigments & chemicals Process control and automation

Speed and technology development

Annual average speed of the best paper machines in the world is about double compared to the best Indian machines. Most of Indian machines have very old technology like rectifier roll headbox, Fourdrinier wire, table rolls, dandy roll, open draws in press section, double tier dryer section, old size press or no size press, open hood, hard nip calender and two-drum winders.

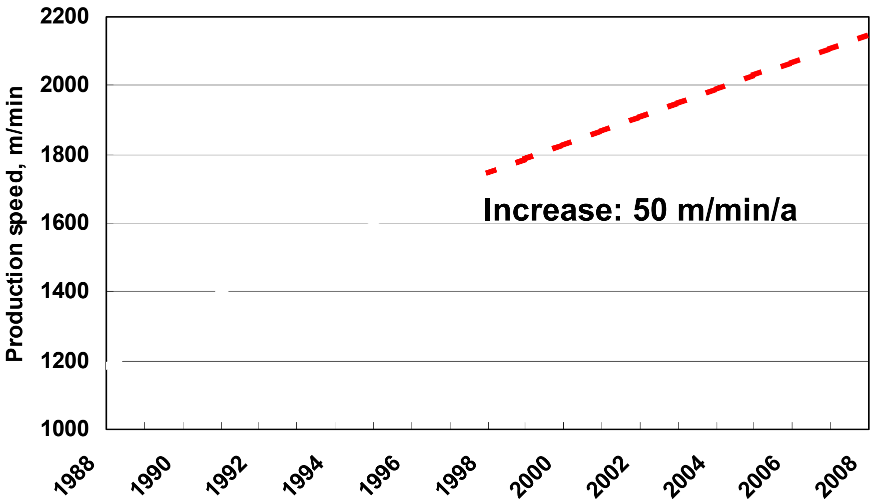
Speed 2002 m/min	World annual average	World design speed	World 24 h record
Mechanical Papers	1 700	2 200	1 902
Woodfree Papers	1 400	1 800	1 524
Corrugating Materials	1 100	1 600	1 402 (7 hours)
Tissue	2 000	2 200	>2 000

Faster and faster machines

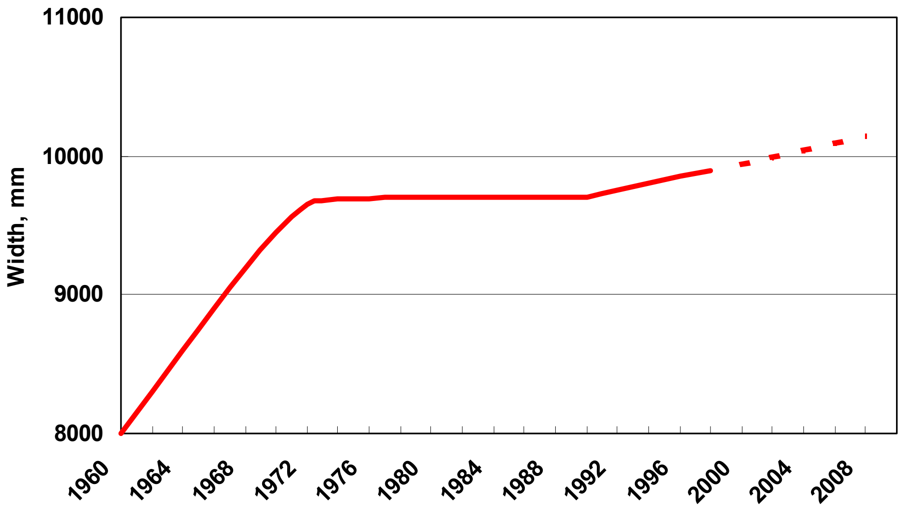
Annual speed increase of fastest machines in the world is about 50 m/min. When the paper machine is designed for highest speed then the product quality and machine runnability are also excellent.

All grades have today very high speeds. Upgraded second hand machines are not viable any more, because they are always too slow compared to new machines.

Annual average for worlds fastest newsprint machines



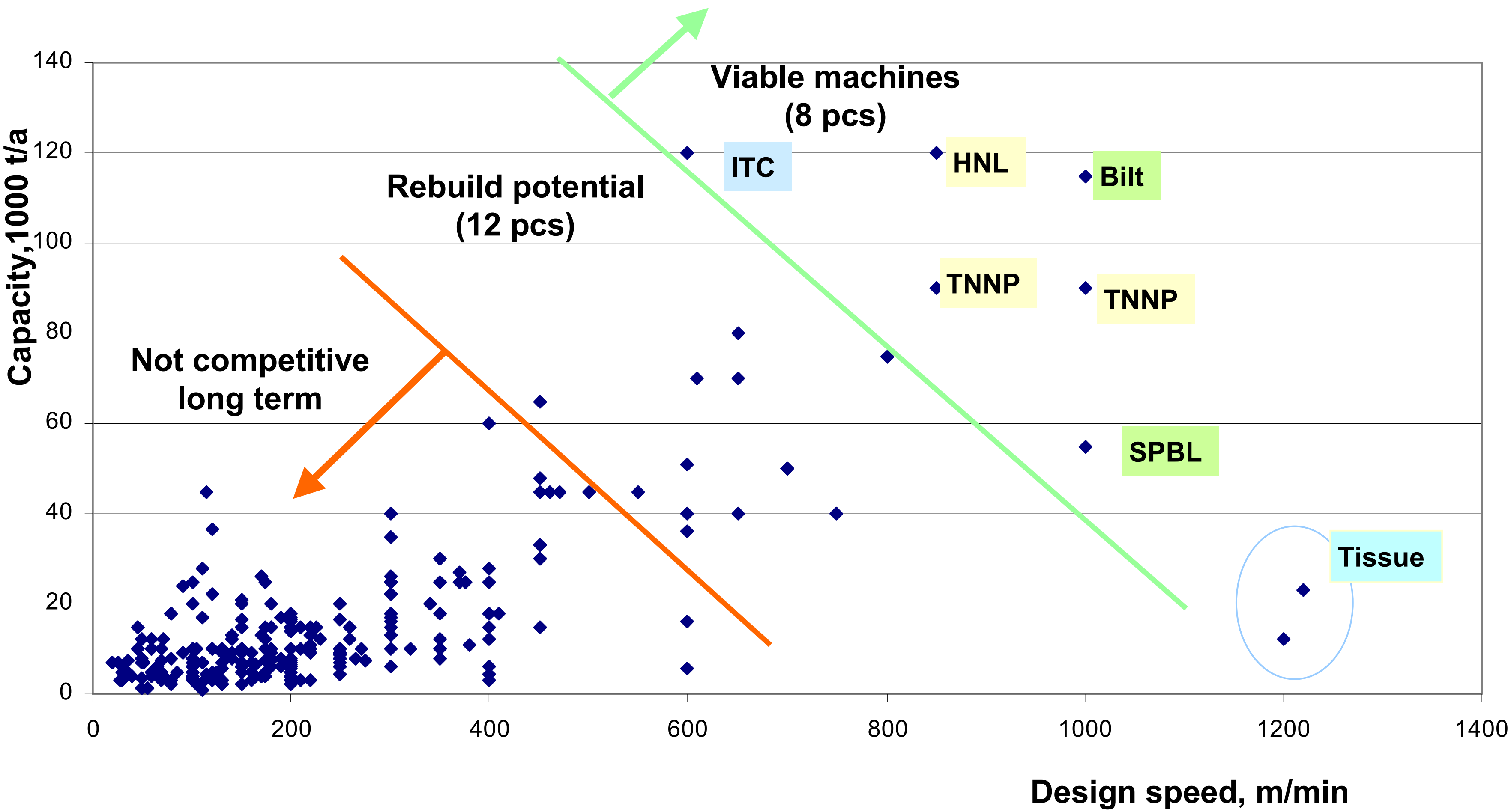
Widest trimmed width at reel



Speech & capacity of Indian paper machines

Project Number 52A0087

The capacity of five Indian paper machines is more than 80 000 t/a, On the other hand, only five paper machines have design speed of 1000 m/min or more.



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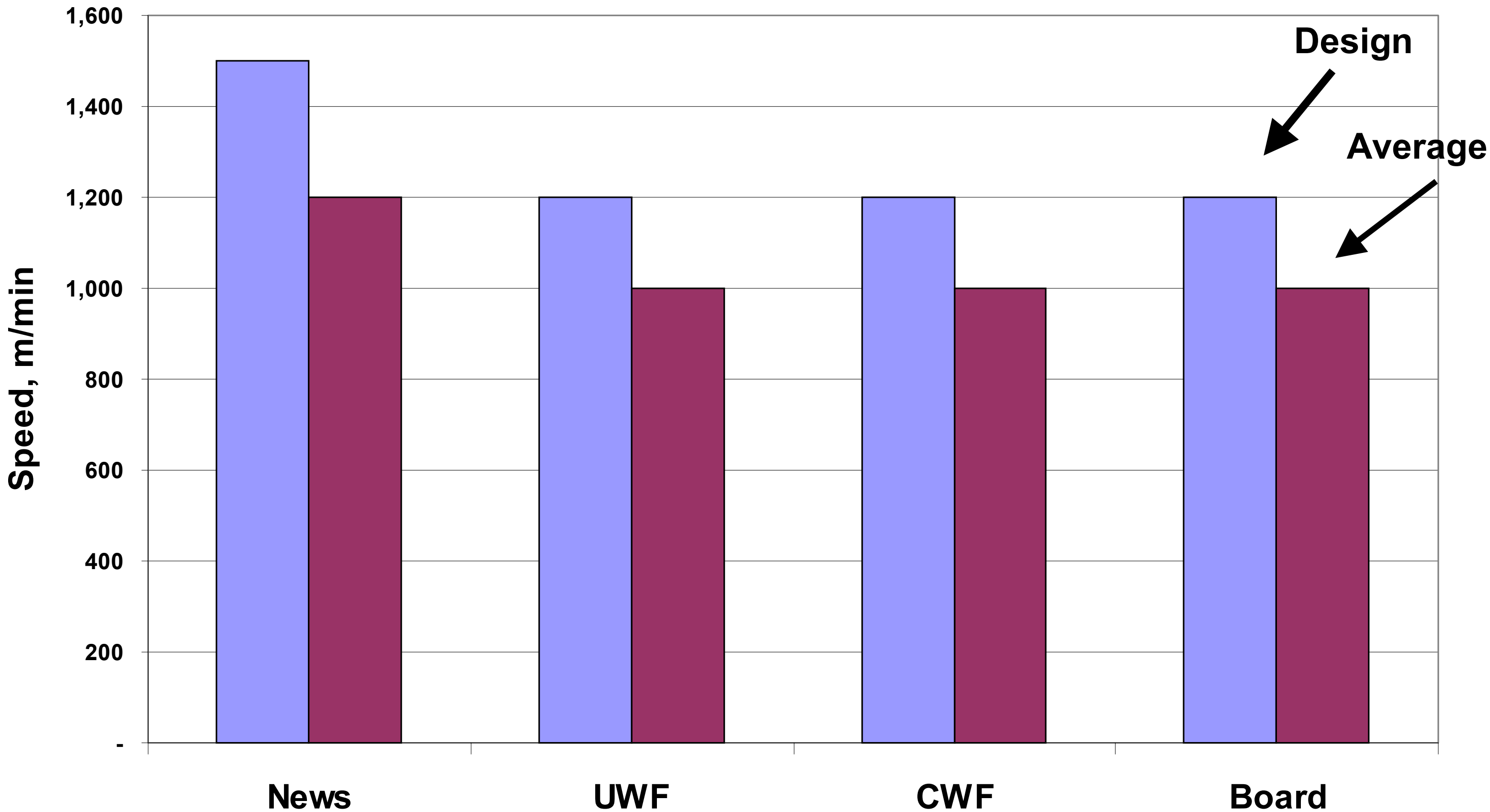
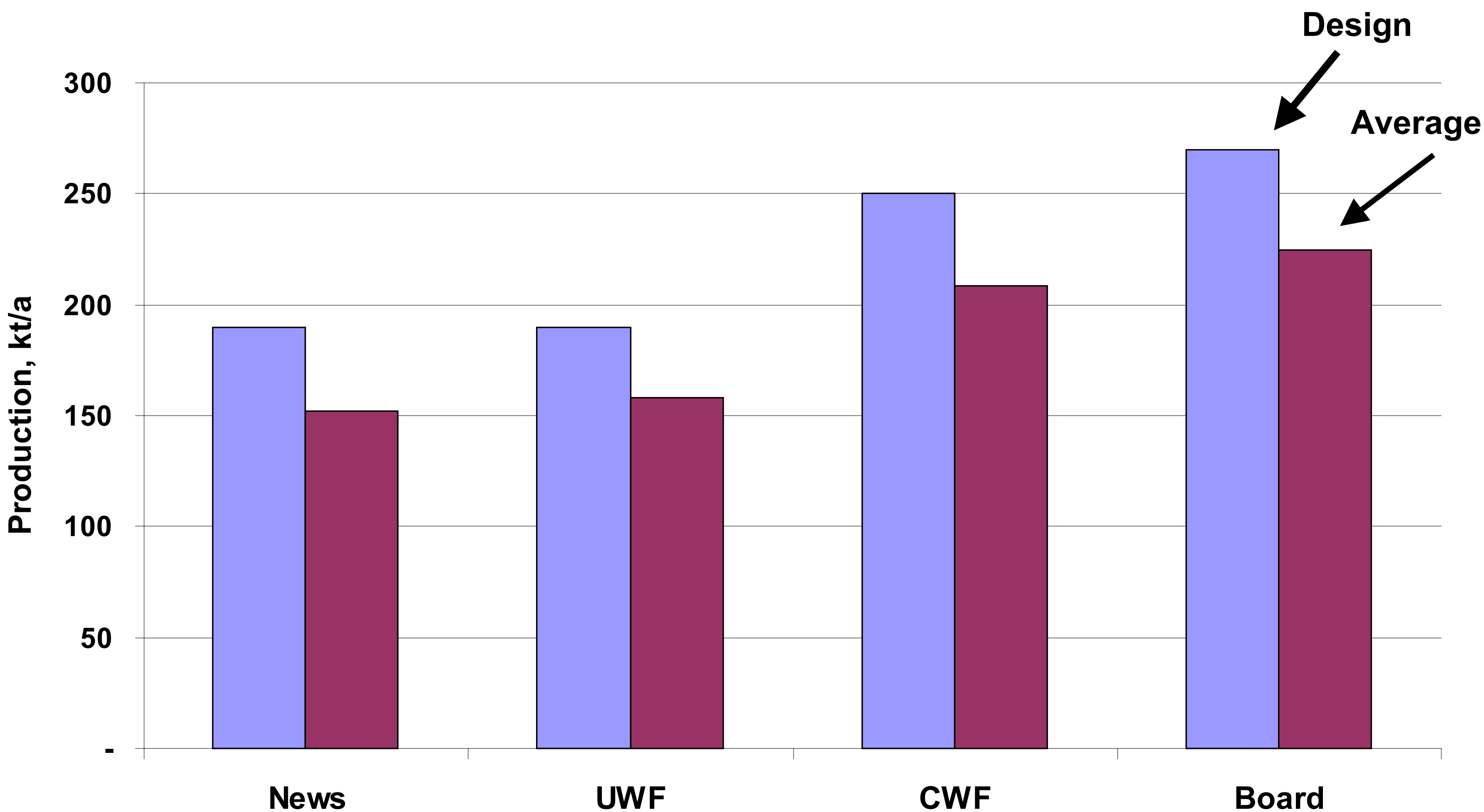
Recommended new paper machine speeds

New machines should have as high speed as is possible to be build mainly in India. This has been made in China and the capacities of those machines are about half of the international maximum capacity.



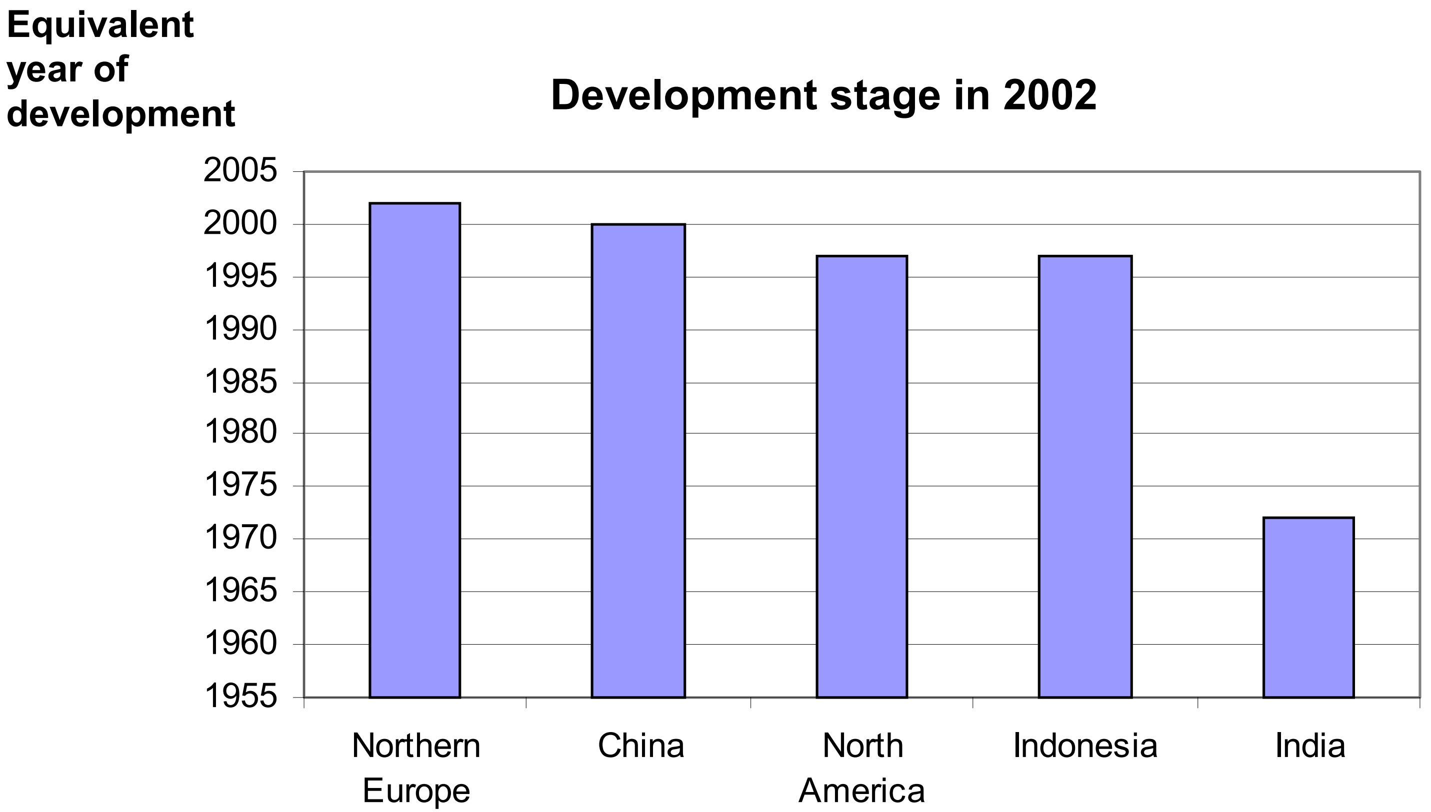
Recommended PM capacity by grade

New machines should have about double production compared to the best present paper machines in India. An optimum mill would have two machines in the future - one new and one older but modernized i.e. total capacity would be 250 - 400 kt/a.



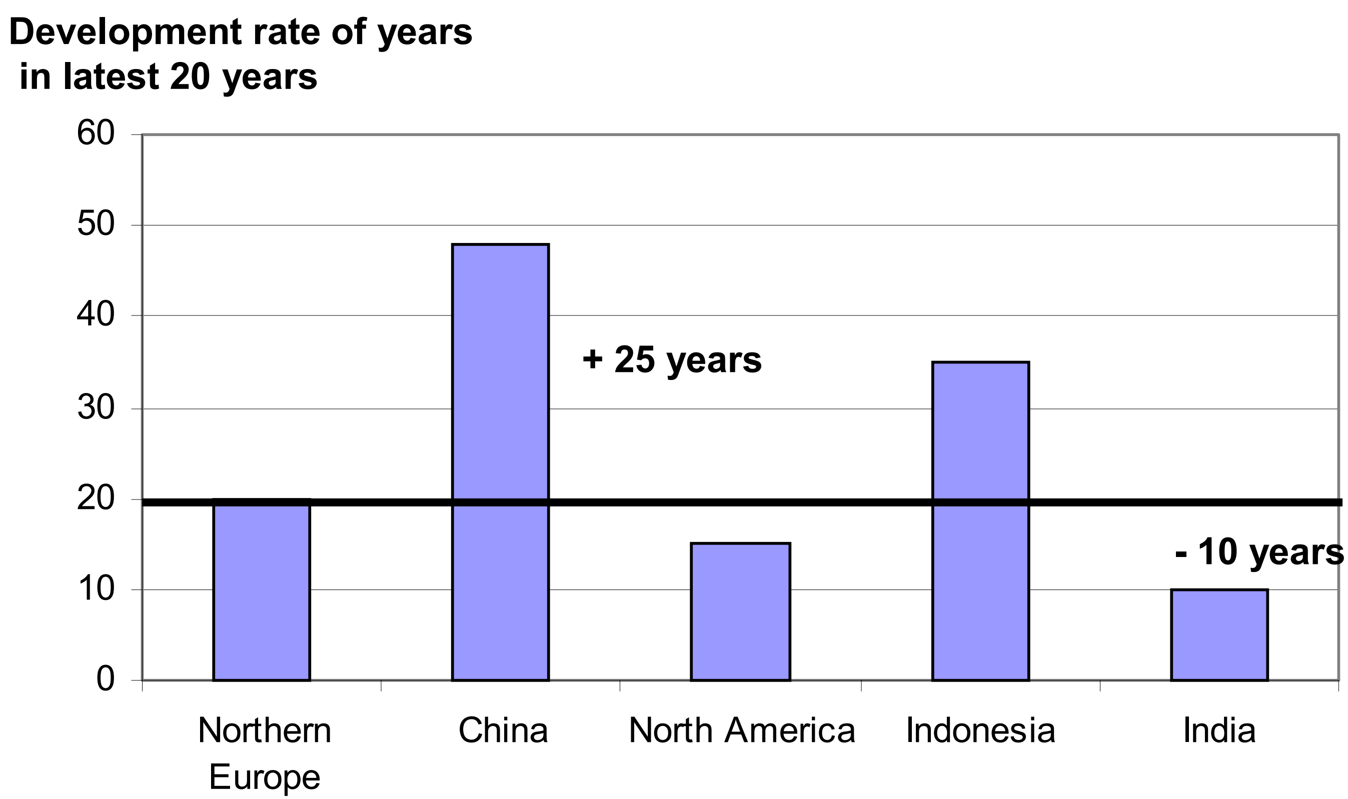
Development level of best production lines

Estimated technology level of best Indian production lines is about 30 years behind the best lines in Europe. Best lines in China are only some years behind the international top level.



Development rate of best production lines

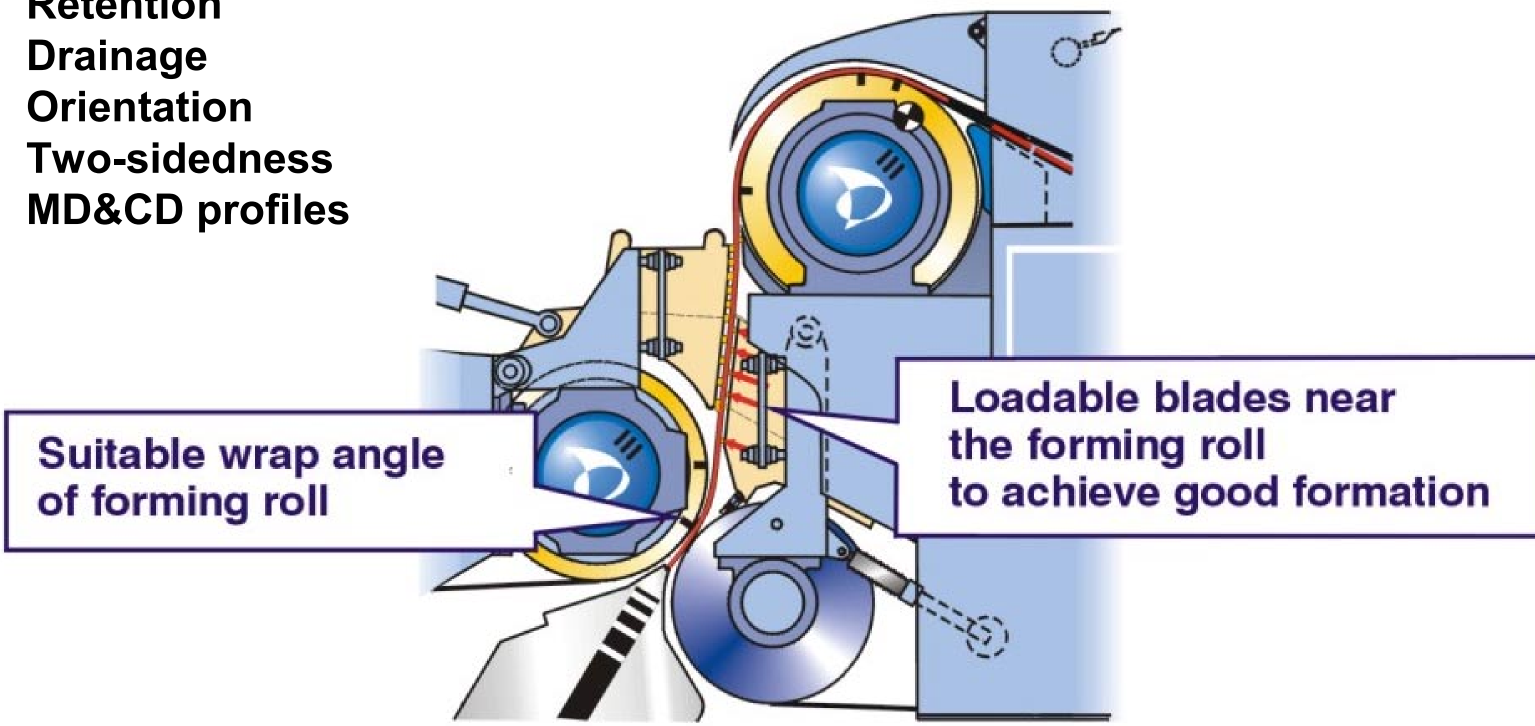
Estimated development rate of best Indian paper production lines during last 20 years is estimated to be about 10 years i.e. the development rate in India is slowing while at the same time the development rate in China and Indonesia has been very fast.



High speeds – better quality with gap former

There are only some twin wire machines in India. Best roll and blade gap formers improve paper quality and drainage, which are important for paper made of Indian raw materials. Roll and blade gap formers give a good combination of the following properties:

Formation
Retention
Drainage
Orientation
Two-sidedness
MD&CD profiles



Source: Metso Paper

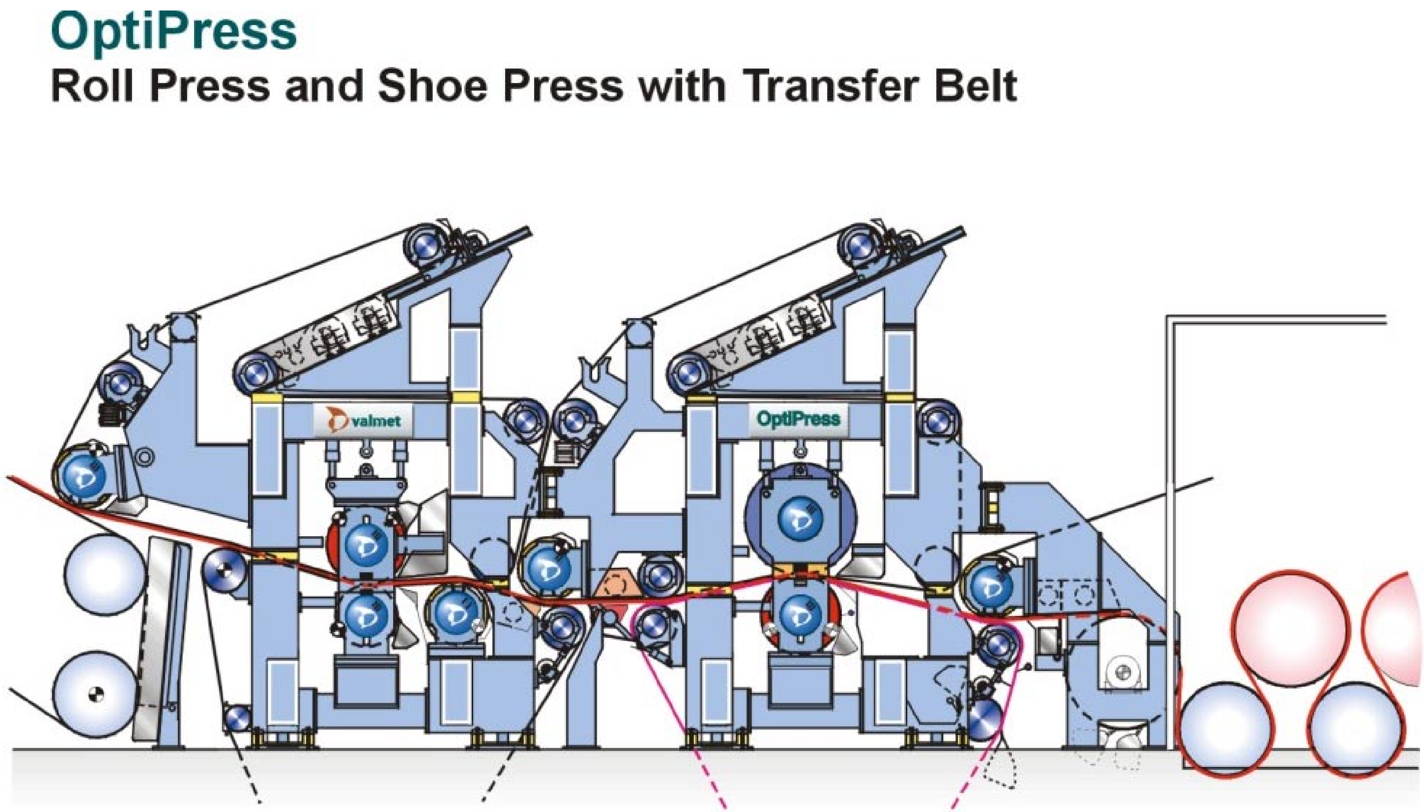
Wire sections of Indian paper industry

Old technology in wire section increases cost of papermaking. Filler content must be low and long fibre content high. Paper formation is not best possible and there are easily pinholes in the paper. Reduction of basis weight is difficult.

- **Headbox** technology is old: open headboxes, rectifier rolls, no automatic CD profile control.
- **Wire section** is normally Fourdrinier with dandy roll. Board machines are still mainly cylinder vat machines. Several machines are without suction pick-up. Even metal wires are used.
- There are only **few twin wire** machines. Even the newest machines can have machine size and technology from 1970s.
- With Fourdrinier and dandy roll it is impossible to get **high filler content** because filler is enriched to the top side. This increases dusting and reduces dry and wet pick. Also two-sidedness and curl of Fourdrinier paper are big problems.
- Low speed Fourdrinier paper is not highly oriented (tensile ratio 1.5 – 2.5). Paper made with a high speed gap former can have tensile ratios from 3 to 4. A **high tensile ratio** improves runnability and gives opportunities to reduce long fibre and to increase filler content.

Better runnability with shoe presses

A two-nip press section with one or two shoe presses is today a standard solution for all paper and board grades. For Indian slow machines only one shoe nip might be best technology.



Source: Metso Paper

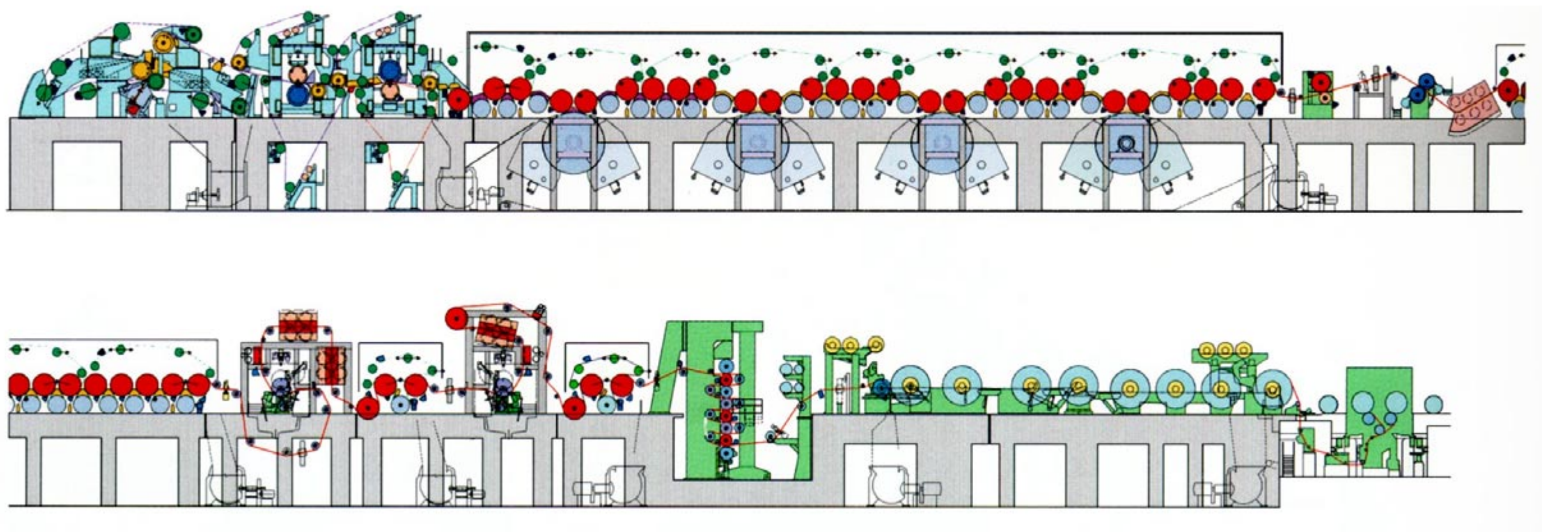
Press sections of Indian paper industry

Open draws in press section increase cost of papermaking. Filler content must be low and long fibre content high. Solids content after press section in India is 5-10 %-unit lower than in developed countries. This increases steam consumption 25 – 45 %.

- Even if there is suction pick-up, open draw follows after first or second nip. Presses are usually pneumatically loaded with **very low linear loads**.
- A good press section is more important in India than in other countries because **fibres are short**. Initial wet web strength with Indian fibres is extremely low and would require best possible press sections.
- A good runnability in the press section allows **higher filler contents**. A higher filler content improves solids content and **reduces steam consumption** in the drying section.
- Indian agro fibres have very high water retention value. These fibres require time to dewater. Extended nip is the only good solution. A high speed machine with one-nip shoe press (or maximum two nips) would be the most suitable concept for Indian raw materials.

New drying concepts

New drying concepts include web supported run with vacuum pick-up to dryer section and single-tier dryers. Hood is closed and there are efficient air and infra red dryers.



Source: Metso Paper

New drying concepts

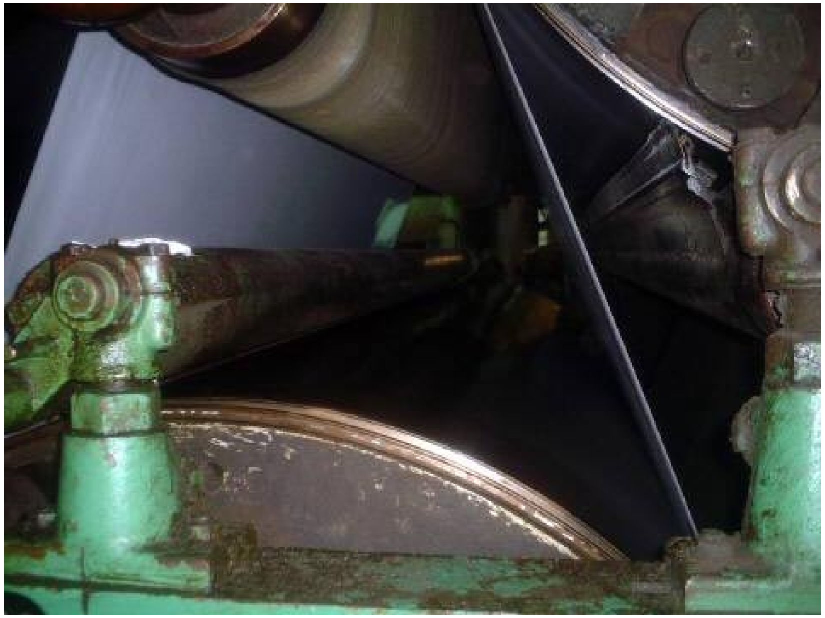
Online coating

Online calendering

Drying sections of Indian paper industry

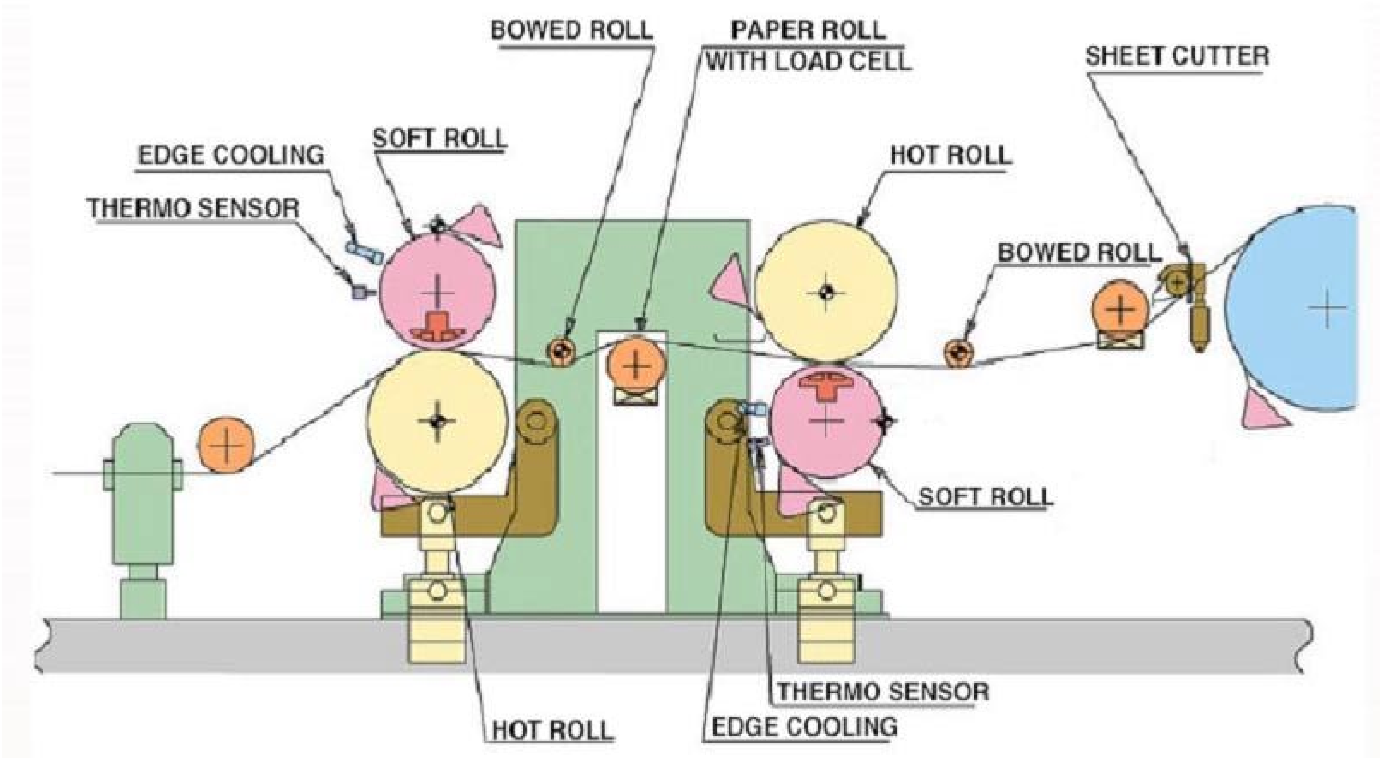
Unsupported web run is normal in Indian dryer section. Hood is open and steam consumption is high. Humidity profiles are poor, paper roughness is high and CD-profiles uneven. Moisture content of final paper is low and calendering very hard.

- Web run in India is normally **unsupported**. This is OK when speed is low. When speed is higher than 600 m/min there should be some single tier dryer groups to avoid web flutter and breaks.
- Hood in India is usually open. The **open hood** means that web is dry at the edges and moisture profile in the cross machine direction is poor.
- To avoid calender blackening with uneven CD profiles the average moisture must be low. This increases paper roughness and decreases strength properties in the calendering. Web is dusty, **fibre rising** and roughening in the web offset printing is very high.
- In many cases there is **no on-line measurement of web moisture** at reel. Before size press the moisture measurement is uncommon. There are only few automatic CD-controls for moisture in India.



World class calendering technology

For newsprint and woodfree papers state-of-the-art calendering technology is soft calendering or multinip calendering with soft rolls. Two stacks are normally not needed today. There are normally 2 - 6 rolls in the stack.



Source: Beloit Mitsubishi

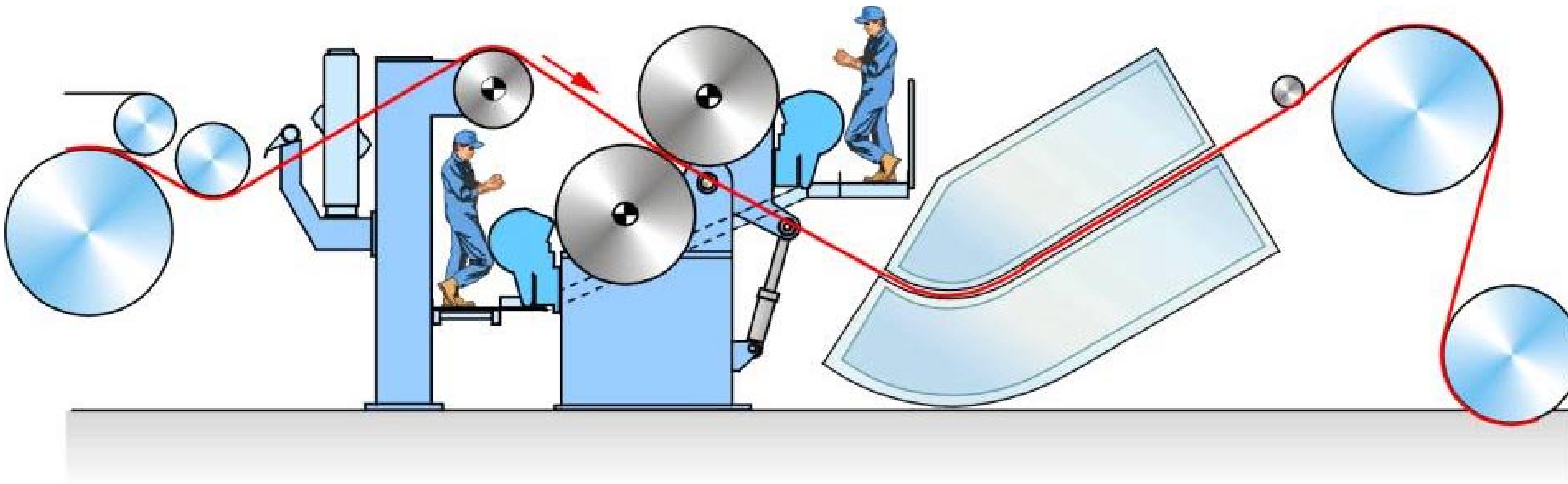
Calendering technology in Indian paper mills

Soft calenders are highly recommended to Indian paper industry. However, these require good CD-profiles and more investments in the process line.

- Indian calenders are normally **hard nip** calenders with four or more rolls.
- Soft calenders could **save bulk** and improve opacity, strength and smoothness. These are critical properties of Indian papers.
- However, soft calenders require **good CD profiles** because the possibilities to control caliper profile are not as good as with a hard nip calender.
- To improve the situation it is not enough to install a soft calender, but there should be a comprehensive **study of CD-profiles**. According to this kind of study it would be easier to consider the required investments with a new calender. This would be a key research area for CPPRI in the future.

World class coating technology

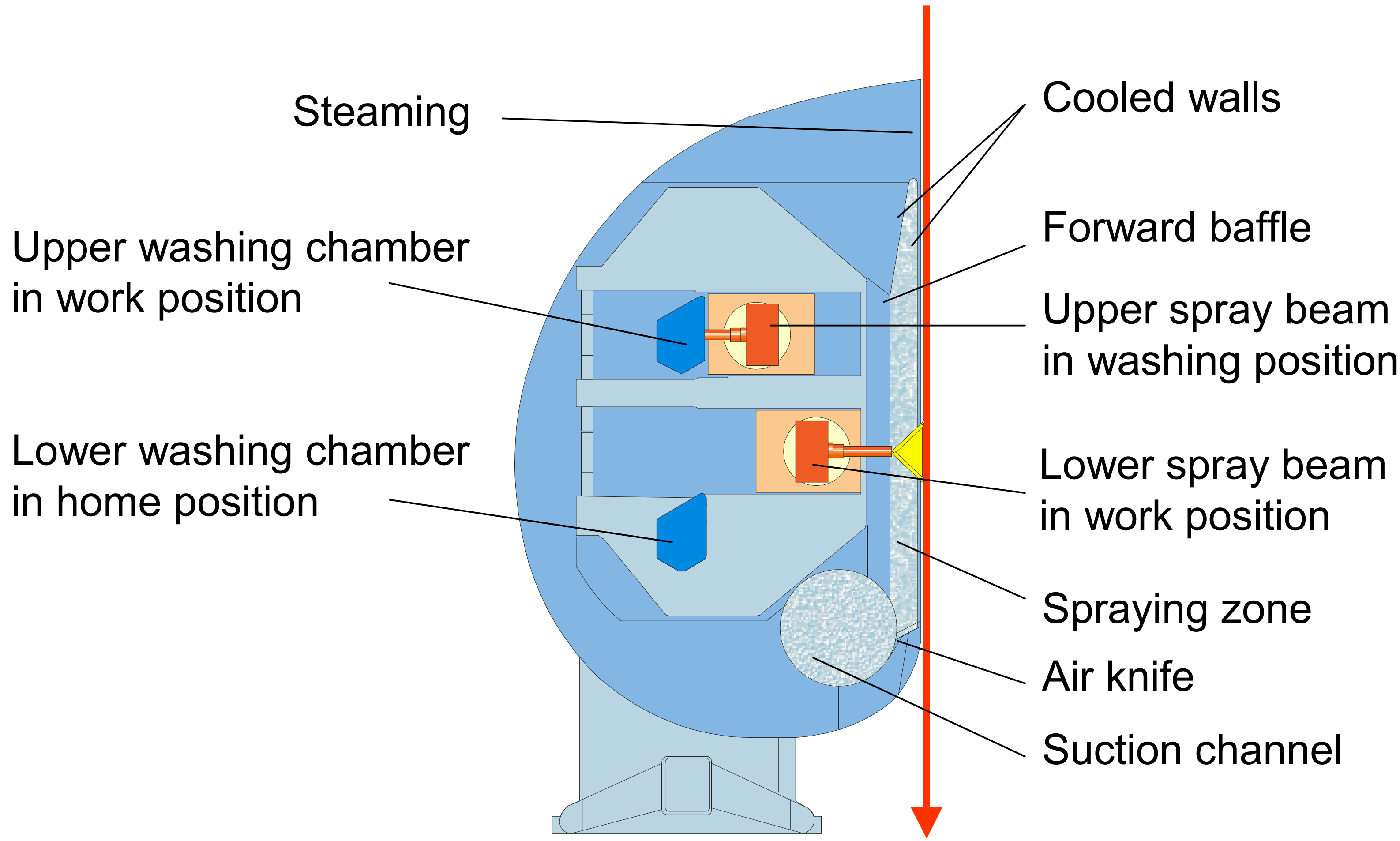
One of the most interesting alternatives for new coating equipment is film coater. Simultaneous coating for both sides with a good runnability. This would suit very well for small Indian machines and for weak base paper. This equipment has been very successful in new Chinese machines.



Source: Metso Paper

Non-contact coating methods

Newest coating methods like spray or curtain coating might be suitable for Indian machine rebuilds and for low strength base papers.



Sorce: Metso Paper

Coating technology in Indian paper mills

Film coaters and on-line calenders are highly recommended for Indian paper industry. However, these require good CD-profiles and more investments in the process line.

- There are only two **coaters of international size** (Bilt and ITC)
- The other Indian coaters are usually **small and even half of the paper machine width**.
- Coating methods are blade and film coaters but still also **air knife** coaters .
- **Production of coated paper is very small** compared to uncoated paper.
- Coaters and supercalenders are often **off-machine** units.
- Automation level of coaters is low and **quality variation is high**.

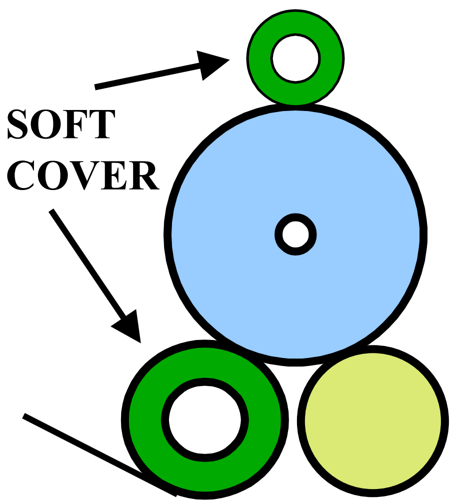
Indian rewinder technology

With higher paper machine speeds and more export Indian paper industry needs better rewinders.

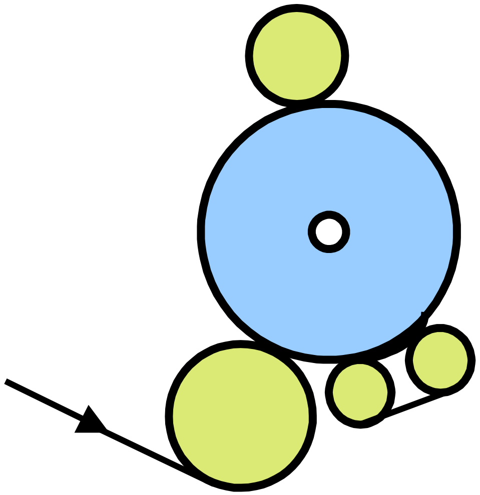
- Rewinders of Indian paper industry are very poor. Winders are almost totally manual without any automation. There is only a mechanical brake and slitters are old-fashioned.
- There are no special rewinders for coated paper or thin paper and large diameter rolls.
- Roll diameters must be small due to roll quality and transport reasons.
- Export of rolls made with these rewinders is impossible to developed countries.
- When machine speeds are more than 1000 m/min these winders will be production bottlenecks.

Suitable winders for news & coated grades

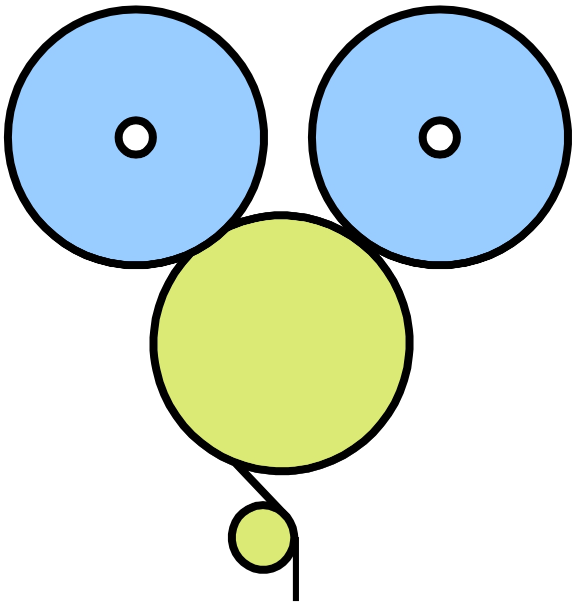
Soft roll rewinders might be a low cost alternative to improve roll quality of thin papers or coated papers.



SOFT ROLL WINDER



BELT SUPPORTED WINDER (WinBelt)



11- 01 O'CLOCK WINDER

Automation in Indian paper industry

Automation level in Indian paper industry is very low. Only best paper machines have QCS and DCS systems. Finishing is totally manual. To be able to export paper and board automation level must be improved.

More and better process automation

- Online coating and calendering
- Faster machine run-ups and grade changes
- Automation in finishing

Faster and broader QCS, less broke

- Better CD profiles, faster control response, better product quality.
- Better production and quality control and reporting.

DCS control systems

- Better MD profiles, faster control response, better product quality and machine runnability.

Sheeting and packaging

Finishing is normally totally manual and without air conditioning in Indian mills.

- When the labour cost in India increases there is lot of room for **automation in the finishing** area. The main reason for poor personnel productivity is finishing area.
- On the other hand, **export quality** requires better sheets and rolls as well as packaging. This is possible only with more automated systems.
- .Sheeting plant is **air conditioned** in developed countries.
- **Core quality** is often poor in Indian mills, especially when mills are making their own cores. For export core quality should be improved.

Product storages and transport systems

Roll and sheet packages in India are normally manually made and include textile cloths.

– Normal practice in developed countries is that there is an **intermediate storage** for sheeting rolls between rewinders and sheeters.

– Rolls are stored and transported in horizontal direction. Export to developed countries requires **vertical roll handling**.

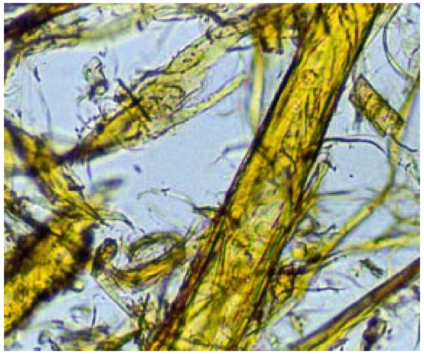
– Cut size cartons are manually loaded to trucks. International practice is to use **palette packages**.

Fibres and Pulps

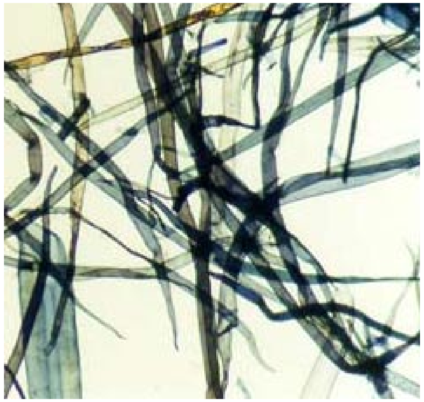
JAAKKO PÖYRY
Jaakko Pöyry Consulting

Properties of Mechanical and Chemical Pulps

Critical Properties	Mechanical Pulping	Chemical Pulping
Energy consumption	>1500 kWh/t	Producing some energy
Production and investment cost	Medium (energy)	High (investment & wood)
Yield from wood	95 %	45 %
Fibre length, mm	<2 mm SW <1 mm HW	2-3 mm SW 0.5-1 mm HW
Paper strength	Low to medium	Medium to high
ISO-brightness, %	Unbleached 55-65% and bleached 65-85%	Unbleached is brown, Bleached 85-90%
Light scattering and paper opacity	Good suitable for low weight papers	Low suitable for high weight papers



Mechanical Pulp (spruce)

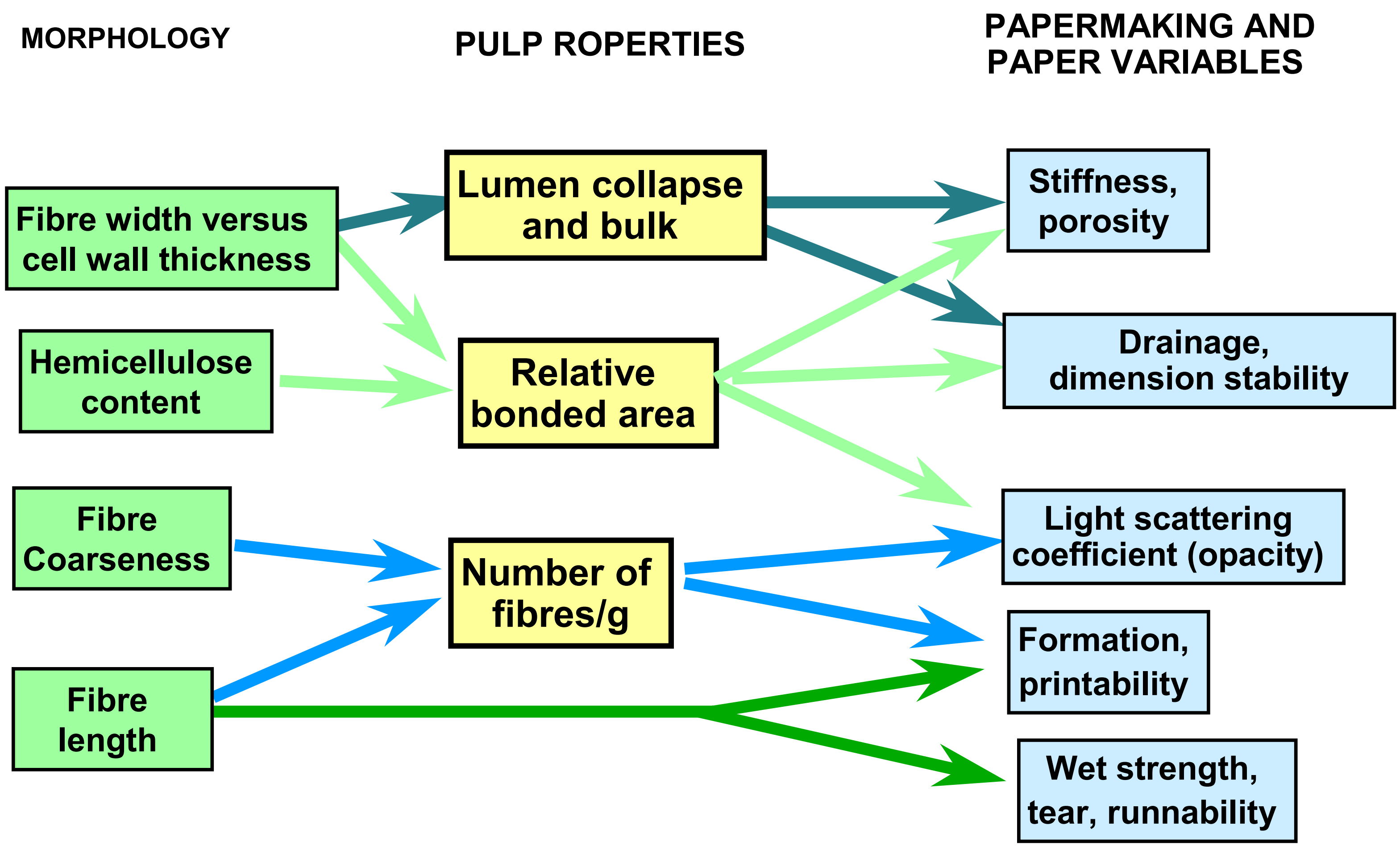


Chemical Pulp (hardwood)

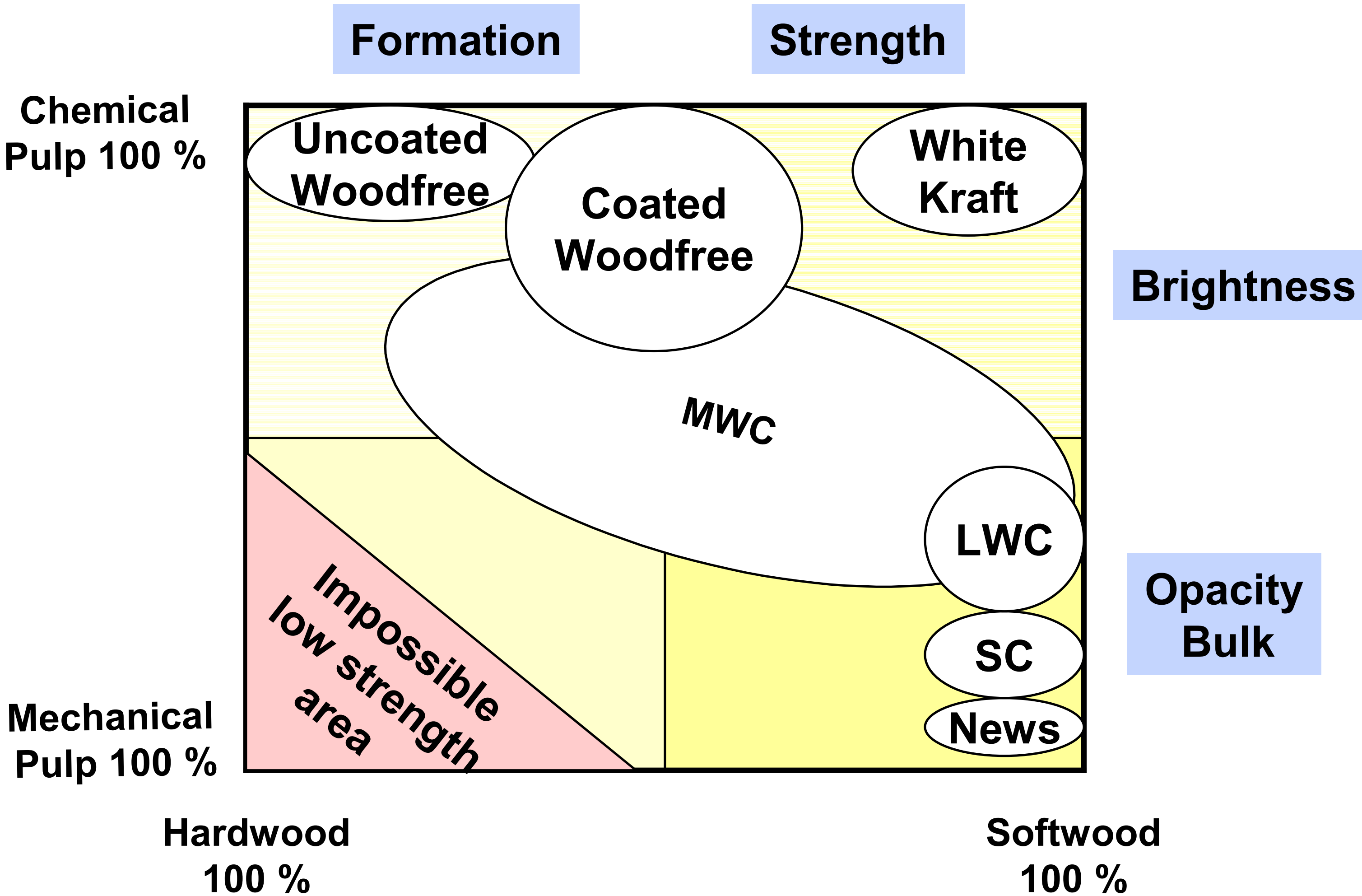
Fibres, chemical pulp and paper properties

Project Number 52A0087

Raw material or fibre properties have a crucial influence on papermaking process and end product quality. International competitiveness requires also international quality from raw materials (plantation hardwoods).

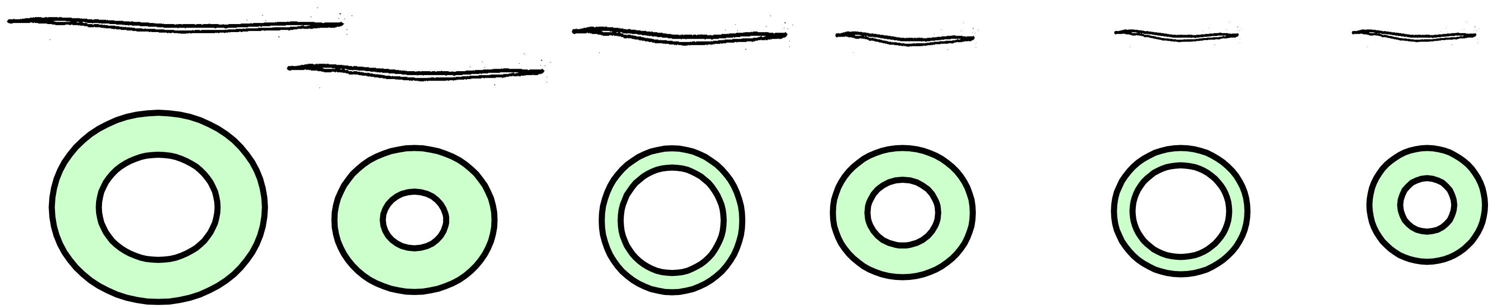


European white papers and fibre combinations



Fibre dimensions of selected fibres

	Norway spruce	*Bamboo*	*Bagasse*	*Eucalyptus grandis*	*Acacia mangium*	*Wheat straw*
Fibre length, mm	**2,2**	**1,7**	**1,4**	**0,8**	**0,7**	**0,7**



Fibre width, µm	26	19	19	17	17	16
Length/width	85	89	74	47	41	44
Lumen width, µm	18	5	15	9	11	6
2 x Cell wall, µm	8	14	4	8	6	10
2 x Wall/width, %	31	74	21	47	35	62

Optimum fibre for papermaking

Comparison of fibre potential

Property	Bamboo	Straw	Bagasse
Processability			
silicate	--	--	-
yield	0	--	--
beatability	-	++	++
drainage	0	--	-
wet strength	+	--	-
tear strength	+	--	-
Raw materials			
long fibre requirement	+	--	-
possible filler content	+	--	-
Paper structure			
formation	-	++	+
bulk	+	--	--
stiffness	0	-	-
Paper quality			
opacity	-	-	-
smoothness	--	+	0
low porosity	-	+	+
surface strength	-	+	+
dimensional stability	0	--	-

+ better than eucalyptus grandis
- worse than eucalyptus grandis

- Compared to best Eucalyptus species bamboo, straw and bagasse are not comparable fibres for papermaking.
- They can be used as additional fibres to give special functional properties.
- Fibres can be developed by refining. However, straw and bagasse do not withstand extented refining or tailoring of fibre properties for paper requirements.
- Straw and bagasse include lot of fines and are like organic filler materials. Cost-efficient filler amount must be kept quite low.

Comparison of chemical pulp properties

Eucalyptus pulp is superior when the combination of runnability and printability is required. The combination of strength, bulk and optical properties is best. It is possible to make paper from Eucalyptus with high speed and filler content without long fibre addition. Straw and bagasse require long fibres to get runnability and drainage.

Straw and bagasse can be used up to 20 – 25 % without major problems together with Eucalyptus pulp. This, however, may need some bamboo or softwood pulp to get better runnability and water removal.

Property	Dim	TAPPI	Bamboo	Kenaf	Euca	Straw	Bagasse
ECF bleaching			Yes	No	Yes	No	No
Freeness	CSF		300	300	300	280	300
Brightness	% ISO	T452	89	86	89	83	83
Breaking length	km	T220	6.5	6.5	7.2	5.5	4.7
Burst index	kPa.m^2/g	T220	4.5	4	4.8	2.4	2.8
Tear index	mN.m^2/g	T220	10	7	7.5	4.2	5.6
Opacity	%	T425	68	75	78	81	80
Average fibre length	mm	T232	1.7	1.5	0.7	0.8	1.4

SWOT analysis for wheat straw

Straw is not a competitive basic fibre but an additional fibre. New projects should be based on wood or RCF. Investments are not viable in smallest straw based mills.

Strengths

- Low raw material cost
- Treefree raw material
- Includes also some long fibres (2 mm)
- Low refining energy consumption and good bonding
- Good formation and smoothness
- Suitable for corrugating medium

Weaknesses

- Bulky, seasonal raw material - high transport and storage cost, low yield, high silicate content and variable quality
- Contains short and sticky fibres, low wet strength and tear, runnability problems
- Low brightness, lumen collapse if refined – lower optical properties and bulk
- Drainage problems and high drying steam consumption

Opportunities

- Twin wire machines and shoe presses
- Supported web run in dryer section
- Soft calender and shoe nip calender
- Only additional fibre (less than 25%)
- New digesting and silicate removal methods

Threats

- Mills size must be small – not competitive
- PM speed must be slow – not competive
- Chemical recovery/effluent treatment is too costly
- Fibre cannot be tailored for papermaking
- Runnability problems – low filler content

SWOT analysis for bagasse

Bagasse is not a competitive basic but an additional fibre. New projects should be based on wood or RCF. Investments are not viable in smallest bagasse based mills.

Strengths

– Low raw material cost
– Treefree raw material
– Longer fibres than with straw
– Low refining energy consumption
– Good formation and smoothness

Weaknesses

– Seasonal and variable raw material - high storage cost and quality variation (pith)
– Low brightness and yield
– Quite short fibre - low wet strength and tear
– Very easy lumen collapse - optical properties, bulk and stiffness problems
– Slow drainage, kow press dryness - high drying steam consumption

Opportunities

– Fibre for corrugating medium
– Twin wire machines & shoe presses
– Supported web run in dryer section
– Soft calender and shoe nip calender
– Only additional fibre (less than 25%)
– New digesting and silicate removal methods

Threats

– Mills size must be small – not competitive
– PM speed must be slow – not competive
– Effluent treatment is too costly
– Fibre cannot be tailored for papermaking by refining
– Runnability problems – low filler content

SWOT analysis for plantation trees

Eucalyptus and similar hardwoods are the best possible fibres for woodfree papers and cartonboards. Paper industry expansions should be based on plantation trees.

Strengths

- Eucalyptus species combine best possible combinations of critical paper properties like tensile-tear, opacity-brightness, smoothness-bulk-stiffness, formation-retention-drainage
- Consistent raw material quality, available year around
- Good runnability, low long fibre addition with high filler content – totally cost-efficient
- Withstands lumen collapse - possible to tailor properties with refining
- High yield, easy to debark

Weaknesses

- Requires some refining energy
- Tree is expensive today in India (reflects high demand)
- Land area for plantations is limited in India

Opportunities

- Waste land for industrial plantations
- Long term policy and support for paper industry plantations

Threats

- Negative public opinion against plantations

SWOT analysis for bamboo

Plantation bamboo is a good alternative for imported softwood fibres. Fractionating of bamboo gives more application possibilities.

Strengths

- Bamboo fibres are long giving good tear, wet strength and drainage
- Available from natural forests as well as from plantations all year around
- Good runnability, softwood is not needed and filler content can be increased
- Withstands lumen collapse - possible to tailor properties with refining
- Debarking is not needed

Weaknesses

- Too rough fibres for printing paper
- Refining energy consumption is high
- Raw material is expensive today in India
- Land area for plantations is limited in India
- High silicate content

Opportunities

- Waste land for industrial plantations
- Long term policy and support for paper industry plantations
- Fractionating – long fibres to kraft papers and short fibres to printing papers

Threats

- Negative public opinion against plantations and/or cutting natural bamboo forests

Indian Fibres for Papermaking

Best fibres for chemical pulp are selected wood fibres e.g. Eucalyptus species.

– There are no good raw materials for mechanical papers (newsprint, SC and LWC magazine or catalogue papers). These grades should be based on import and waste papers.

– Each fibre raw material should be used only for the grades where they are most suitable.

– For printing and writing grades the best fibre raw material is Eucalyptus or similar wood species. Agro based fibres can be additional pulps (less than 25%).

– Bamboo should be used mainly for kraft papers and boards. Another possibility is to fractionate bamboo and to use the coarse part for kraft papers and boards and the fine part to printing papers.

– Bagasse is most suitable for corrugating medium. Bagasse is not the best fibre for newsprint or woodfee grades.

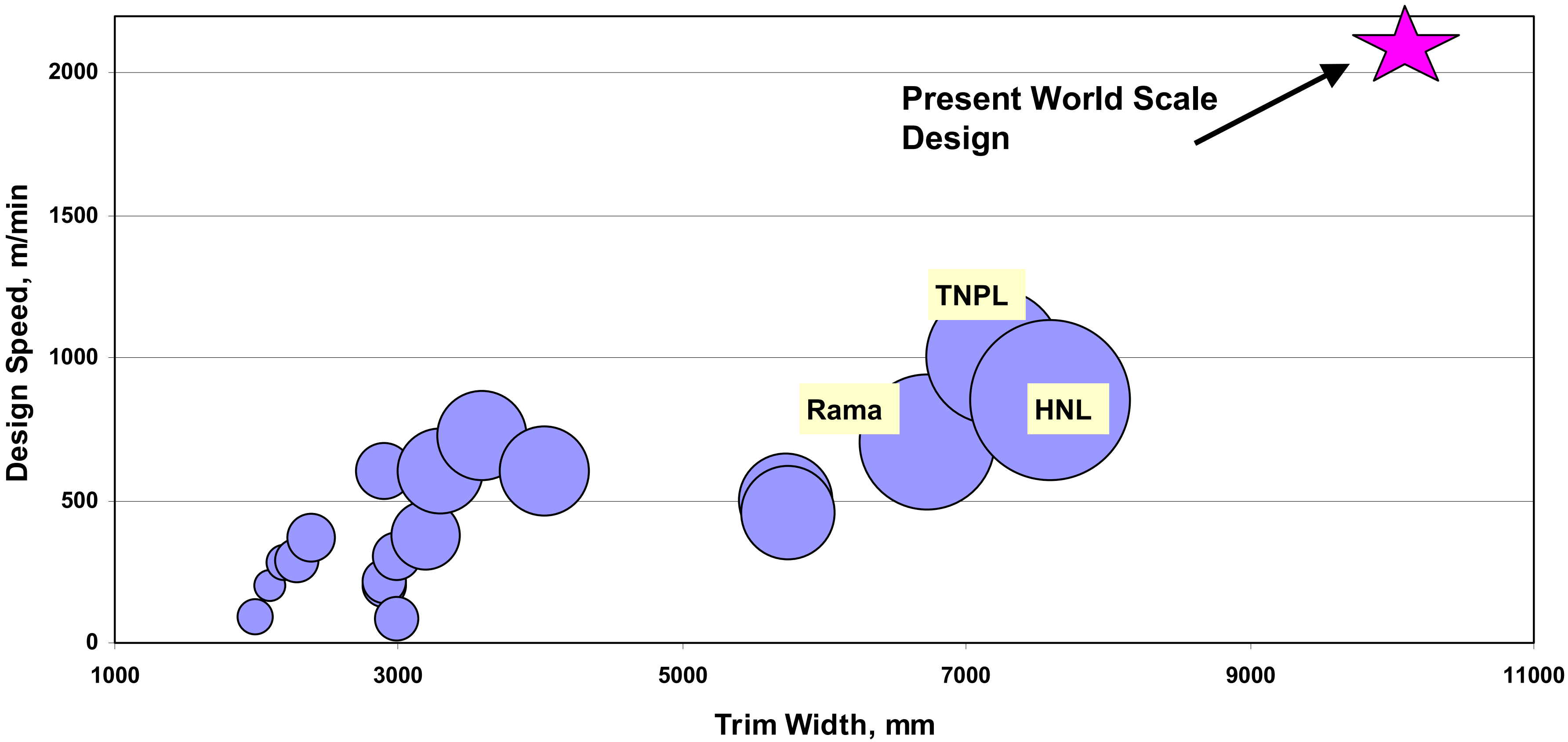
Newsprint Industry

JAAKKO PÖYRY
Jaakko Pöyry Consulting

Speed & width of major Indian newsprint PMs

Project Number 52A0087

World class newsprint machines have double speed and are 50% wider. The capacity is triple compared to the best Indian machines.



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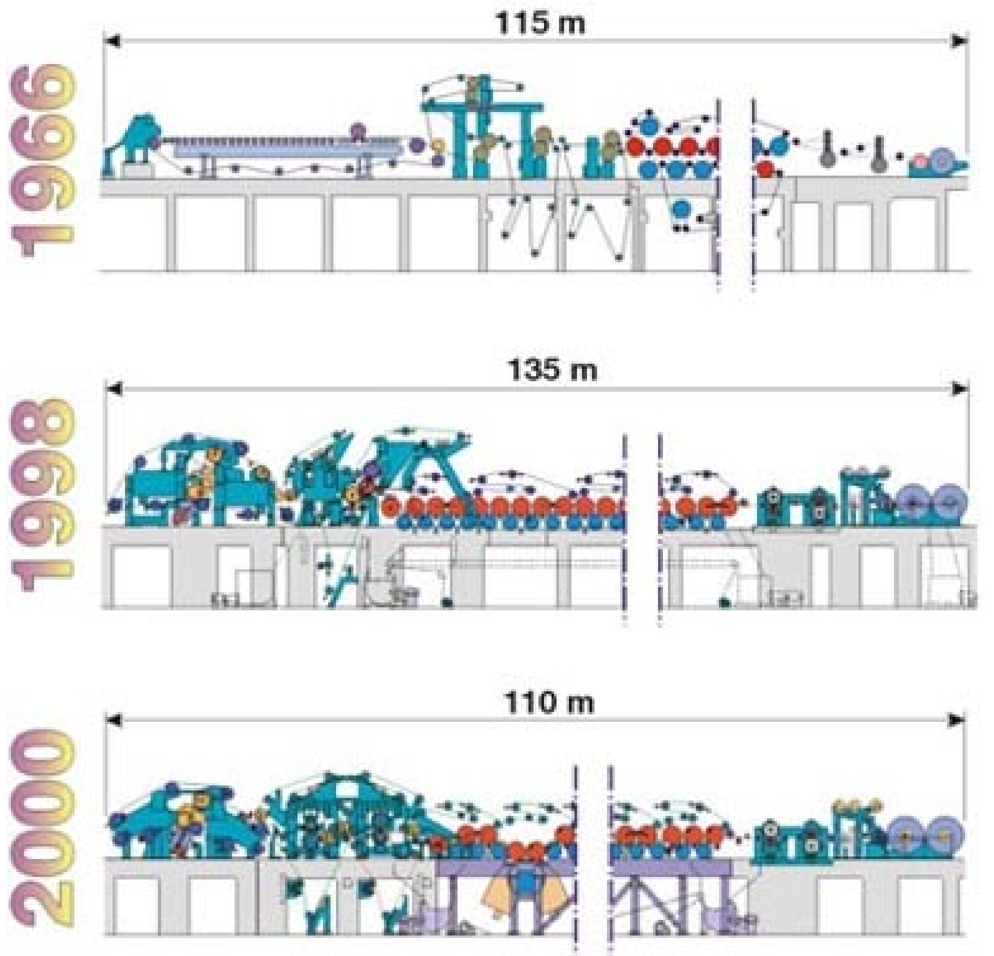
Jaakko Pöyry Consulting

Development of newsprint machine design

The increase rate of newsprint machine capacity is almost 10 000 t/a.



1966, Width 6.5 m
Speed 600 m/min
Production 100 000 t/a
Production/length = 0.9 kt/a/m
Production/width = 15 kt/a/m

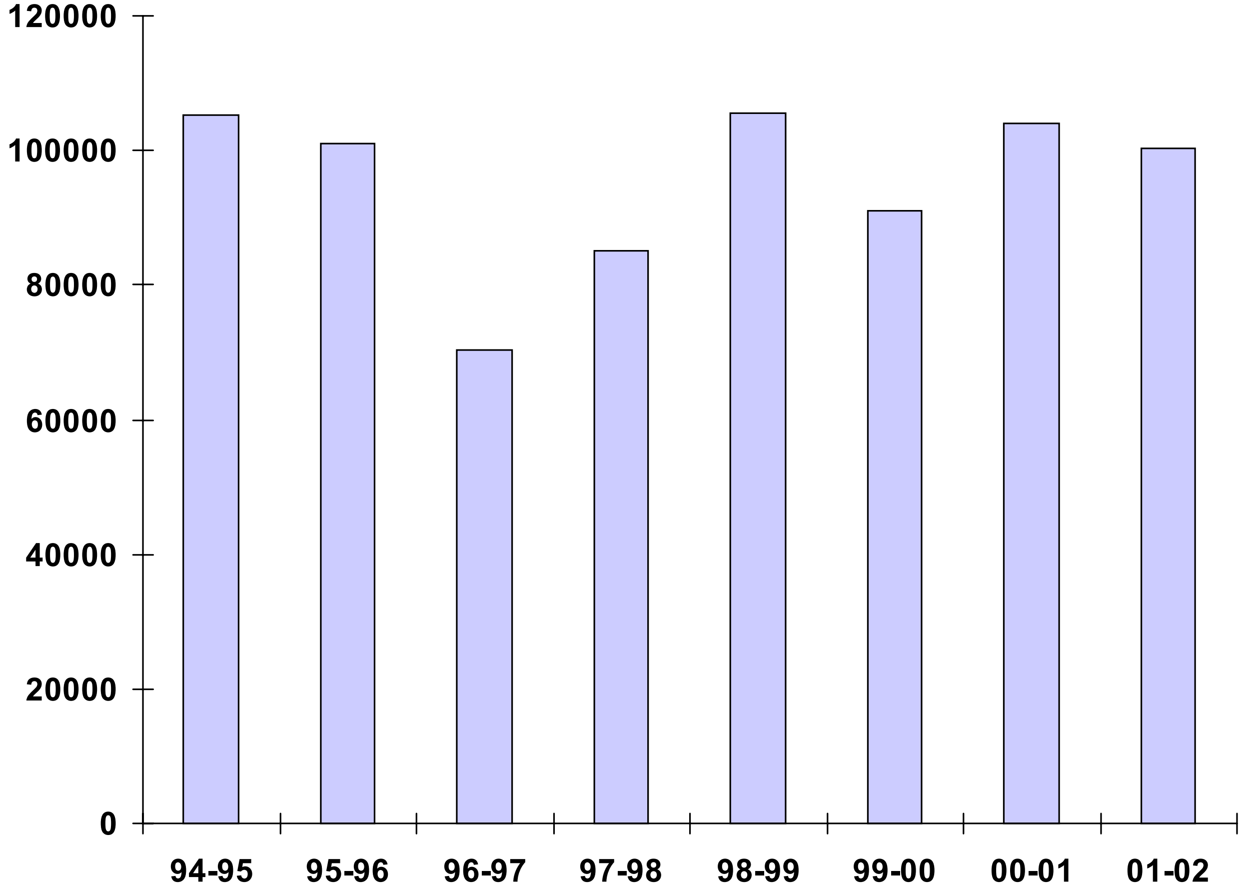
1998, Width 9 m
Speed 1800 m/min
Production 320 000 t/a
Production/length = 2.4 kt/a/m
Production/width = 36 kt/a/m

2000, Width 10 m
Speed 2000 m/min
Production 400 000 t/a
Production/length = 3.6 kt/a/m
Production/width = 40 kt/a/m

Production of an Indian newsprint machine

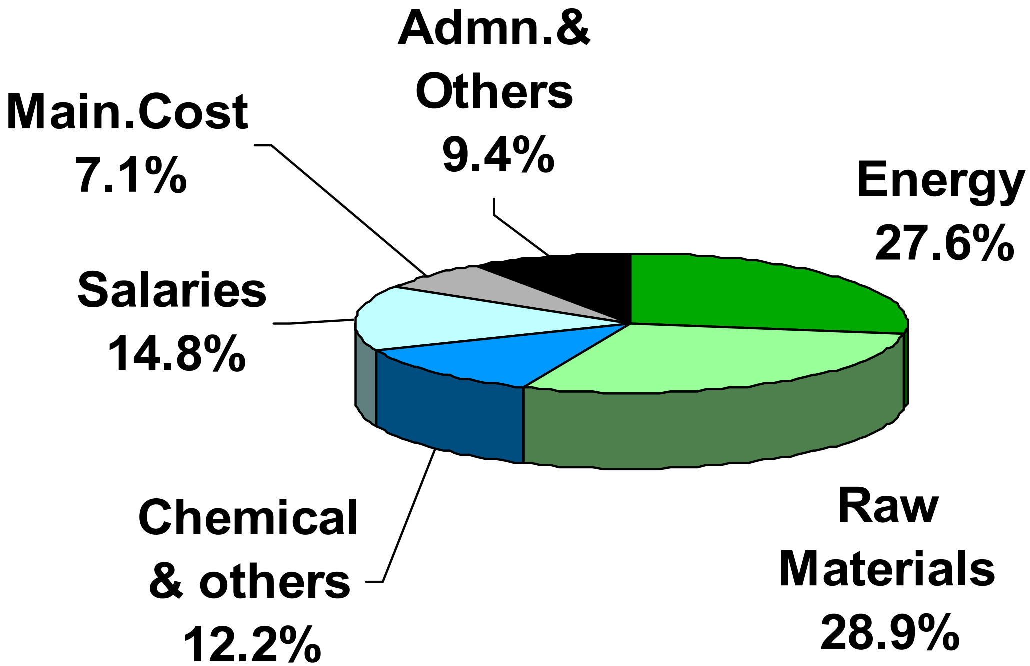
Project Number 52A0087

Best machines can double production in ten years. Indian machines, without major rebuilds, produce the same amount from year to year. There should be more rebuilds and efforts to increase production.



Typical Break-up of Production Costs

Main cost factors for a CMP-based newsprint mill are raw materials and energy. Chemi-mechanical pulping requires too much energy compared to softwood grinding or TMP process. Energy consumption can be minimised by using more domestic and imported ONP/OMG for deinking processes.

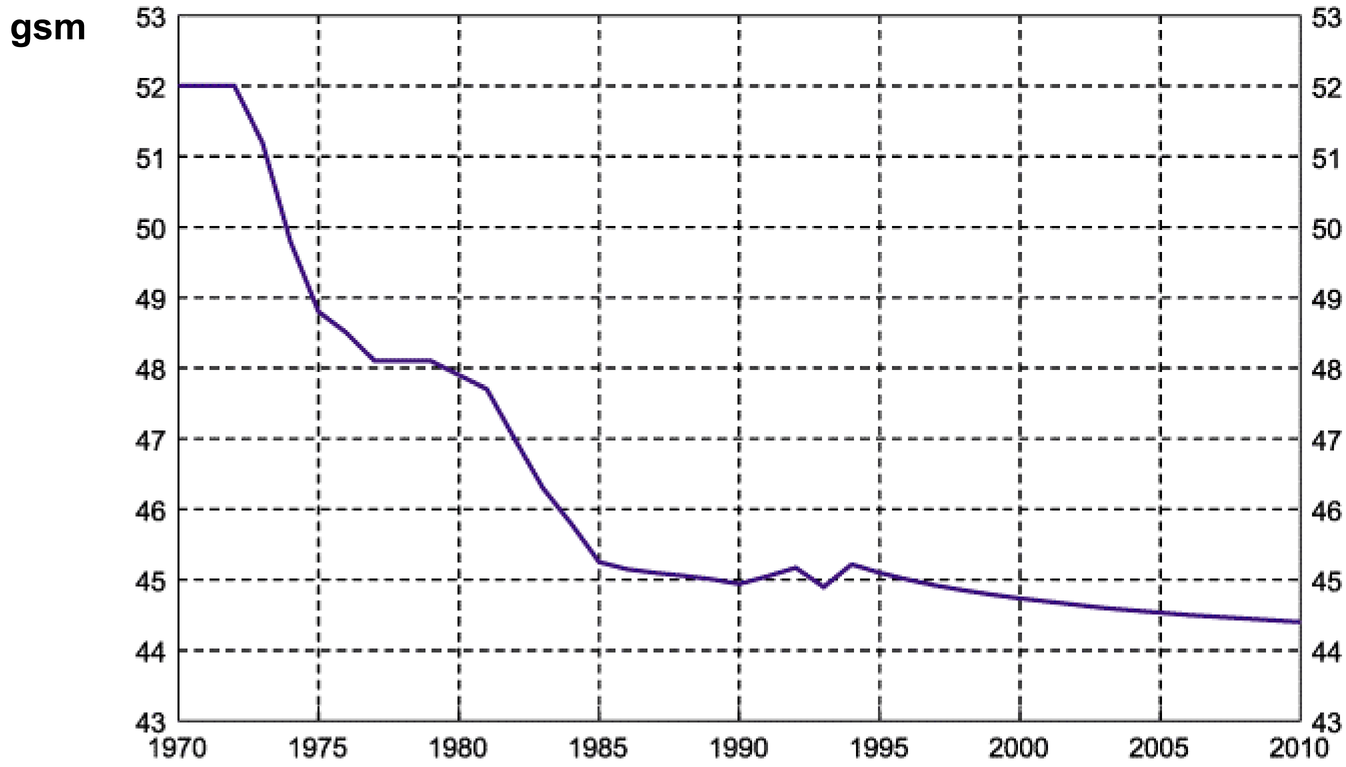


Newsprint Quality

Development of avg. grammage in Europe

Project Number 52A0087

The most common grammages in Europe today are 42-45 gsm. In India the common range is higher: 45-49 gsm. With a lower basis weight it is possible to save raw materials and energy in the papermaking as well as costs in transport, storage, printing and distribution. Present Indian newsprint quality is not suitable for good quality newsprint of basis weight 40 - 45 gsm .



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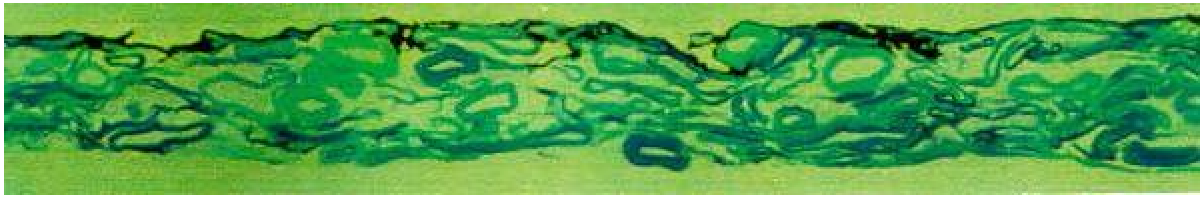
Quality of large Indian producer vs. world class

World class newsprint is superior compared to Indian quality, not only in bulk and evenness, but also in optical properties.



- Indian newsprint is **dense but porous**. This combination is possible if formation is poor and there are **lot of pinholes**. Lack of mechanical pulp based fine material is the main reason.
- The **brightness of Indian newsprint is low**. It could be higher but then opacity is low. This is typical for a paper with **low specific light scattering coefficient** having poor formation and pinholes.
- Due to the low bulk and uneven quality **moisture content** of Indian newsprint must be kept on the low side. This has a negative effect on runnability, dusting and production costs.
- Normally Indian **newsprint is rough**. In this special case paper is smooth enough. However the **combination of smoothness and bulk is poor**.
- Newsprint made on **Fourdrinier machine** is common in India. This machine has top wire. Orientation is big enough giving quite good tensile and tear strengths.

Indian newsprint vs. world class properties

Indian newsprint is smooth but porous and strong but low in brightness. Bulk and moisture are low as well as tear in cross machine direction. Low opacity is an additional problem with low grammage.

Property	Dim	World	India	World	India
Basis weight	ADgsm	49	49	45	45
Moisture	%	9.2	8.2	9.2	8.2
Thickness	μm	78.4	70.1	72.5	64.1
Bulk	cm^3/g	1.60	1.43	1.61	1.43
ISO Brightness	%	59	55.1	59	55.9
L*	%	83.7	79.0	83.7	79.9
a*	%	-0.45	1.52	-0.45	1.43
b*	%	5.00	2.92	5.00	3.48
Opacity	%	94.0	94.0	93.0	91.8
Roughness, top	ml/min	106	98	99	90
Roughness, bottom	ml/min	98	88	92	80
Roughness, avg	ml/min	102	93	96	85
Two-sidedness	ratio %	92	90	93	89
Porosity, Bendtsen	ml/min	220	640	265	491
Tensile index MD	Nm/g	48.0	52.5	47.5	50.9
Tensile index CD	Nm/g	14.9	18.2	14.9	17.9
Tensile ratio	ratio	3.2	2.9	3.2	2.8
Tear index CD	mNm^2/g	6.1	5.4	6.2	5.4
Ash content	%	6.0	5.7	7.0	5.7

Proposals to improve newsprint quality

Low quality of Indian newsprint is not only question of raw material but also machine technology has a great influence.

- Bulk and light scattering coefficient can be improved by using real mechanical fibres, good roll and blade –type gap former, shoe press and advanced soft calendering. Mechanical fibres are available in imported ONP and OMG.
- To keep the fibre and filler fines in the paper better overall retention of fines is needed.
- To get a good combination of formation and retention, roll and blade -type gap former is needed together with microparticle retention system.
- To keep fines in paper web a closed water circulation in the paper mill is recommended (less than 20 m^3 water/ ton of paper). This requires a good disc save all in the white water circulation.
- To be able to make good printability for the final paper, the paper machine must have latest runnability components. Only by this way it is possible to use more fines and short fibres to get printability.

Finnish paper machine from 1980s

Benefits of soft calendering

Project Number 52A0087

The weakest properties of Indian waste paper based newsprint like bulk, opacity, fibre rising, web strength and stiffness could be improved by using softcalendering instead of hard nip calendering.

Mill 1		Uncalen-dered	Hardnip calendered	Softnip calendered	Soft-Hard %
Caliper	µm	82	52	69	33
Light scattering coefficient	m^2/kg	49.5	35.4	48.7	38
Roughness, top	ml/min	350	210	190	-10
Roughness, bottom	ml/min	540	280	250	-11
Tensile index MD	Nm/g	43.0	28.5	40.5	42
Tensile index CD	Nm/g	20.5	15.0	18.5	23
Fibre rising test, LRC	mm/m	44.0	32.0	11.0	-66
Fibre rising test, SRA	mm^2/m	13.1	9.1	6.5	-29
Mill 2		**Uncalen-dered**	**Hardnip calendered**	**Softnip calendered**	**Soft-Hard %**
Caliper	µm	72	50	62	24
Light scattering coefficient	m^2/kg	39.8	29.5	38.4	30
Roughness, top	ml/min	370	240	140	-42
Roughness, bottom	ml/min	460	290	180	-38
Tensile index MD	Nm/g	48.5	39.5	46.5	18
Tensile index CD	Nm/g	19.0	15.0	17.5	17
Fibre rising test, LRC	mm/m	46.0	34.0	15.0	-56
Fibre rising test, SRA	mm^2/m	12.9	9.4	7.2	-23

Source: CPPRI

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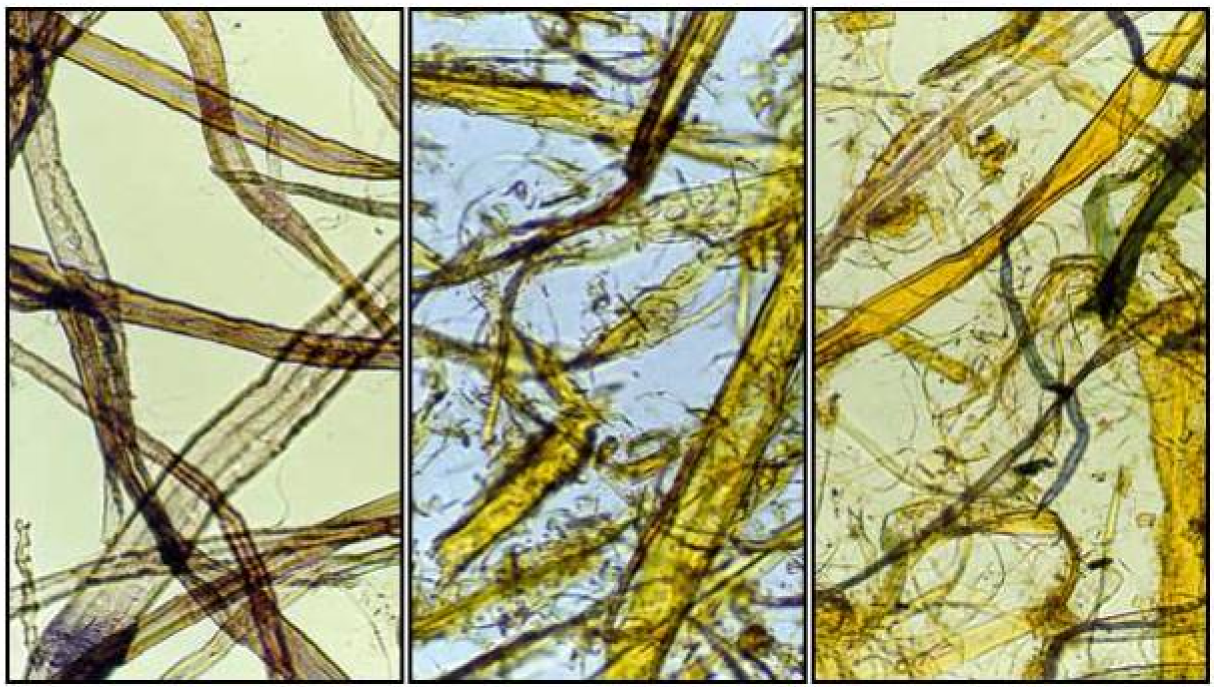
Jaakko Pöyry Consulting

Best pulp for newsprint

Without softwood in India it is not possible to produce good quality pulp for thin newsprint (i.e. with a high amount of mechanical fines giving good light scattering coefficient). A chemical treatment needed for Indian raw materials separates fibres without producing enough suitable fines. The best alternative is to import and recycle ONP/OMG for deinking in India.

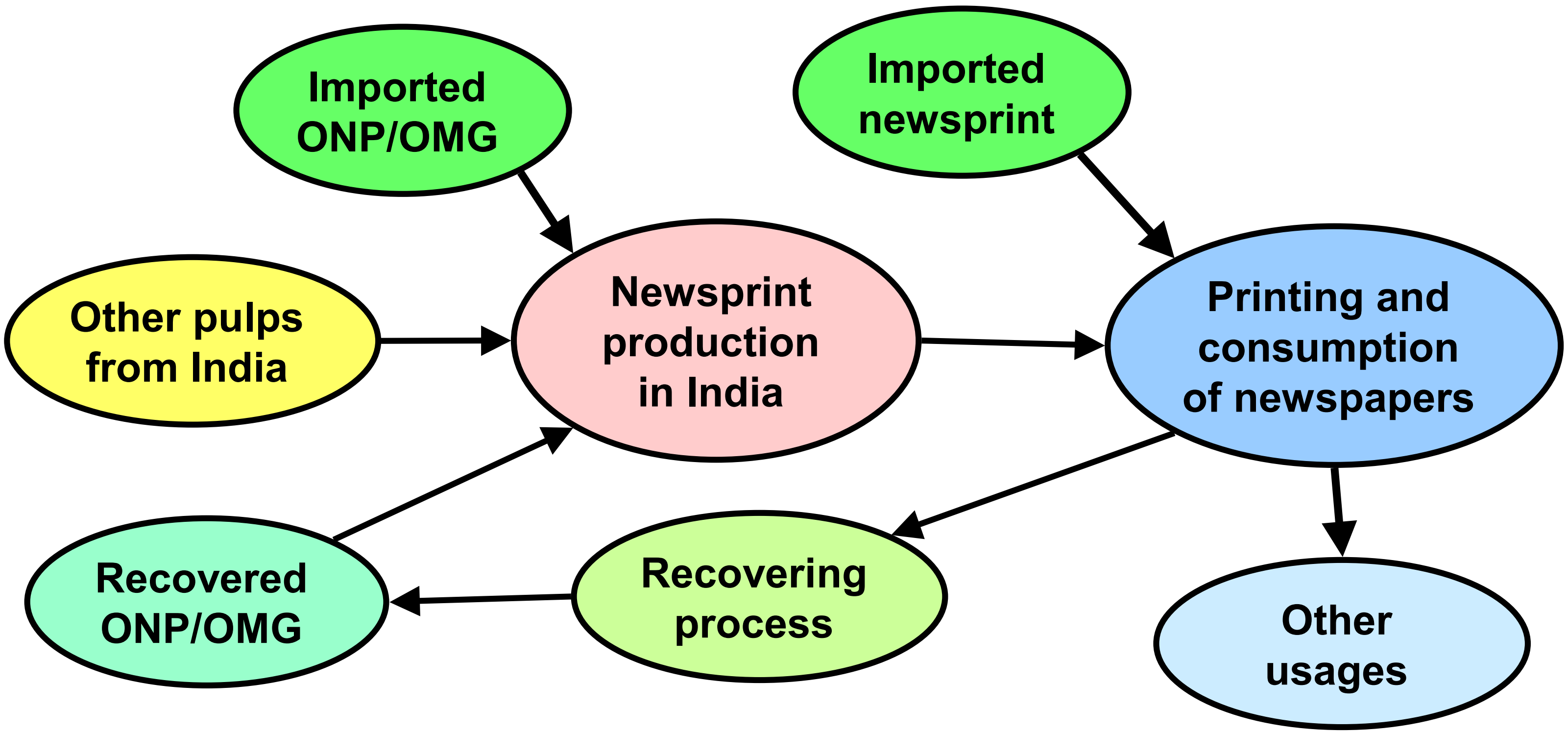


Chemical Pulp | **Mechanical Pulp** | **Deinked Pulp**

Newsprint raw materials in India

Project Number 52A0087

Share of imported good quality ONP/OMG should be more than third of the raw materials in Indian newsprint. Only imported old newspapers (ONP) or imported newsprint paper include so much mechanical fibre fines that it is possible to make good quality newsprint also in India. It would be better to import ONP than to import newsprint paper to the circulation.



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Summary of Recommendations

Newsprint machines should be big enough to afford modern technology and latest automation.

– Raw material and energy costs are so high in India when making chemi-mechanical pulp that it is better to use recovered fibre material which includes true mechanical fibres and fines.

– There should be one or two large scale newsprint machines in India (capacity more than 200 000 t/a). This requires more consolidation, high-speed machines, newest imported machine technology, imported waste paper, export markets and export quality instead of newsprint import.

– It is important to use new papermaking technology which can improve bulk, porosity and evenness of paper. The following technology is highly recommended:

  - Closed water circulation with disc saveall
  - High-speed machine (> 1500 mpm) with roll and blade gap former
  - Shoe press technology (extended nip press)
  - Good runnability components after press section
  - Closed hood
  - Automatic CD-profile control of grammage, moisture and thickness
  - Soft- or multi-nip calender technology
  - Better winders, roll wrapping machine, upender for storing and transport of rolls vertically.

Modern Technology and Paper Properties

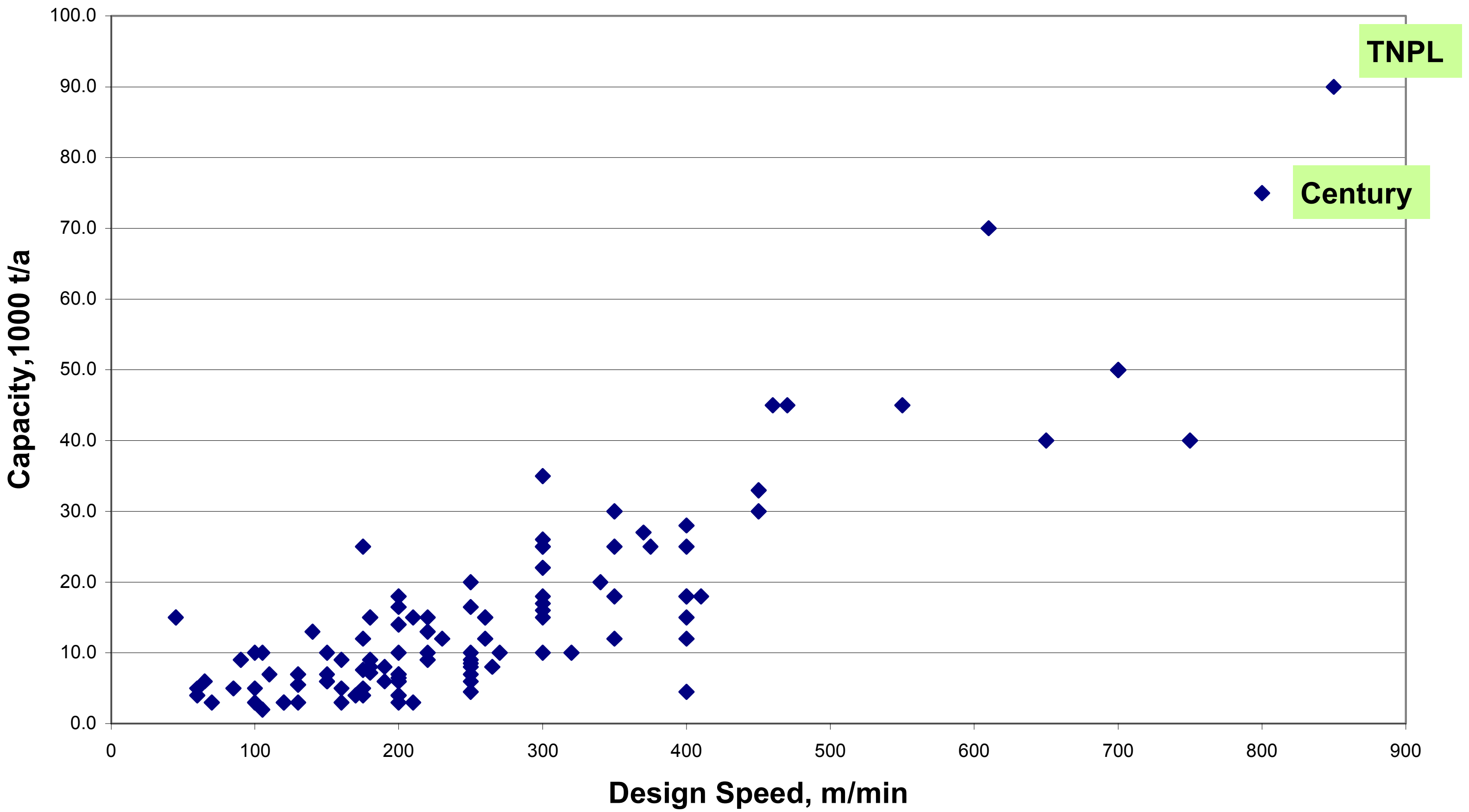
The effect of newest technology on basic newsprint properties. In India, where raw material quality is not competitive process and machine technology should be good to compensate the deficiencies in raw materials.

Paper property	Papermaking Technology					
	New formers	Double shoe press	Hot air drying	New calendering	New winding	Wrapping & storage
Better bulk	+	+	+	++		
Good formation	++					
Low porosity	++					
High opacity	+	+	+	+		
Good smoothness	+	+		+		
Better PM runnability	+	++	+			
Printing room runnability	+	+	+	+	++	++

Woodfree Paper Industry

Capacity vs. speed of Indian WFU machines

Capacity of uncoated woodfree machines in India is low. World class machines are designed for 400 000 t/a. This is more than four times the capacity of best Indian machines (about double speed and double width)



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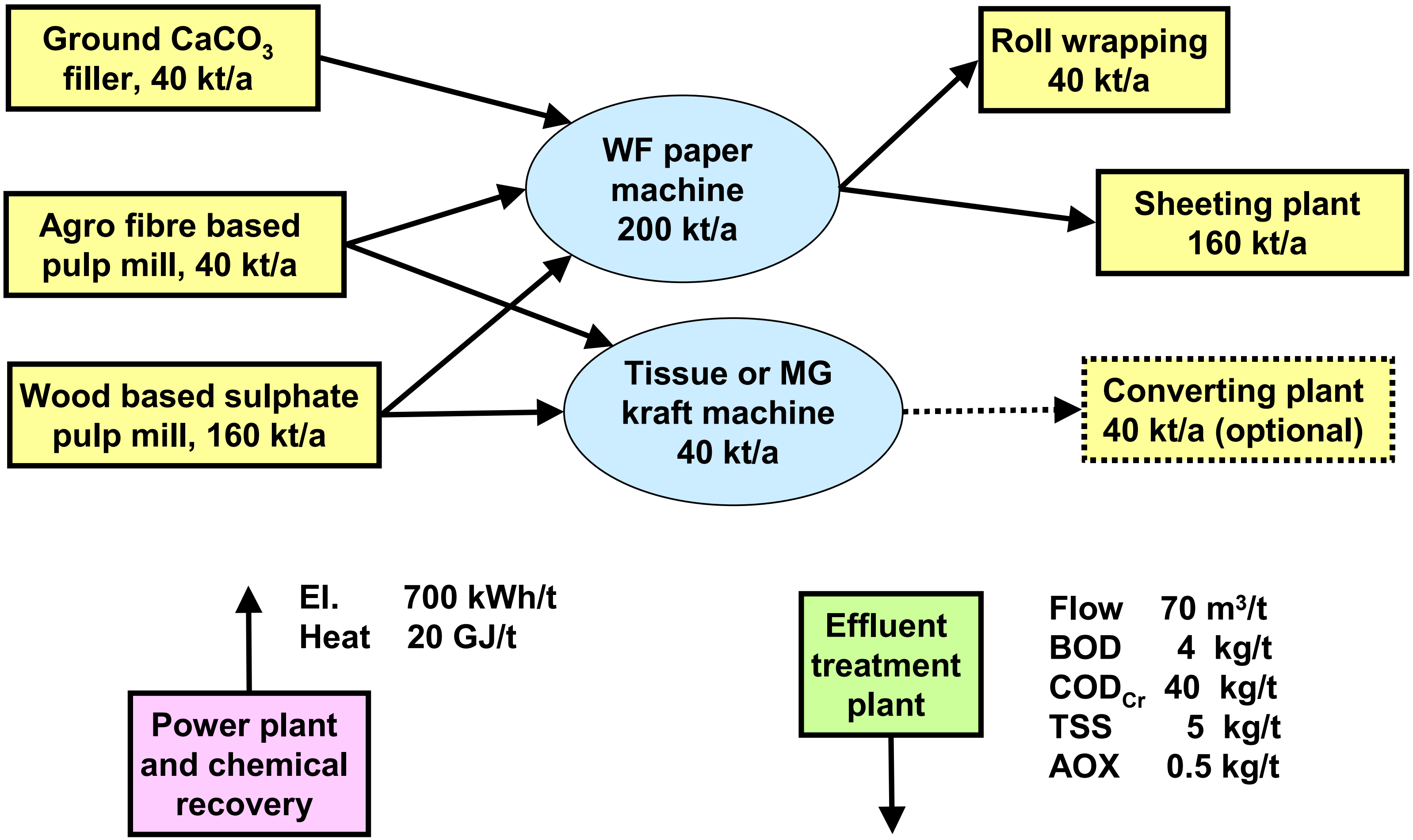
Optimum Indian woodfree integrate

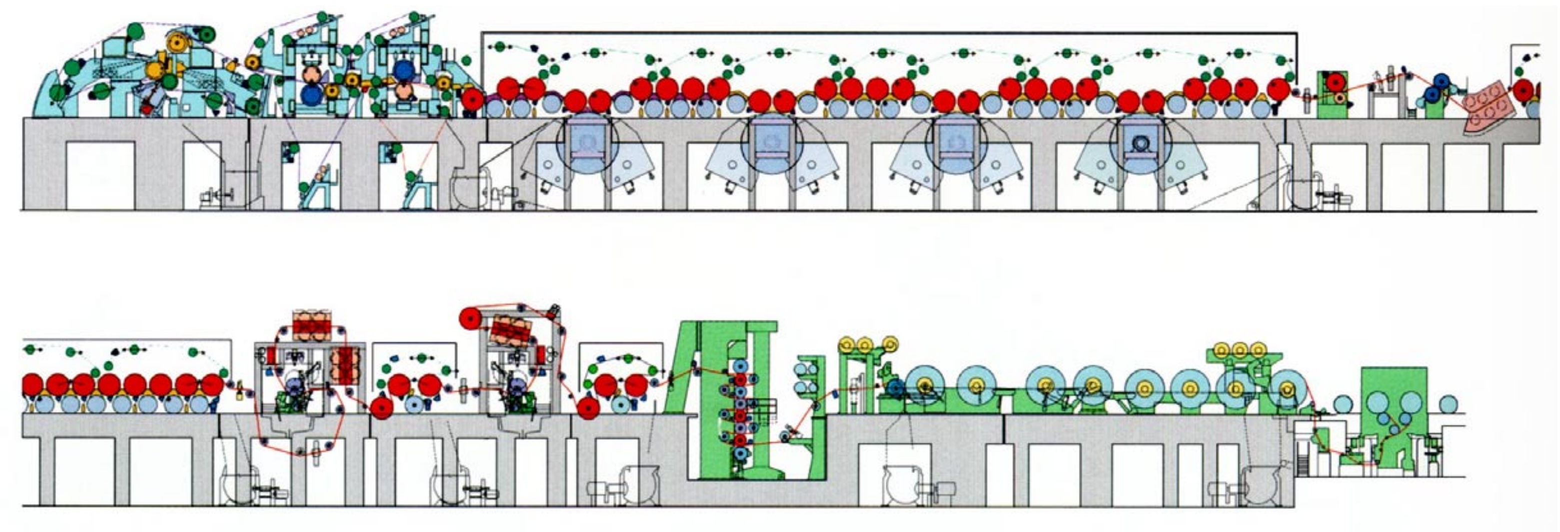
Project Number 52A0087

Mills and paper machines should be double the present top size. Papers should be made mainly from wood based sulphate pulp. About 20% of fibres could be agro based.



New coating and calendering concepts

On-machine technology is well suited for Indian small machines.



Source: Valmet Paper Technology

Forming

Pressing

Film coating/ sizing

Calendering

Fibres

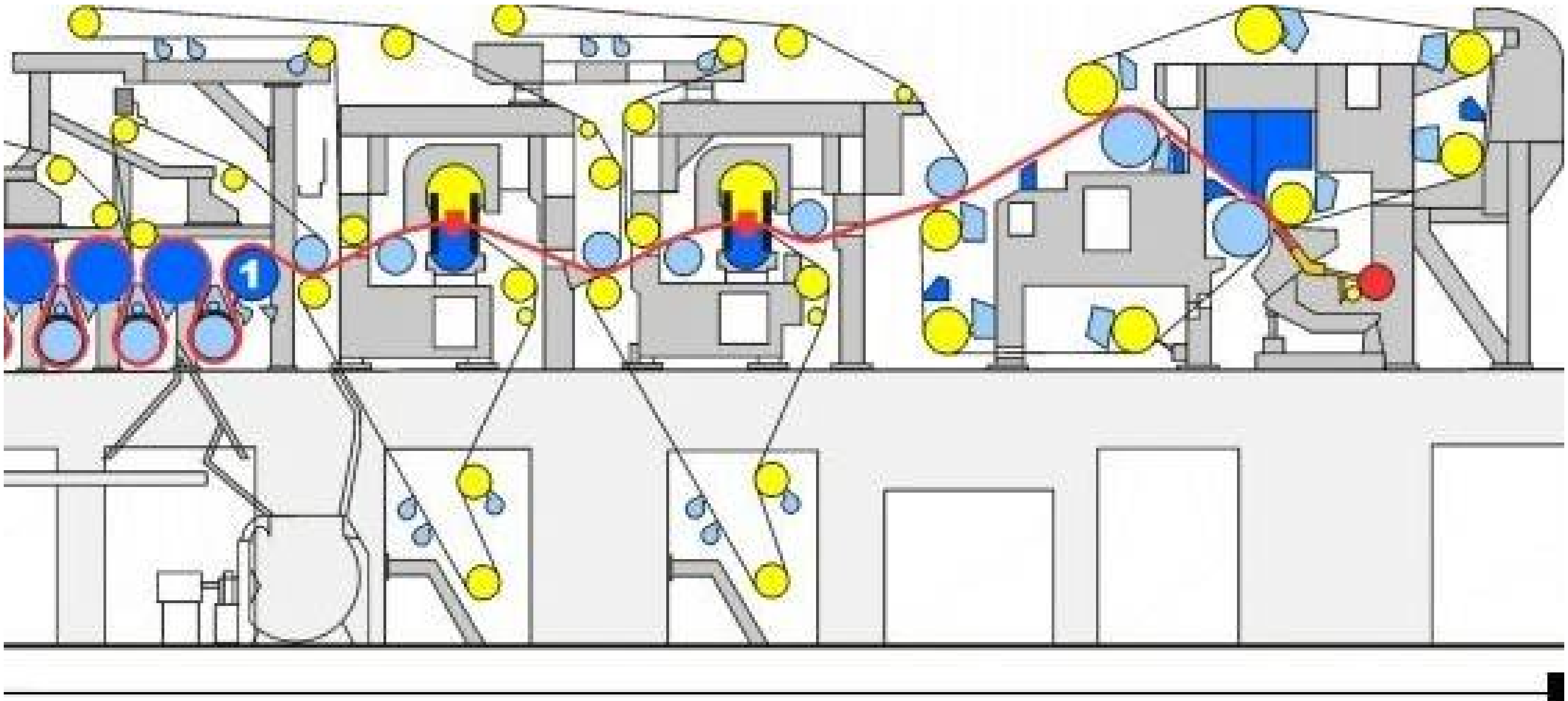
Pigments

Chemicals

Improve quality and runnability with shoe press

Shoe press technology is needed to improve solids, bulk and runnability.

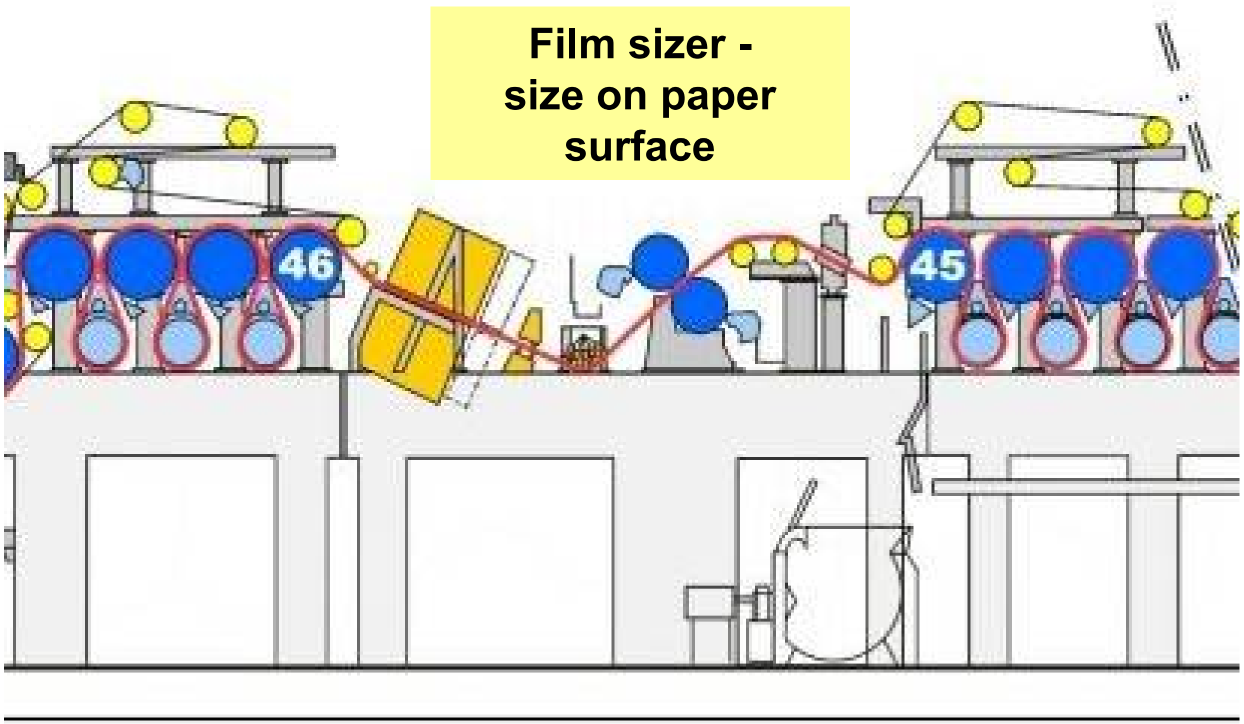
Bulk saving shoe presses



Source: Soporcel PM2

Improve runnability and quality by film sizer

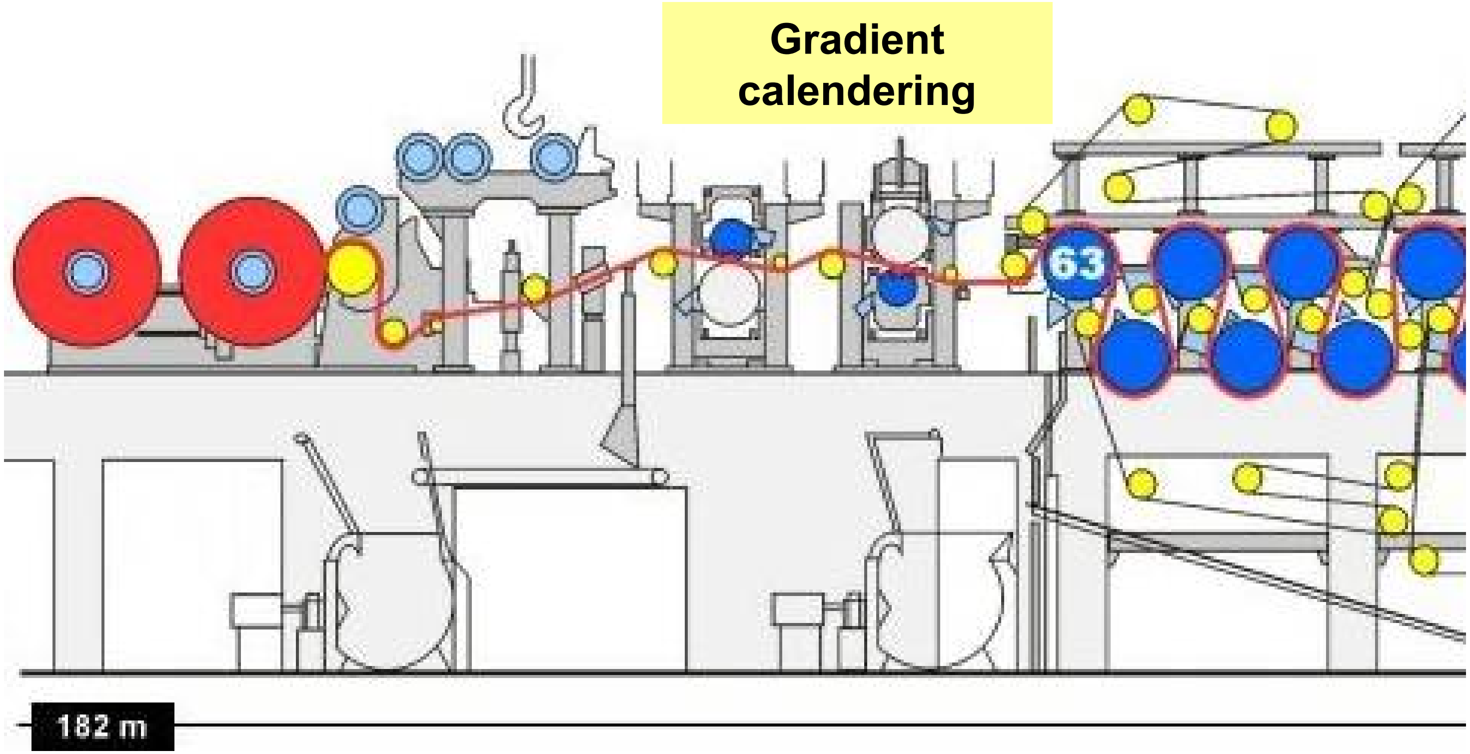
All European and American woodfree machines have surface treatment – sizing or coating. About 50% of Indian woodfree capacity is without any treatment. These machines cannot compete with imported paper.



Source: Soporcel PM2

Improve bulk with soft calenders

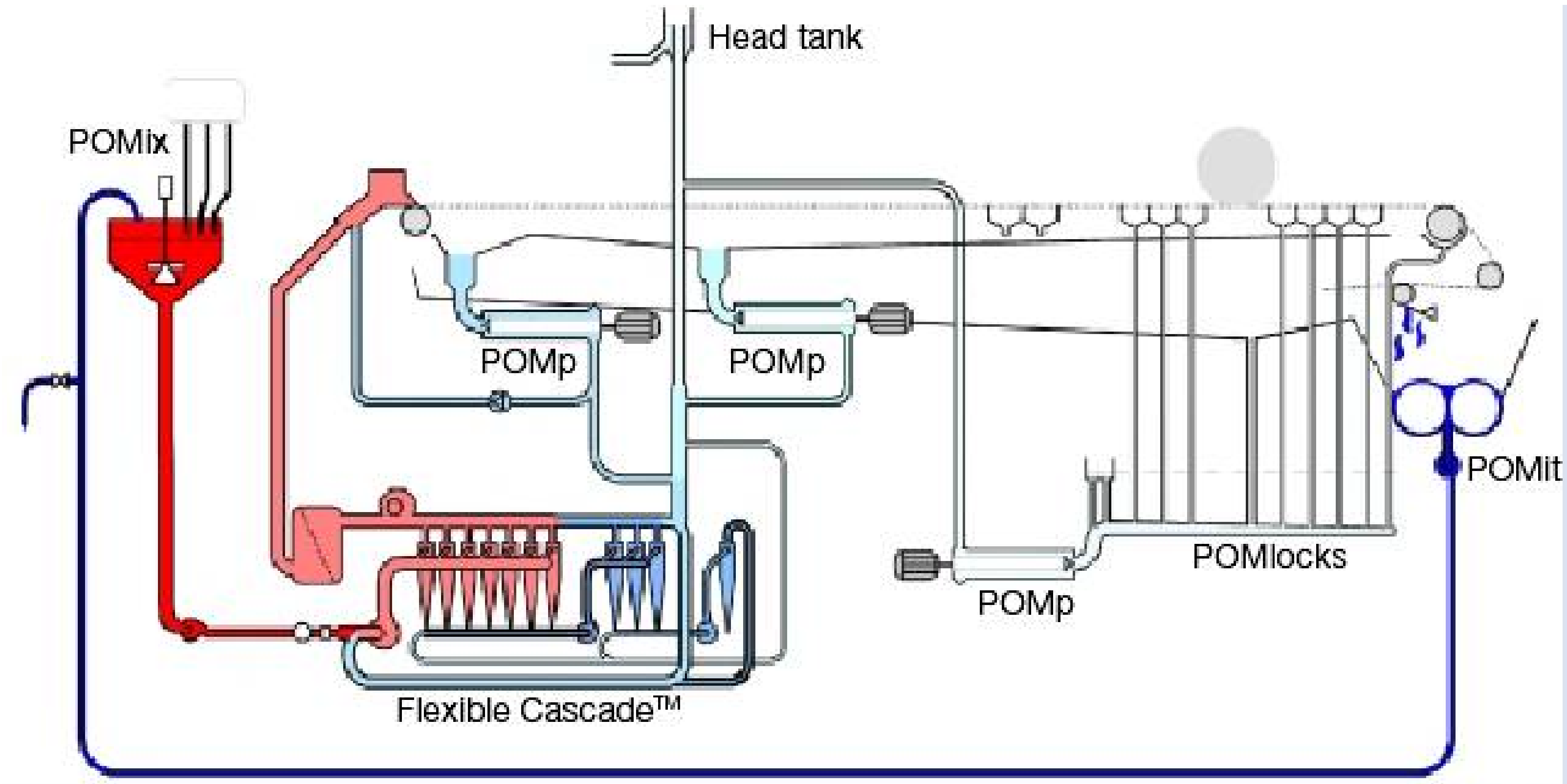
Soft calenders or multi-nip calenders are well suited to Indian paper industry. Compared to hard nip calendering they improve bulk, smoothness strength and printability.



Source: Soporcel PM2

Approach flow for multi-grade machine

Consistent quality is one of the biggest problems in Indian papermaking. This is not only question of automation but also how suitable is the process design. There are interesting possibilities to shorten the grade change time and to improve the process by using better approach flow systems (www.pom.fi).



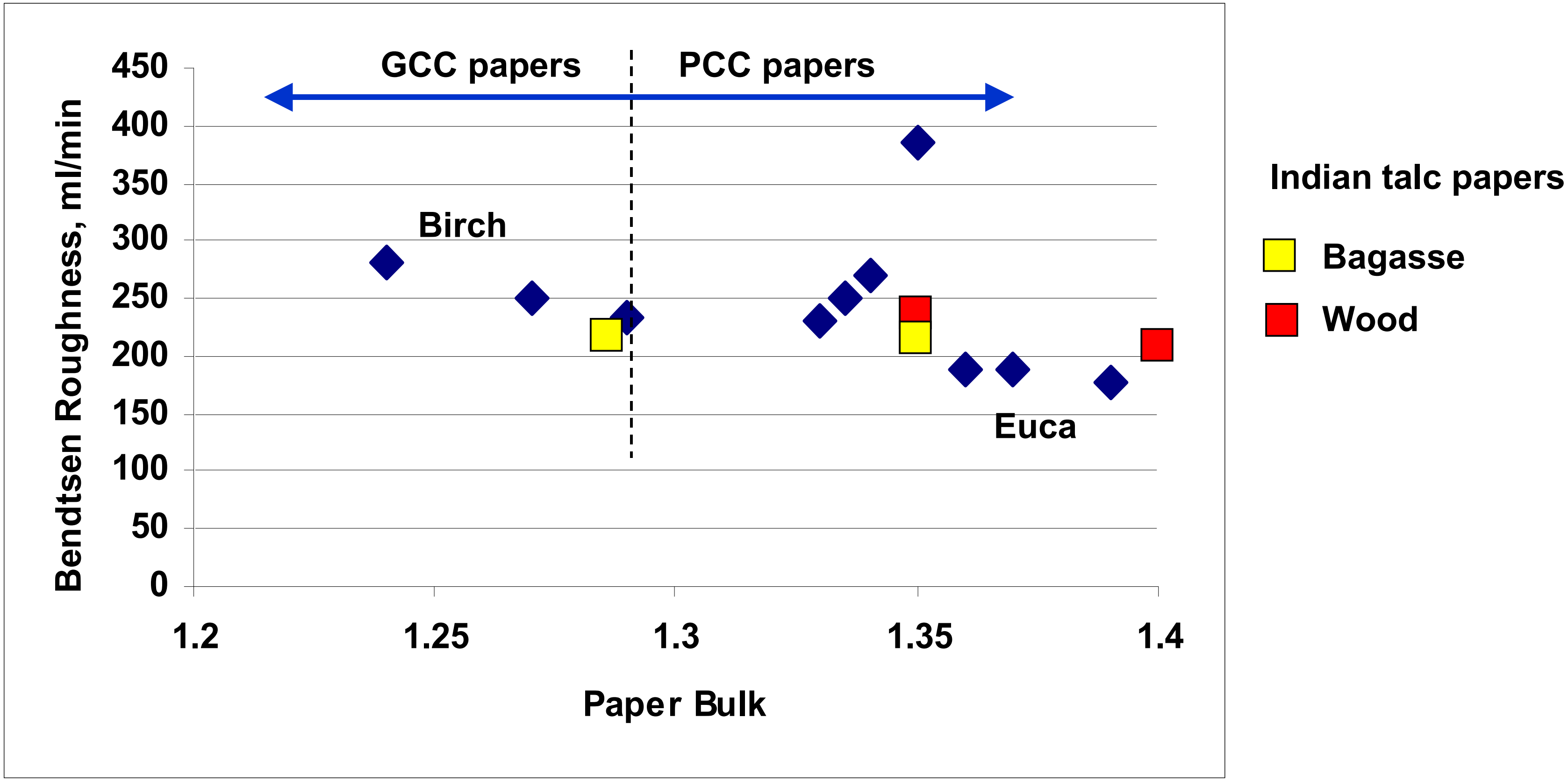
Quality of Indian copier paper

Optical properties of Indian copier papers is poor. Especially bagasse based paper shows poor light scattering coefficient and bulk. Filler content is extremely low and two-sidedness high.

Property		Indonesia MTH	Europe Birch	India Wood	India Wood	India Bagasse
Basis weight	ADgsm	75	75	75	75	75
Moisture	%	4.7	4.4	<3.5	5	5
Caliper	µm	104	99	106	101	96
Bulk	cm^3/g	1.39	1.32	1.41	1.35	1.28
ISO Brightness	%	92	95.4	92	84	88
CIE Whiteness	%	135	150	158	n/a	n/a
L*	%	90.2	95.4	90.1	n/a	n/a
a*	%	1.3	1.9	4.7	n/a	n/a
b*	%	-5.2	-4.5	-8.8	n/a	n/a
Opacity	%	90.8	91.4	91.3	88.0	88.0
Roughness, top	ml/min	225	181	182	180	150
Roughness, bottom	ml/min	203	231	250	300	300
Roughness, average	ml/min	214	206	216	240	225
Two-sidedness	ratio	1.11	0.78	1.37	1.67	2.00
Tensile MD	kN/m	4.4	4.8	4.3	3.3	3.3
Tensile CD	kN/m	2.2	1.9	2.7	2.4	2.4
Tensile ratio	ratio	2.0	2.5	1.6	1.4	1.4
Ash content (500 C-grade)	%	20	24	12.1	n/a	n/a
Fibre	ADgsm	60.0	57.0	66.0	n/a	n/a
Filler	ADgsm	15.0	18.0	9.1	n/a	n/a

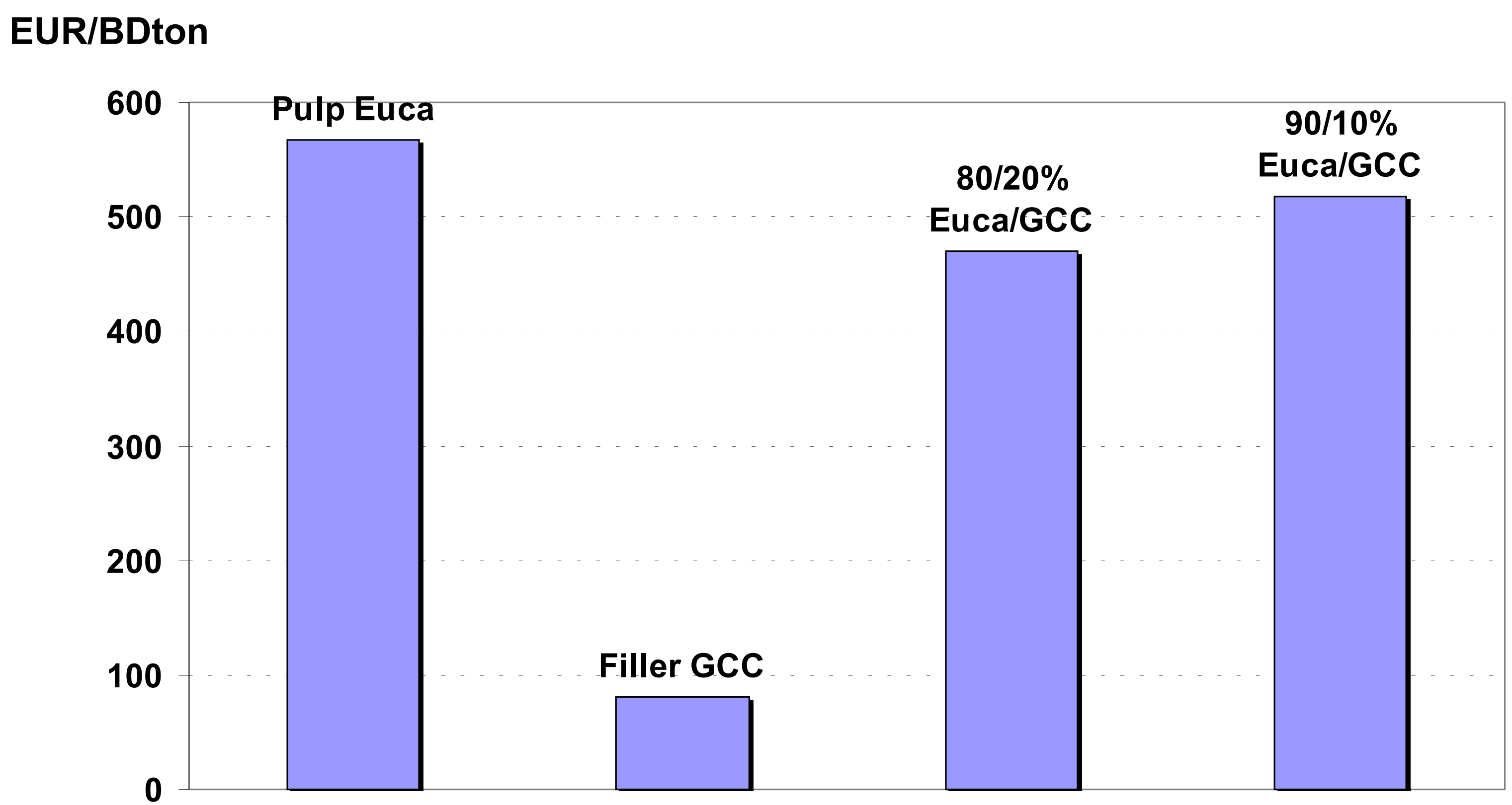
Roughness vs. smoothness benchmark

Paper bulk is very variable in India depending on the raw materials, solids after presses and type of filler. High bulk Indian paper is made with inefficient press section and high steam demand in drying.



Raw material costs & filler content

European papermakers have filler contents more than 20%. Pulp price is 7 times filler price. This means that the mix of filler and pulp is 10% more expensive with only 10% filler in paper (Indian practice). European paper industry would not be competitive with this kind of low filler content.



Recommendations

Domestic raw material supply including fibres, pigments and chemicals should be improved. Import duty of new machines should be same or less than for second hand machinery and imported paper.

- **High speed machines** (>1000 m/min) are needed for cultural papers. With a higher design speed, technology and paper quality will be closer to the international standard.
- The amount of **sulphate wood fibre** should be higher to get better paper quality and bigger machines. Large plantations of eucalyptus and other hardwoods are needed.
- The total **amount of pigments** (fillers and coating pigments) should be higher to reduce raw material costs and to get brighter paper.
- Good quality domestic filler **carbonate pigment** is needed instead of talc. This is the only way to get international quality.
- Rosin size and alum should be replaced by **synthetic size (ASA** or **AKD)** and microparticle retention systems to produce white papers in neutral conditions.
- Biggest machines should include gap former, shoe press and soft calender. **Import duty for new paper machinery** should not exceed import duties of paper or second hand machinery.

Paperboard Industry

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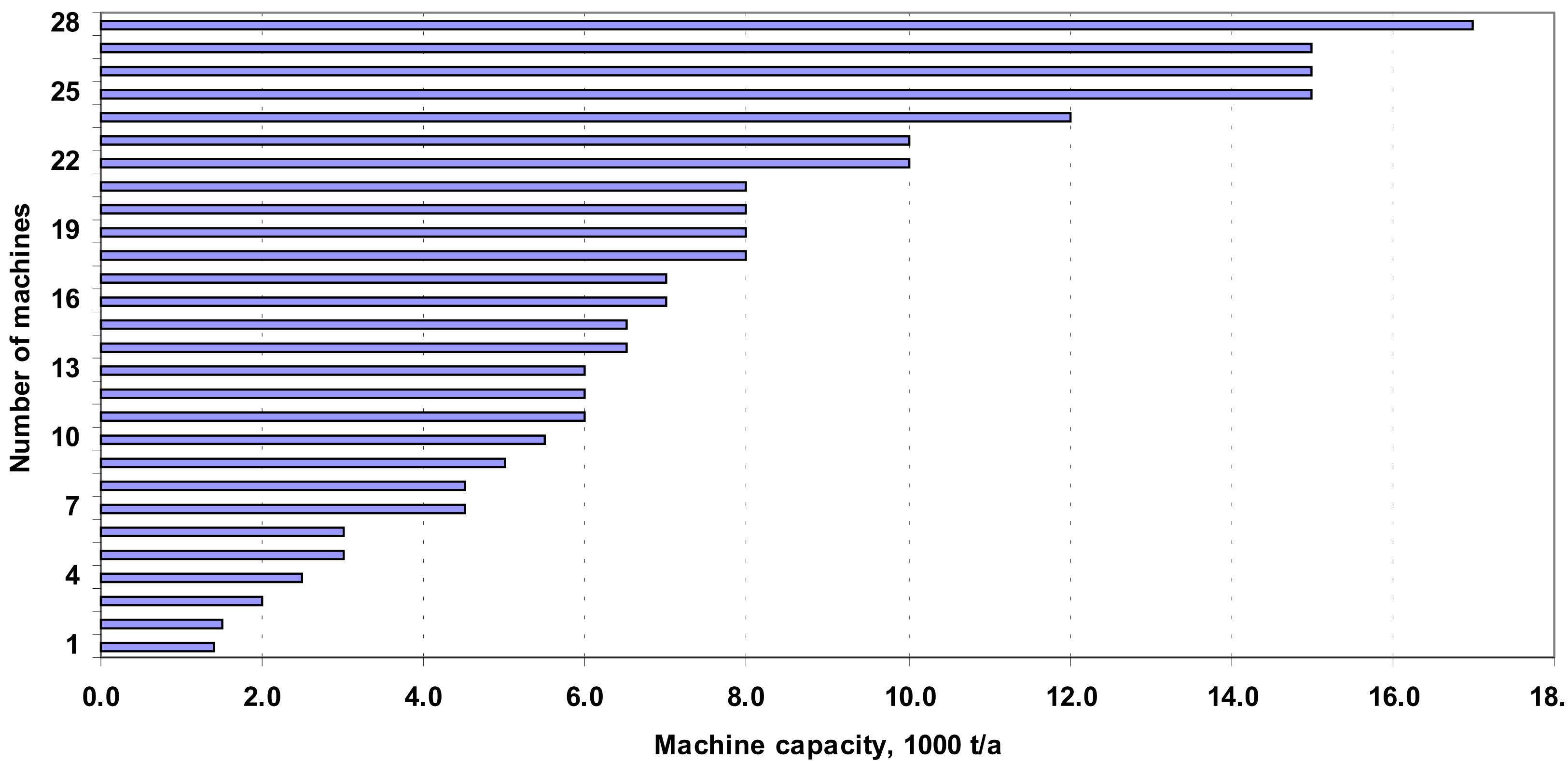
Capacity of Indian fluting machines

Capacity of all Indian corrugating medium machines is very small. Design capacities of new international fluting machines are 400 - 500 kt/a. This is about 30 times the capacity of best Indian machines.



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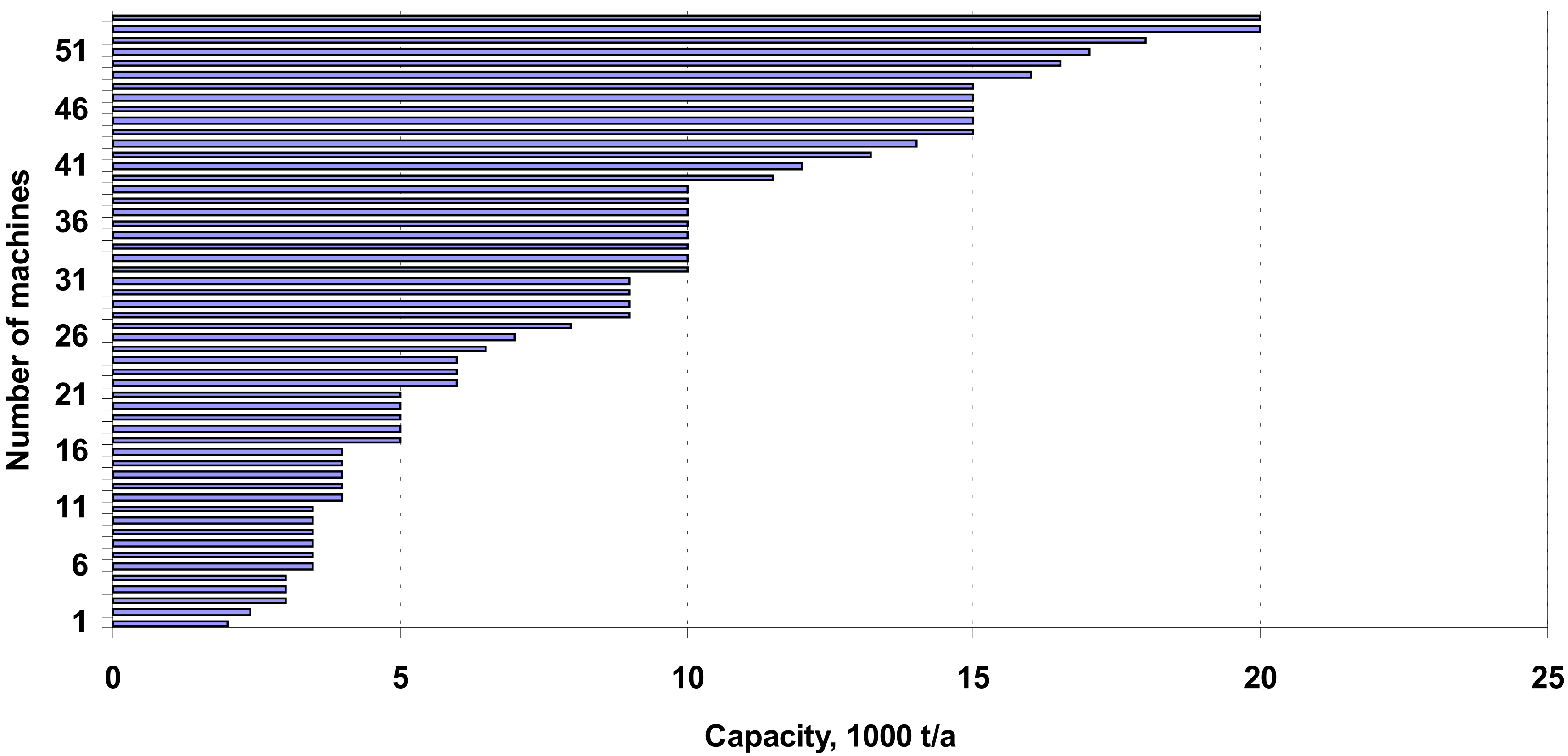
Capacity of Indian liner machines

Capacity of all liner machines in India is also very small. Design capacities of new international liner machines are 400 - 600 kt/a. This is more than 20 times the capacity of best Indian machines.



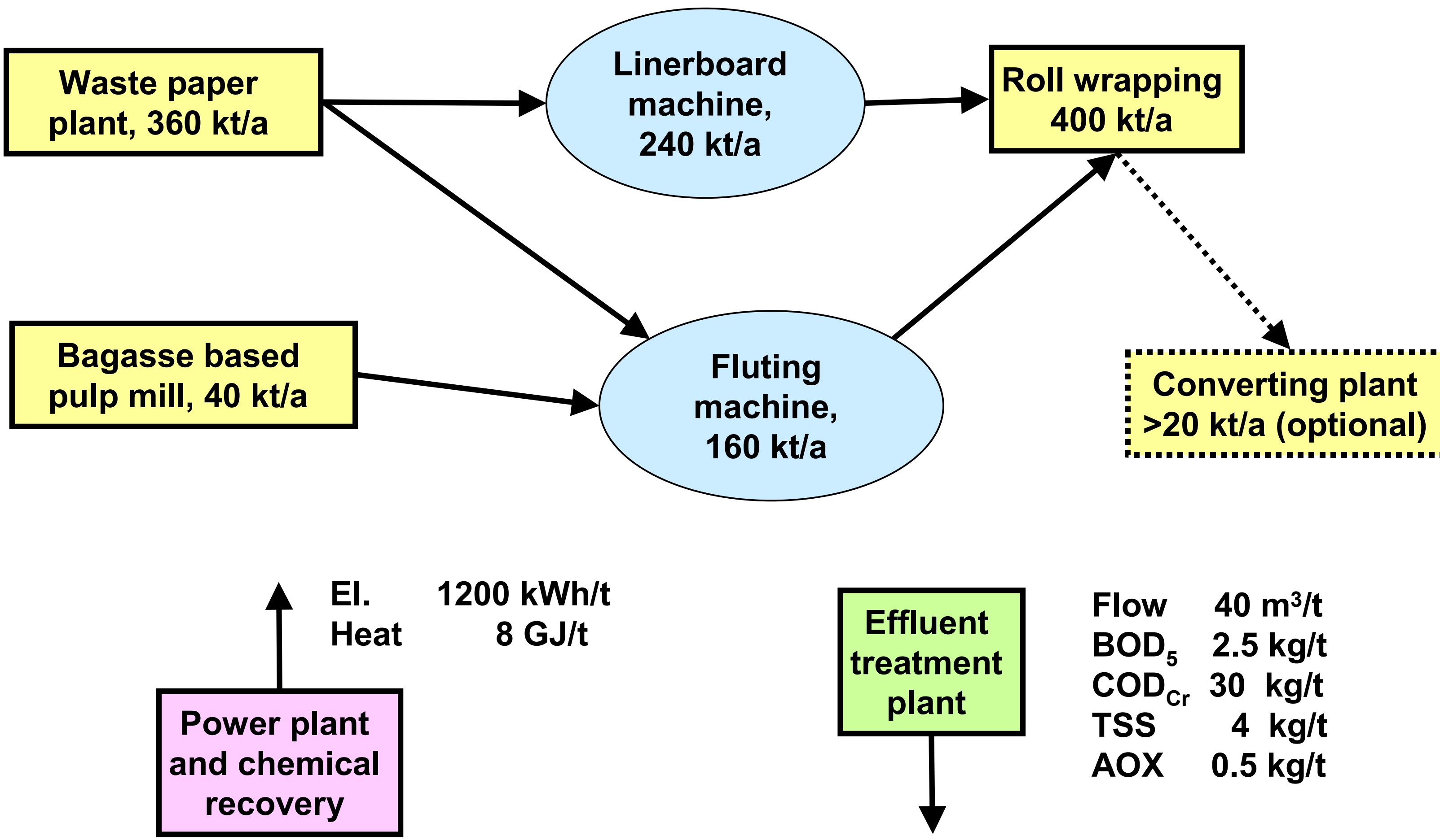
Indian board industry

Old paper machine technology is a big disadvantage in most of Indian board mills. Even if raw material is imported quality is not comparable with international standards.

- Machine concept and product quality of the best Indian **coated paperboard** machines is quite close to the international standard due to the new PM4 of ITC Bhadrachalam.
- **Containerboard sector** is not competitive. Machines are too small and quality is not good.
- One reason for the poor quality and low production is old technology with second hand **cylinder vat** machines. Cross direction properties are poor due to the high orientation and poor formation.
- There should be at least **one competitive linerboard** as well as **corrugating medium machine** in India. Size could be about 200 000 t/a.
- Raw material could be mainly **waste paper** (imported and domestic) but also **bagasse** is suitable for fluting. Fractionating of waste material is recommended (long fibres to liner and short fibres to fluting).

Optimum Indian containerboard integrate

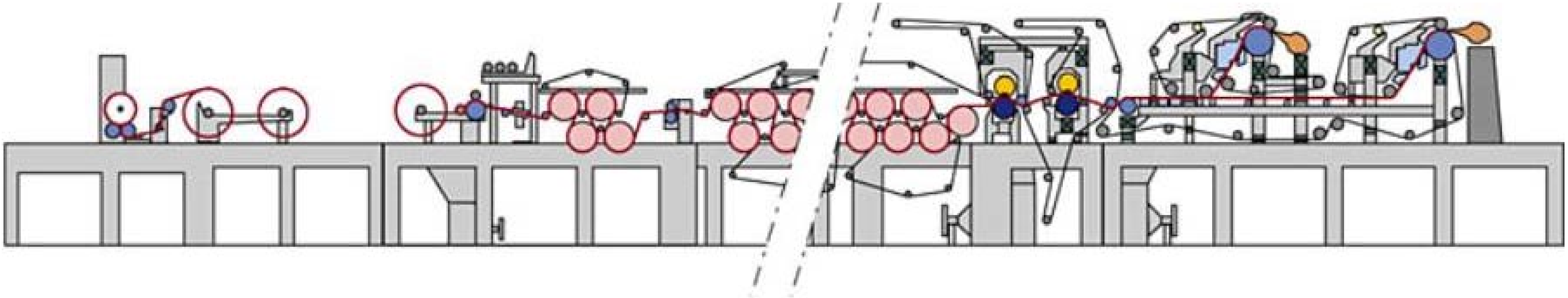
Mills and paper machines should be more than ten times the present top size. Paperboards should be made mainly from waste paper. About 30% of fibres could be bagasse based for fluting.



Advanced linerboard machine

One of the biggest technological steps in the paper industry is the present speed increase of board machines equipped with gap formers.

- New linerboard machines have two gapformers. **Gapformer** gives good formation and superior printing properties for the top layer of linerboard. Cross direction stiffness is also good due to better formation and lower orientation compared to the cylinder vats.
- Present benchmark machine is PM6 at Papierfabrik Palm in Germany. This machine will have width of 10 m and speed of 1500 m/min. Design production is **600 kt/a** (www.wellenwunder.de and www.mwtsopaper.com).
- Design speed of linerboard machine should be **more than 1000 m/min**. A good benchmark mill in Asia is Nine Dragons Paper Industries in China, started 1988 and having an annual capacity of one million ton (www.ndpaper.com).

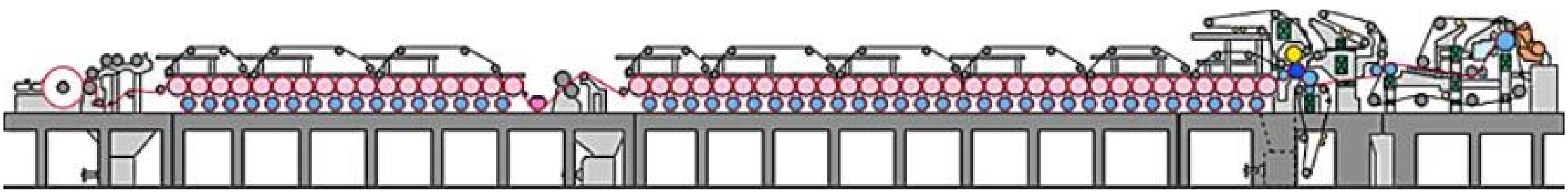


Source: Voith Paper

Fluting technology

Virgin fibre based fluting is always hard to dewater. Latest solutions with gap former and shoe press are well suited also for Indian machines.

- On October 12, 2000, SAICA started their PM9 fluting machine in Spain. This machine is a good benchmark machine for corrugating medium. This machine produced corrugating medium with a basis weight of 75 g/m^2 during a seven-hour period at a speed of 1402 m/min. That resulted in a production of 48 t/h which is equals more than 350 000 t/a.
- The machine is equipped with a gap former. Gap former can increase dewatering capacity considerably when raw material is fine and agro based.
- Shoe press is also required when speed is high and pulp is hard to dewater.
- Size press is also important for surface sizing to improve properties of OCC- or agro fibre based fluting.



Voith Paper SAICA PM9

Quality of Indian linerboard

Indian liner is often made with cylinder vats. This can be seen in some important properties.

- Orientation is very high. This requires best imported raw materials to get good enough cross direction properties which are critical.
- Formation and CD profiles are poor. Board must be overdried to get more even properties.
- Smaller Fourdrinier machines using domestic raw materials have very low burst strength compared to international standards.

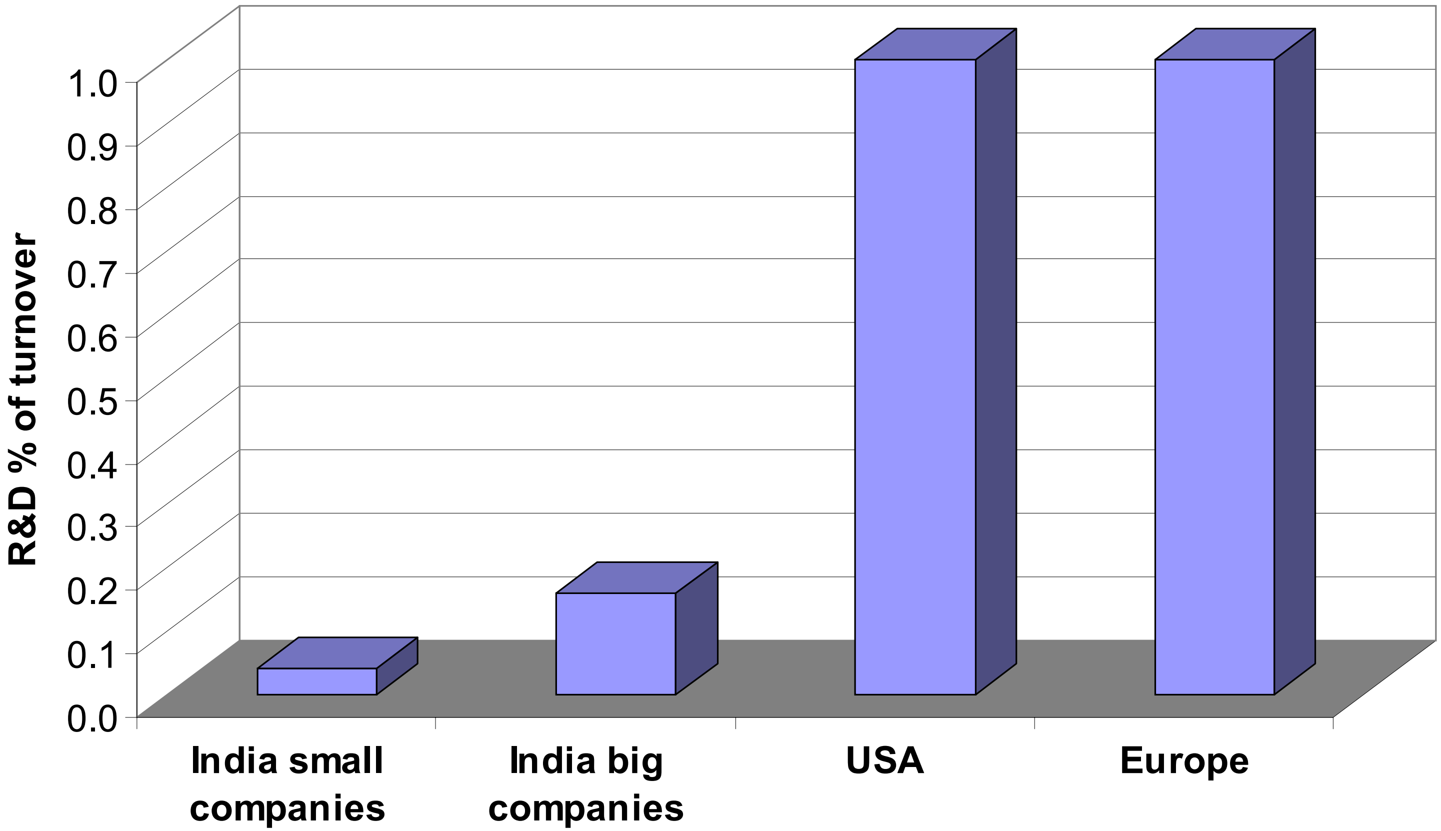
Property		India Testliner 1	India Testliner 3	Europe Testliner 1	Europe Kraftliner
Basis weight	ADgsm	180	155	175	150
Moisture	%	6.7	6.5	8.0	8.5
Burst index	kPa-m^2/g	3.5	2.7	3.9	4.7
Ring crush test CD	kN/m	2.4	1.7	2.1	1.6
Breaking length MD	m	8500	n/a	8600	n/a
Breaking length CD	m	3000	n/a	n/a	n/a
Tensile ratio MD/CD		2.8	n/a	n/a	n/a

Research & Development

R&D spending of Indian paper industry

Project Number 52A0087

R&D expenditures of Indian paper industry are relatively and especially absolutely very small compared to Europe and USA. Companies need to be bigger to afford reasonable R&D for final products and production processes. Focus should be in applications and developments not in research.



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Central Pulp & Paper Research Institute

Central Pulp & Paper Research Institute (CPPRI) is located at Saharanpur, a city in the state of Uttar Pradesh, 168 kms from Delhi, well connected by rail & road.

CPPRI, a National Level Institute to promote R&D in the field of pulp & paper, was established in 1980 as an autonomous body under the administrative control of Dept. of Industrial Policy & Promotion, Ministry of Commerce & Industry, Govt. of India.

All affairs of CPPRI are managed by Council of Association, consisting of 15 members comprising of representatives from Paper Industry, Ministry of Commerce & Industry (DoIPP), and Dept. of Science & Technology (DST), Council of Scientific and Industrial Research (CSIR), Indian Council of Forestry Research & Education (ICFRE) and University of Roorkee. The Secretary Industrial Policy & Promotion, Ministry of Commerce & Industry, Govt of India is the president of the Council of association. The Association performs various functions such as deciding the budget , approval of annual plan, purchase and disposal of equipment etc.

The management also constitutes the Research Advisory Committee (RAC). It is a committee represented by Senior Executives from Pulp & Paper Industry, associations, research organizations and Ministry of Commerce & Industry and plays a vital role in planning and monitoring of research activities.

Short history of CPPRI

The origin of Central Pulp & Paper Research Institute (CPPRI) dates back to the year 1975 when the UNDP-GOI Project became operational with an objective to create the required R & D facilities for evaluation of fibrous raw material for the Indian paper industry. After the conclusion of the above project, CPPRI came into existence as "National Level Research Institute" dedicated for the assistance to the Indian paper industry.

In the early years of operation the focus of CPPRI was on finding alternative fibre raw materials for paper industry, understanding their behaviour in the pulping and paper making processes and resource conservation (fibres, energy, water, etc.).

In the late 1980s CPPRI put more emphasis on the research work in processing technology leading to the innovation of the process and technologies in the areas like pulping, chemical recovery, environmental management and quality improvements.

Now CPPRI is looking into the need for long term sustainability of the industry , the need has been felt for increased interaction with the paper industry in resolving the problem relating to cost competitiveness, quality improvements and new & emerging environmental issues for growth of the paper industry.

Objectives of CPPRI

Presently the objectives of CPPRI are very scientific and research oriented. There should be more technology transfer from international practices, more working in the mills, more training and applications of best available technologies.

The objectives of CPPRI are:

- To promote research and scientific work connected with Pulp and Paper Industries.
- To establish and maintain laboratories, pilot plant and workshops for pulp and paper research and conducting experiments.
- To publish periodicals on the activities having bearing on the industry.
- To encourage discoveries and acquire patent information.
- To assist research work of any society or Institute connected with pulp and paper industries.

Core activities and oganisation

Total constructed area of the Institute is over 10 000 m^2. This includes one administrative block, two laboratory blocks, pilot plant, library and documentation centre, Guest House and residential complex.

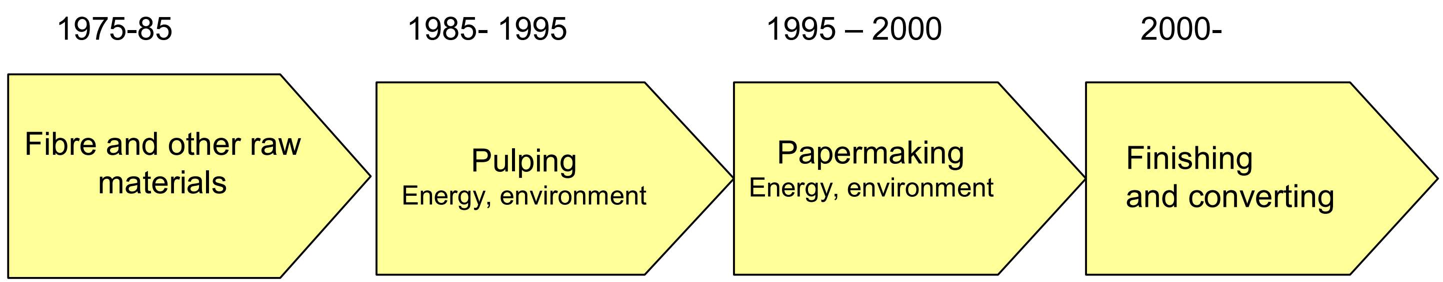
The core activities are research work, pilot trials and laboratory services. The current organisation of CPPRI is divided to the following divisions:

- Physical chemistry, pulping & bleaching.
- Stock preparation, papermaking and conversion
- Chemical recovery, energy management, by-products, biotechnology and effluent treatment
- Solid waste and air pollution
- Pilot plant
- Engineering, maintenance & planning
- Library, documentation and information services
- Business development & marketing
- Support services (administration, finance and accounts)

Concept note on CPPRI

Changing CPPRI focus

In close cooperation with paper mills



Paper industry supply chain

Future development targets for CPPRI could be:

– to maintain leading edge know how in using non-conventional fibre raw materials in paper industry

– to improve services related to papermaking, paper quality and finishing/converting, so that the above papermaking supply chain is fully covered, and end user requirements are taken into consideration in all parts of the chain

– increase cooperation with paper mills by offering training as well as mill process measuring and troubleshooting services.

– sell services and consultancy projects to international clients eg. in non-wood pulping and papermaking

Proposed future projects for CPPRI

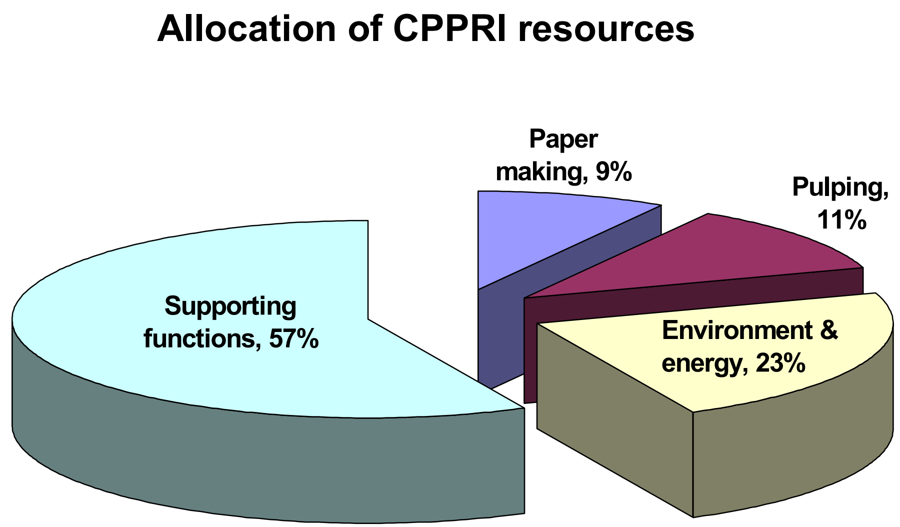
The following weaknesses of Indian paper industry should be improved by training, developing new projects and investing in measurement devices:

- **Better contacts with industry** and utilisation of research achievements by making process measurements of main production lines and proposing improvements at the mills.
- Program package of conversion to **neutral papermaking** by using calcium carbonate and AKD/ASA sizing.
- Training on increased pigment content in paper i.e. why and how to increase **coating amount and filler content**.
- Development of good quality **domestic fillers and coating pigments** (especially carbonates and kaolin). How to get international know-how to Indian paper industry.
- Training and improvement in basic structural paper properties: **uniformity, formation, orientation, two-sidedness** and **curl**.
- Better **measurement devices for formation and orientation** (www.ambertec.fi).
- **Improvement of paper uniformity**, measurement services and devices for MD and CD – profile measurements (www.tapiotechnologies.fi).
- How to make smooth paper with **higher strength, bulk and stiffness**.
- Training in optical properties of paper. Theory and practice of higher **light scattering coefficient** for simultaneous improvement of brightness and opacity.
- How to make better **laid paper and watermarks**.

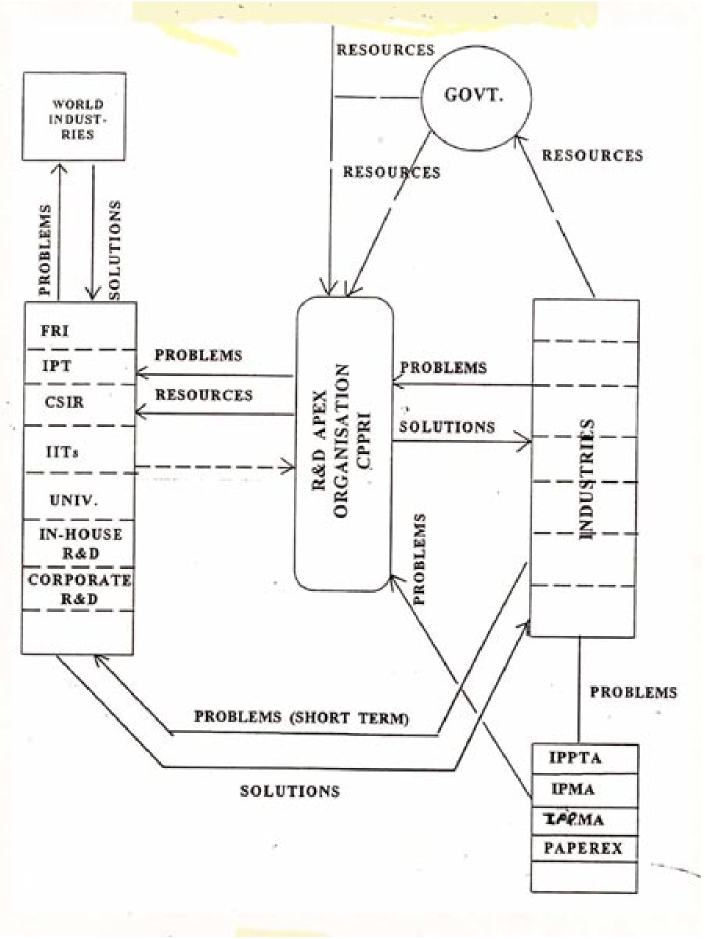
Allocation of CPPRI resources

More focus on end products and main processes i.e. on papermaking is needed.

- The total annual budget is about 0.5 Million USD (Rs. 1222 lacs for 1997-2002). This is divided about 57/43 % between supporting functions and three main divisions.
- Allocation between the three main divisions is 9% for papermaking, 11% for pulping and 23% for energy and environmental divisions.
- The end products of Indian paper industry are paper, paperboard and converted products. The allocation of resources should be **more focused on papermaking**, where the quality and profitability problems finally appear. If the basic business is not viable there is no meaning to invest in the supporting functions and utilities.



Proposed R&D organisation



Good example of practical research

New pilot machines for coating and soft calendering form a good basis for industry oriented research and development. The utilisation of these equipment should be high to improve paper quality closer to the international standards.

More research or applications?

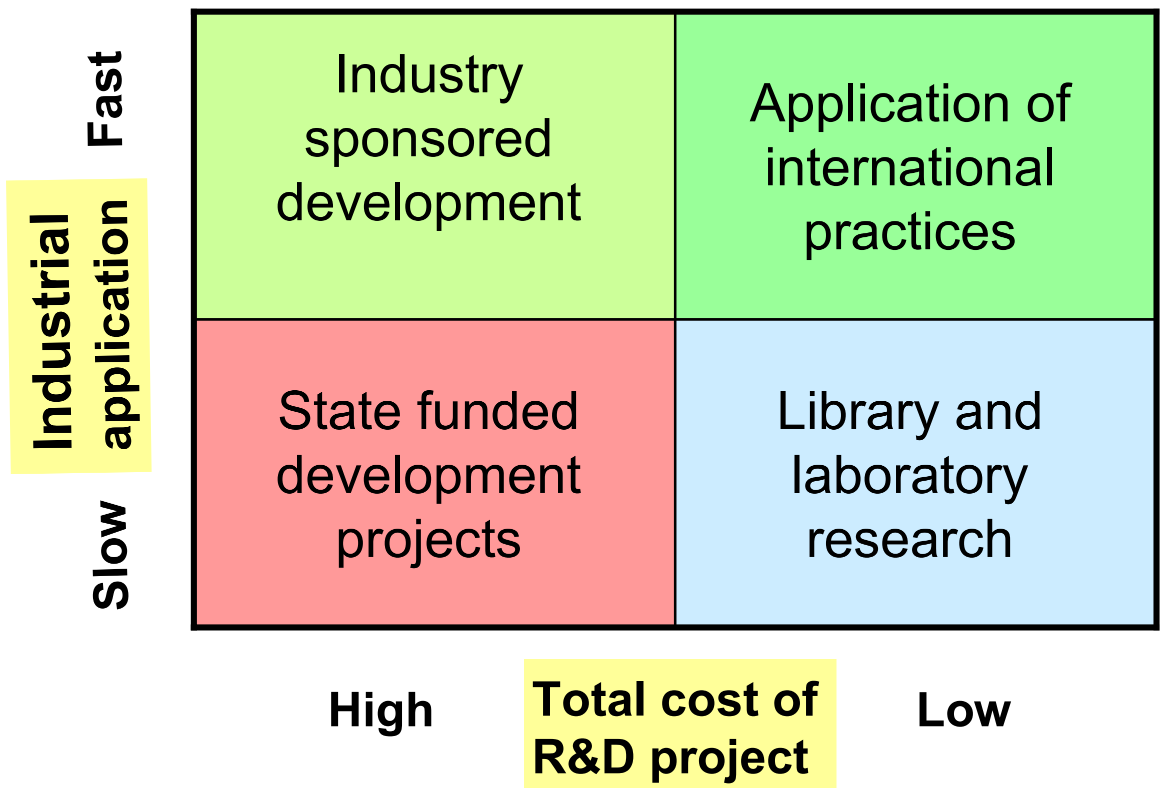
Indian paper industry needs more technology transfer and application of best international industry practices and less own research and innovations. Innovation with Indian resources is too slow path in international competition. A good start for the correct way is the new information centre of CPPRI.

– The **new library** for CPPRI should be efficiently used by Indian paper industry to adopt international practices.

– In addition to the conventional issues like management, environmental and energy topics there should be strong focus on **process concepts, paper pigments, chemicals** and **running practices** of the machines.

R&D project efficiency

The dilemma of research institutes is how to transfer the results to industrial use or are the results applicable at all for the industry in the long term. Industry should be more involved in R&D. This is only possible when industry funding is bigger. This requires bigger companies and more co-operation within the total forest cluster.



Management Practices

Management practices

Indian mills are increasingly adopting ISO 9000 and ISO 14 000

Practice area	Objectives	Current state and development needs
Marketing management	Marketing planning, organisation, implementation and control	Large companies have adequate marketing organisation for domestic sales. Experienced export managers are needed when exports start to grow Demand growth and international competition will create new challenges for marketing management
Quality management	Ensure even and high quality of production and deliveries	Quality variations are still one of the main problems of most mills. Raw material, technology and machinery must be improved.
R&D management	Research and development, product/quality testing, finding new products and technologies	Large companies have R&D departments and laboratories for testing. Calibration of measurements needs to be improved. R&D costs shoud be about 1 % of turnover. Both industry and company wise R&D is needed.
Inventory management	Optimise inventory investments, important function in India, where long delivery times of raw materials, spare parts, etc. are common.	Large mills have more developed systems. Just-in-time system difficult to apply in India due to infrastructure. Becoming more important due to increasing competition and growth of company size.
Financial management	Financial planning and control. Minimise capital costs, currency exchange risks, maintain profitability and cash flow. Investment financing.	Importance of financial management will drastically increase in line with the industry growth, mill size expansion, modernization of technlogy and entry to WTO.
HRD	Human resource recruiting and development. Training for new international applications.	Large mills have on going training processes like TPM (Total Production Maintenance). Growth of industry will increase the need for qualified personnel at all organisational levels and in all functions.

Focus in operating performance

When the industry is capital intensive and fixed costs high also, profits are very sensitive on operational performance. Modern pulp and paper mills represent this type of facilities. In the old, depreciated mills which operate in low labour cost environment, high performance is not as critical.

The key operational performance parameters (mill operation) in pulp and paper manufacture are:

- Capacity utilization
- Raw material yields / losses
- Paper losses in papermaking
- Paper furnish
- Personnel productivity

Modern production lines typically reach capacity utilization of 88 – 90% of which about 5% unused throughput potential and 5 – 8% time losses. Production skills and quality of maintenance function are the key issues to reach high utilization.

The raw material losses which are in control of mill management, are basically related to wood losses. Wood losses in mixed tropical hardwood processing could reach a level of 5%.

Paper losses in papermaking depend on paper grade, but best practice levels for example in uncoated wood-free reels is 5%.

Uncoated wood-free paper at basis weight of 70 g/m2 is produced based on 100% short fiber pulp at filler level of 20%. Newsprint with 100% recycled fiber furnish is produced.

Man-hour requirement in modern large BHKP mills is about 1 man-hour / AD pulp produced, and in roll paper production also about 1 man-hour / ton inclusive all personnel.

International Prices

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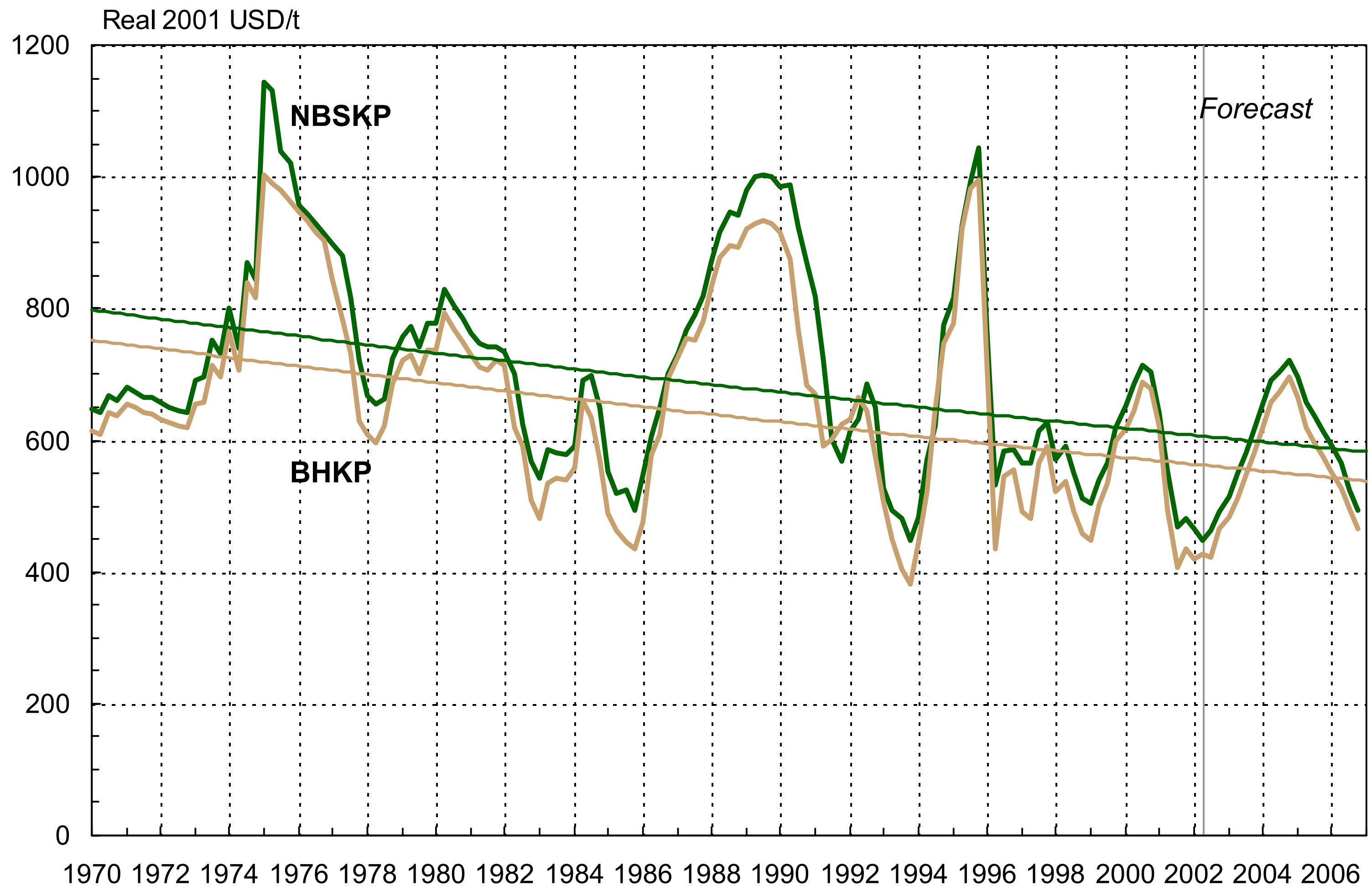
Real Price of NBSKP and BHKP in 1970 – 2006

Market pulp/CIF North Atlantic/North Sea port



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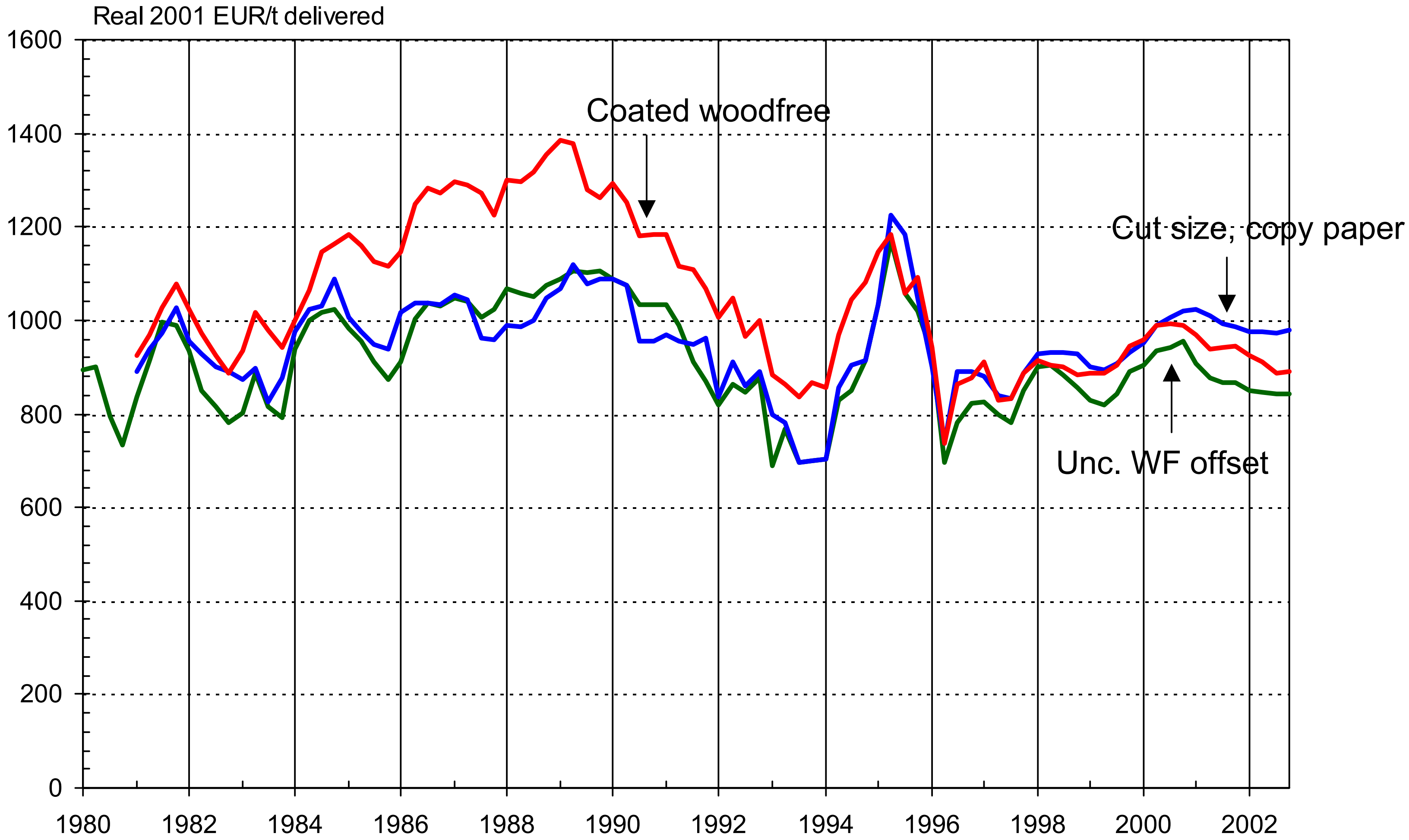
Real prices of woodfree papers in Germany

Woodfree price fluctuate in business cycles, overall real price trend is slightly declining, gap between coated and uncoated grades has decreased (economies of scale effect/oversupply in Europe)



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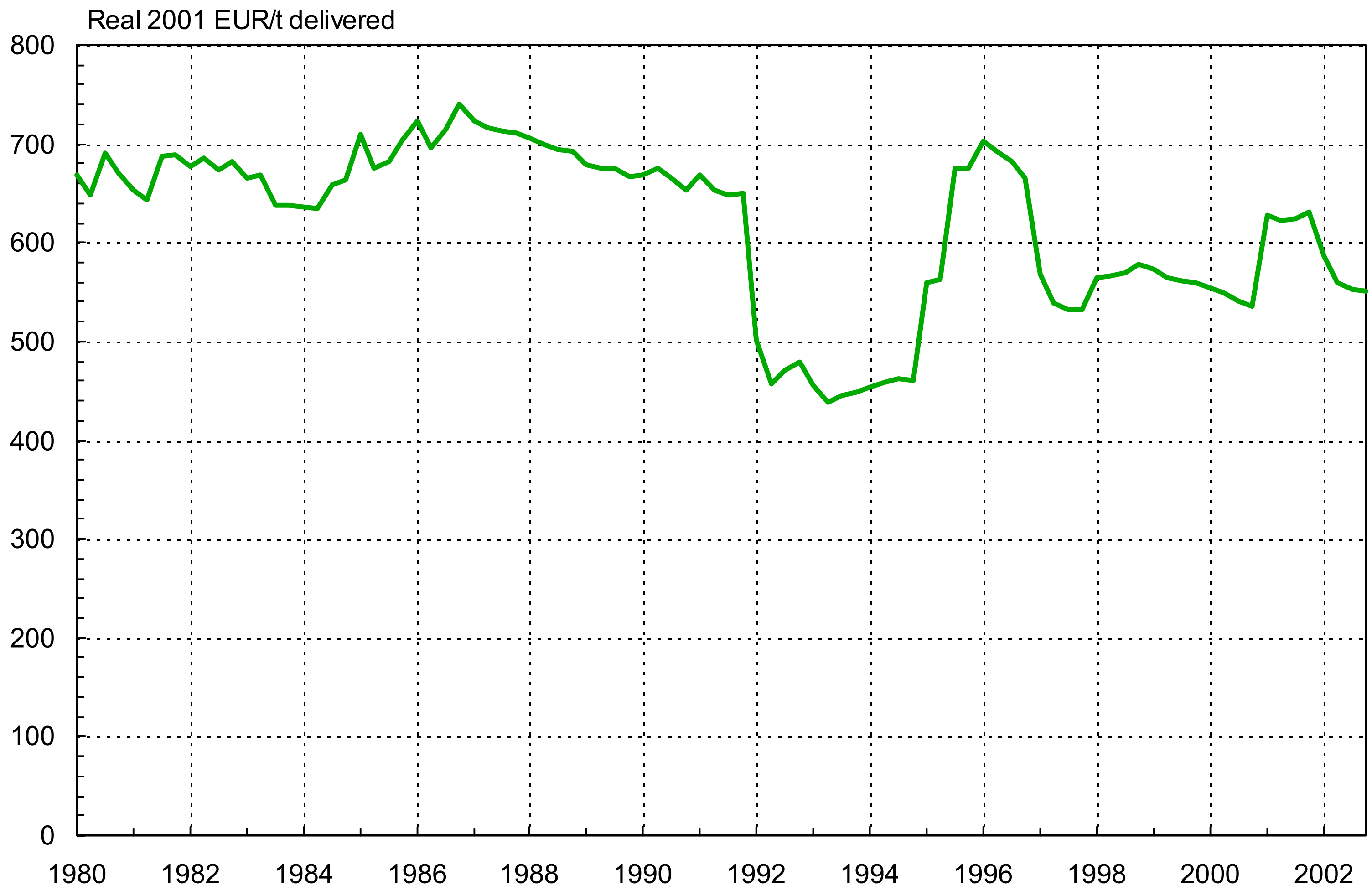
Real price of newsprint (45 gsm) in Germay

Project Number 52A0087



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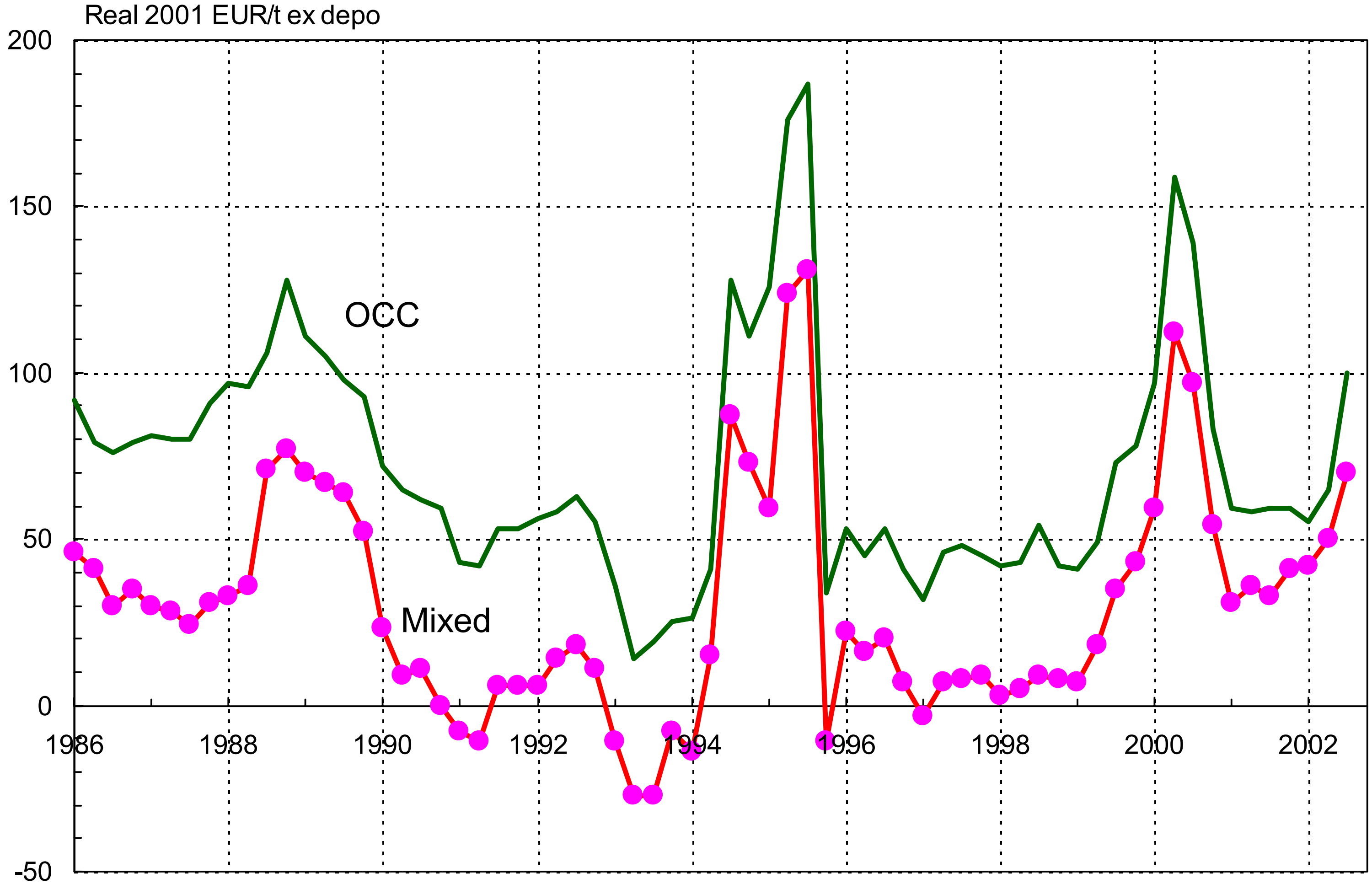
Real price of OCC/mixed waste in Germany

Wide fluctuations are typical for waste paper prices



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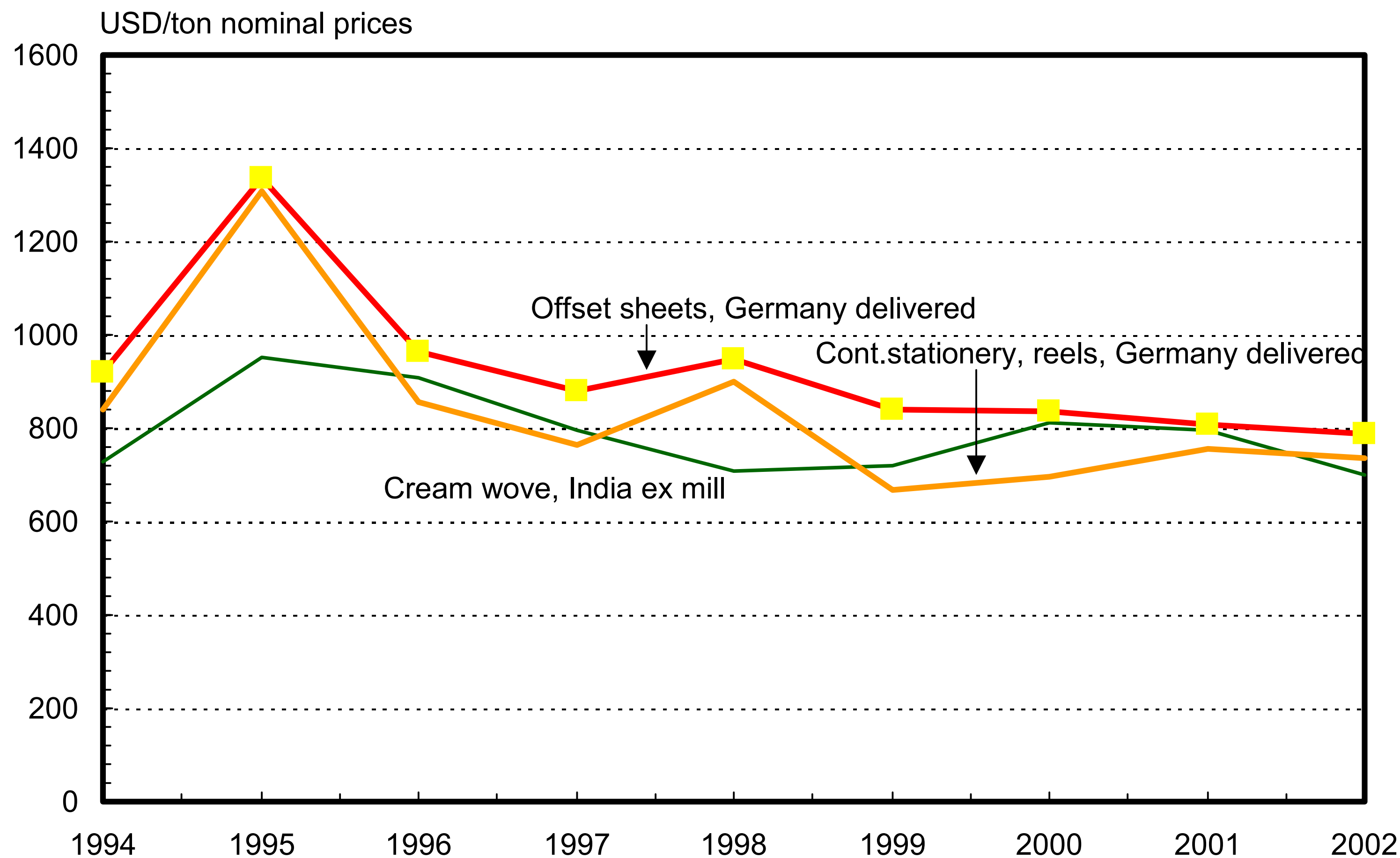
Uncoated woodfree prices

Project Number 52A0087

Indian ex mill prices have recently been close to German delivered prices



Paper price comparison

Except for newsprint, the current Indian delivered prices are higher than corresponding prices in Germany

Paper prices in India and Germany 2002/II

Grade	India Ex mill	India CENVAT 16 %	India Transport	Stockist fee 6%	India delivered price	Germany delivered price	Difference India-Germany
	USD/ton	USD/ton	USD/ton	USD/ton	USD/ton	USD/ton	USD/ton
Newsprint (imported)	400		20		420	525	-105
Creamwove 58 g/m2	694	111	20	49	874	770	104
Maplitho 70 g/m2	673	108	20	48	849	770	79
Offset/Agro	571	91	20	41	723	wood based 850	-127
Coated WF	810	130	20	58	1017	950	67
Copier	918	147	20	65	1150	900	250
Duplex, coated	670	107	20	48	845	800	45
Testliner, burst 25	347	56	20	25	448	370	78

Paper prices in India

There is a clear price differential between wood based and agro/recycled based grades

Paper prices in India 2002/II (ex mill)

Grade	India Wood based	India Agro/recycled
	1000 INR/ton	1000 INR/ton
Creamwove 58 g/m2	32.0-35.0	27.5
Maplitho 70 g/m2	32.5-33.5	
Offset		27.5-28.5
Copier	45.0	32.5-36.5
Duplex, coated		28.0-32.0
Greyboard		12.5
Linerboard, burst 25		17.0

Government Policies and Special Issues

Government policies and their impact

Policy	Objective	Impact
National forest policy	Ensure forest cover for the country	Not successfull for paper industry, shortage of wood
Small Scale Industry policy	Increase use of non forest based raw materials eg. by giving excise duty concessions	Fragmented industry, oversupply in the 1980s, several non competitive mills
Import duty policy	WTO commitment – opening up the market by lowering duties	Increasing international competition, cheaper imported raw materials and machinery for the industry, will lead to restructuring and consolidation of the industry
Environmental policy	Environmental protection	Closure of small agro based mills, which cannot meet the regulations
Exit policy	Facilitate closure of non competitive/polluting mills (BIFR, Bureau of Industrial Financing and Reconstruction)	Will speed up restructuring of the industry
Foreign investment policy	Allow direct investments to India	Foreign participation in paper industry is likely to increase
Literacy mission for education	Increase literacy/education levels	Increase in paper consumption
Energy policy	Uninterrupted supply of power at affordable costs	Still big variations in energy prices between states and problems in availability and quality of coal
Export incentive policy	Encourage exports (DEPB scheme)	DEPB rate for paper industry is still lower than that for other industries

Availability of critical inputs in India

Input	Availability	Recommended actions
Wood availability	Current plantations will not cover the industry needs Biggest deficit in softwood (long fibre), which is difficult to plant locally	Increasing plantations (degraded forestlands + farm/social forestry) Increasing imports of wood Fibre fractionation of bamboo (increase long fibre availability)
Waste paper	Local recovery does not cover fibre needs, waste paper will be available from international markets	Develope local recovery Allow duty free imports of waste paper, develope international sourcing Sorting of mixed waste paper Fibre fractionation to improve long fibre availability
Non wood/agro fibre	Good availability, but problems due to seasonal variations, transport costs, paper quality and environmental issues	Improve bagasse availability (energy subsidies limit the availability for paper industry) Develope non wood pulping technology Shut down of obsolete, non competitive mills
Papermaking chemicals/pigments	Basic chemicals are available from domestic market, but there is a high import duty for essential speciality chemicals. Quality of special local chemicals is often poor.	Import duty should be lowered eg. at the same level as duty for imported paper Foreign participation/know how for local manufacturing of speciality chemicals

Availability of critical inputs in India

Input	Availability	Recommended actions
Skilled labour	Availability of skilled labour is generallly not a problem in India. Also labour costs are lower than in several Asian countries.	Training could still be developed. CPPRI could have a central role in specialised training, which cannot be normally given at a company/mill level. Key personnel should visit foreign best practice mills.
Market access	Indian market has enormous growth potential, but international competition is increasing due to WTO agreement.	Competitiveness of the industry should be increased, which can only be done through major restructuring of the industry.
Technical know how	Good availability of Indian specific know how, lack of knowledge of international practices.	More international contacts. Better access to internet. Better training for new applications (eg. neutral sizing)
Financing	Investments in pulp and paper industry are generally high. Profitability of especially to smaller mills is low, and they have difficulties in getting capital from financial institutions.	Financial assistance from Government and international institutions like IMF and ADB Allow duty free imports of new pulping and papermaking machinery
Transport	Due to road conditions generally only 10 ton trucks can be used (reloading of eg. 20 tons containers is required) Ports are not well equipped for wood chip imports	Improvment of key roads and ports
Power	Availability and quality of coal is a problem, electricity costs from grid are high and vary regionally	Energy policy for paper industry need to be developed

WTO entry

Joining the WTO will mean further reduction of import duties. This will mean stronger competition from foreign mills in India. On the other hand it can mean local producers have better opportunities for getting more foreign financing and new technology sources.

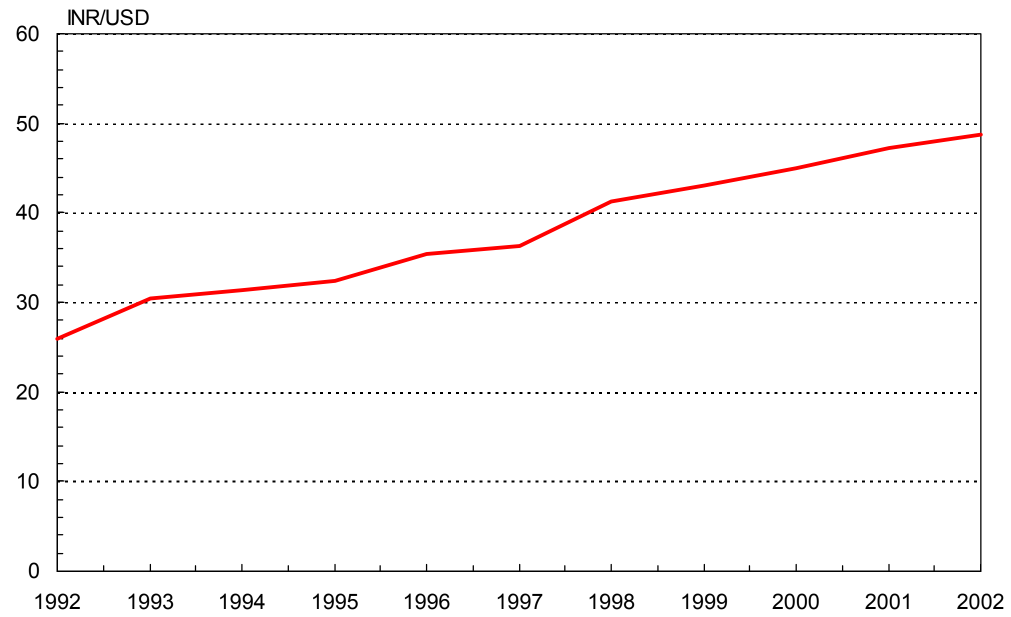
WTO entry will also mean more favourable trade conditions, and is likely to boost overall exports from India. This will increase the demand for certain paper grades like corrugating materials and duplex board.

To meet the demand for better quality papers and converted products, better raw materials, machinery, control and automation as well as know how will be needed. Local producers need to find foreign partners to gain these advantages. On the other hand foreign companies need local companies in order to get better access to distribution channels. Therefore the amount of joint ventures, partnerships, alliances and direct foreign investments is expected to increase after India’s entry to WTO.

Exchange rate development

- The long term trend for Indian Rupee has been to fall in value against the major currencies.
- This trend will increase the cost of imported raw materials and machinery.
- On the other hand exports of paper will benefit as in international markets paper is still mainly quoted in US dollars (or Euros)

Indian rupee vs. US dollar exchange rate



Environmental issues/investments

Environmental pollution control was introduced in India through legislative measures such as the Water Act 1974 and Air Pollution Control Act 1981. Boards have been set up at the central and state levels to administer the provisions of these acts and standards for air and water pollution.

In recent years the government has become more environmentally conscious and has begun to force industry to perform or close down.

Most large paper mills have adequate pollution control equipments. However, this is not the case with e.g. small agro based mills. Due to their size installation of chemical recovery systems is uneconomical. The minimum size for a chemical pulp mill with proper pollution control equipment is considered to be 33 000 tons or more in Indian conditions, which is still small by international standards.

It is estimated that some 1-1.5 million tons of capacity could be closed down due to environmental reasons. Some of the mills can change their raw material base to waste paper or purchased pulp, but for cost reasons this is feasible only for part of the mills.

Closing down a mill in India has recently become easier due to BIFR filing system

In China more than 4 000 polluting mills with a capacity of less than 5 000 t/a were forced to close down by State Council directives in 1996-97.The offending mills had no waste treatment facilities and they produced mainly poor quality packaging grades from non wood fibres such as straw. Also numerous printing and writing paper producing machines were closed down. Total capacity of the closed mills amounted to some 3 million tons. The capacity limit for pulp mill closures is expected to rise to 15-20 000 t/a

ECO – labels

Europe

European Union label is used in many products. In paper industry it is used e.g. in copy papers. Criteria are related to pulp and paper industry's emissions to water and air, bleaching methods, energy consumption, etc. AOX level should be less than 0.3 kg/ton of paper. Fibre raw material for paper should be waste paper or virgin fibre from sustainable managed forests.

Many European countries have additionally their own eco-labels.

Similar concept could be developed for Indian conditions using overall environmental impact of the mill as criteria. The fibre base could be wood, waste paper or agro, as long as the paper is produced with an environmentally acceptable process.

Waste paper legislation

Global trends

In North America the utilisation of waste paper has been below average. To encourage the utilisation of waste paper a minimum content of waste paper has been defined for newsprint and selected paper grades used by the government. However, the U.S. government is a relatively small user of printing and writing papers, as it does not purchase school books, text books, etc, like the Government of India. The utilisation of waste paper has increased in the USA, but mainly for other reasons (cost reasons+ improved waste paper processing technology).

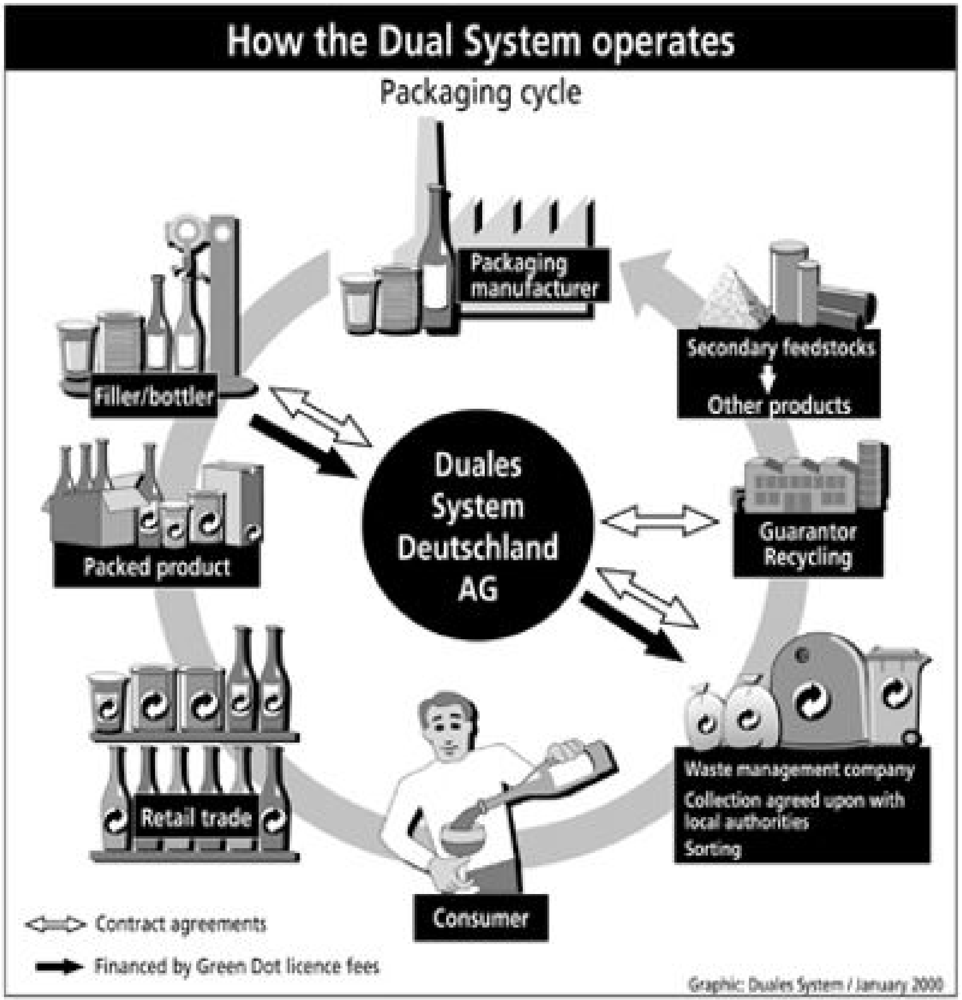
In Europe recycling quotas were considered for newsprint and printing and writing papers, but a different approach was selected. Industry has voluntarily taken actions to increase utilisation of waste paper, and this has proven to be a successful approach. In this way waste paper utilisation can be directed to applications where it best suits. On the other hand the landfill charges are rather high, which minimises the amount of waste paper to be put into landfill.

In the EU packaging directive there are regulations related to packaging material recycling and re-use. The aim of the packaging directive is to reduce the amount of packaging waste ending up to landfills, and thus the collection of packaging waste is well organised in most EU countries (see German system in the following chart).

Indian situation

In India the problem is different than in the USA and Western Europe. Practically all waste paper is collected, but it has better paying alternative uses than paper industry. Fot this reason the recovery rate for paper industry is only about 20 %. It is difficult to increase the collection by legislation. Educational campaigns in the schools can be arranged, which can have a positive long term effect. Also paper companies can actively source waste paper from big users (printers, converters, industry (which purchases/imports components in corrugated boxes), shopping centres, etc.).

German Dual System - Example



Environmental Issues

In India the environmental standards focus on the discharge measured per liter of water, whereas in Europe the BAT (Best Available Technique) standards are related to kg pollutant per ton of paper produced.

Liquid effluents discharge standards in Indian pulp and paper mills

Parameter	Large Mills Above 24000 T/year	Small Mills Upto 24000 T/Year	
		Agro based	Waste Paper based
Volume, m^3/T	**175 pulp & paper mills (150 rayon grade/ news print)**	**200 (150)**	**75 (50)**
pH	**6.5 - 8.5**	**5.5-9.0**	**5.5-9.0**
BOD_5 at 20^0C mg/l	**30**	**30**	**30**
COD mg/l	**350**	**---**	**---**
SS mg/l	**100**	**100**	**50**
TOCl *kg/T paper	**2**	**---**	**---**

Figures in bracket are for new mills set up after 1992
***   From January 1992**

Source: EPA Notification (GSR 93(E) dt feb. 21. 1991)

Environmental Issues – BAT in Europe

The BAT (Best Available Technique) emission levels in non-integrated woodfree mills refer to yearly averages and exclude the contribution of pulp manufacturing. Although these values refer to non-integrated mills they can also be used to approximate emissions caused by papermaking units in integrated mills. The waste water flow is based on the assumption that cooling water and other clean water are discharged separately.

Emission levels with the use of BAT – non integrated mills

Parameters	Units	Uncoated and coated woodfree
BOD	kg/t of paper	0.15-0.25
COD	kg/t of paper	0.5-2
TSS	kg/t of paper	0.2-0.4
AOX	kg/t of paper	<0.005
Total P	kg/t of paper	0.003-0.01
Total N	kg/t of paper	0.05-0.2
Flow	m3/t of paper	10-15

Note: there are regional/local differences in application of environmental standards in Europe

Environmental issues – BAT in Europe

For mechanical pulp and waste paper based mills the emission levels refer to yearly averages. In mechanical pulping the ranges of COD depend on the fibre furnish and share of peroxide bleached pulp (upper limits are valid for mills with high proportion of peroxide bleached TMP). The waste water flow is based on the assumption that cooling water and other clean water are discharged separately.

Emission levels with the use of BAT – mechanical pulp and waste based mills

Parameters	Units	Integrated mechanical pulp/paper eg. newsprint	Waste based mills with deinking eg. newsprint	Waste paper based mills no deinking eg. testliner
BOD	kg/t of paper	0.2-0.5	<0.05-0.5	<0.05-0.15
COD	kg/t of paper	2.0-5.0	2.0-4.0	0.5-1.5
TSS	kg/t of paper	0.2-0.5	0.1-0.3	0.05-0.15
AOX	kg/t of paper	<0.01	<0.5	<0.5
Total P	kg/t of paper	0.004-0.01	0.005-0.01	0.002-0.005
Total N	kg/t of paper	0.04-0.1	0.05-0.1	0.02-0.05
Flow	m3/t of paper	12-20	8-15	<7

Note: there are regional/local differences in application of environmental standards in Europe

AOX discharge levels in India 2002

In India AOX levels kg/ton of paper are close to the European standards for dissolving and newsprint mills, but clearly higher for most other paper mills.

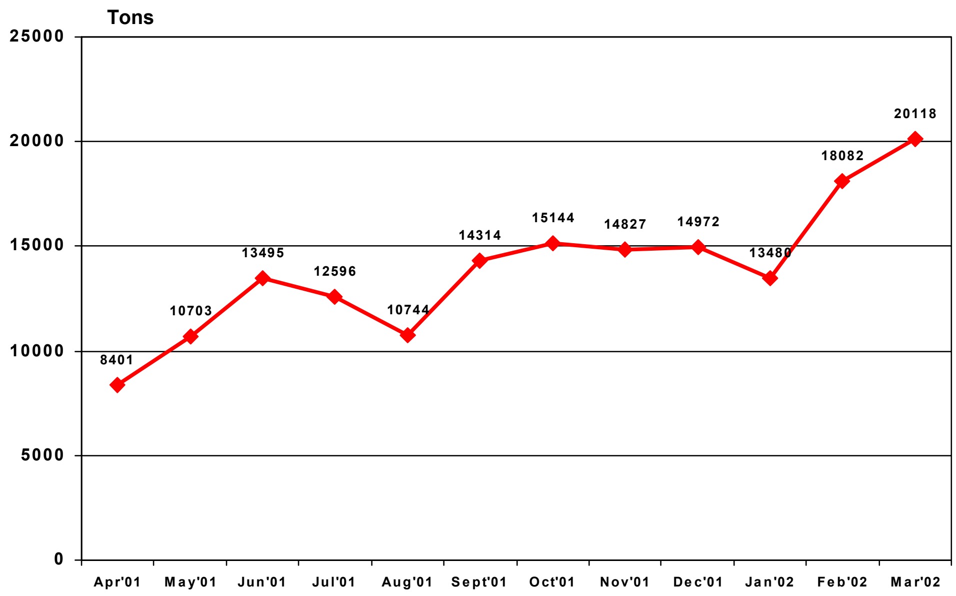
Mill type	AOX level kg/ton of paper
Dissolving/rayon grade pulp	<0.5
Newsprint	<0.5
Large paper mills	1.0-2.5
Medium and small paper mills	**4.0-6.5**
Finland average	<0.2

Source: CPPRI Studies

Export incentives

The recent trend in paper and board exports has been rising. However, DEPB rate for paper industry is currently 6 % (3 % for duplex board), which is considerably lower than DEPB rate for other industries

Monthly exports of IPMA mills



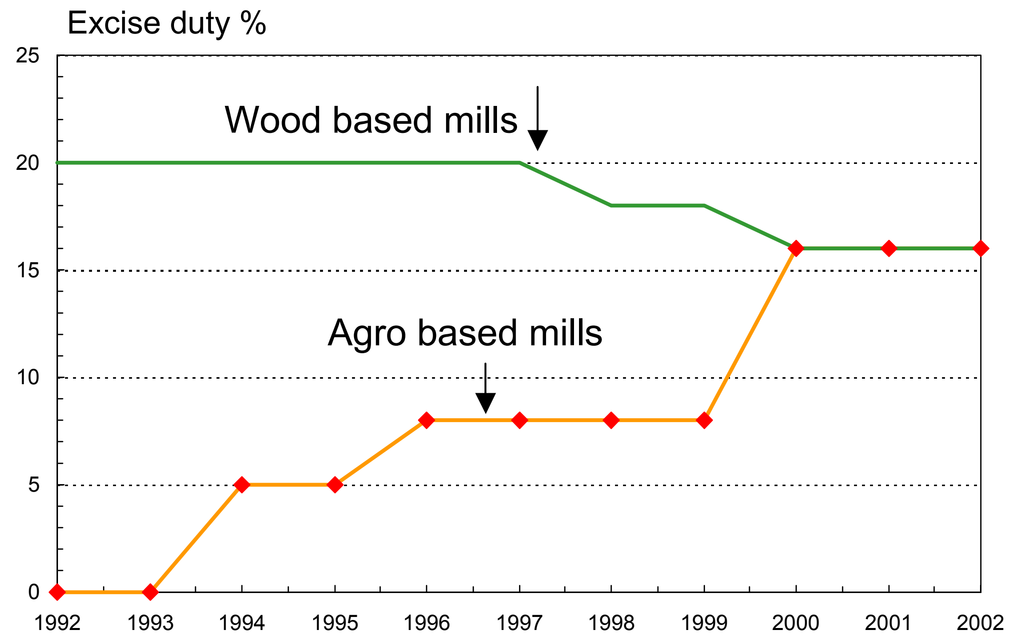
DEPB rate

ITEMS	DEPB %
Lamps & Tubes	14
Nut & Bolts	13
Carbon steel	17
Alloy & S steel	20
Galvanized pipe	17
Auto Tyres	19
Bicycle Tubes & tyres	20
Acrylic Sheet	18
Articles Made of PP	18
Rubber & canvas shoes	13
Readymade Garments	14
Black & White T.V.	16
Colour T.V.	20

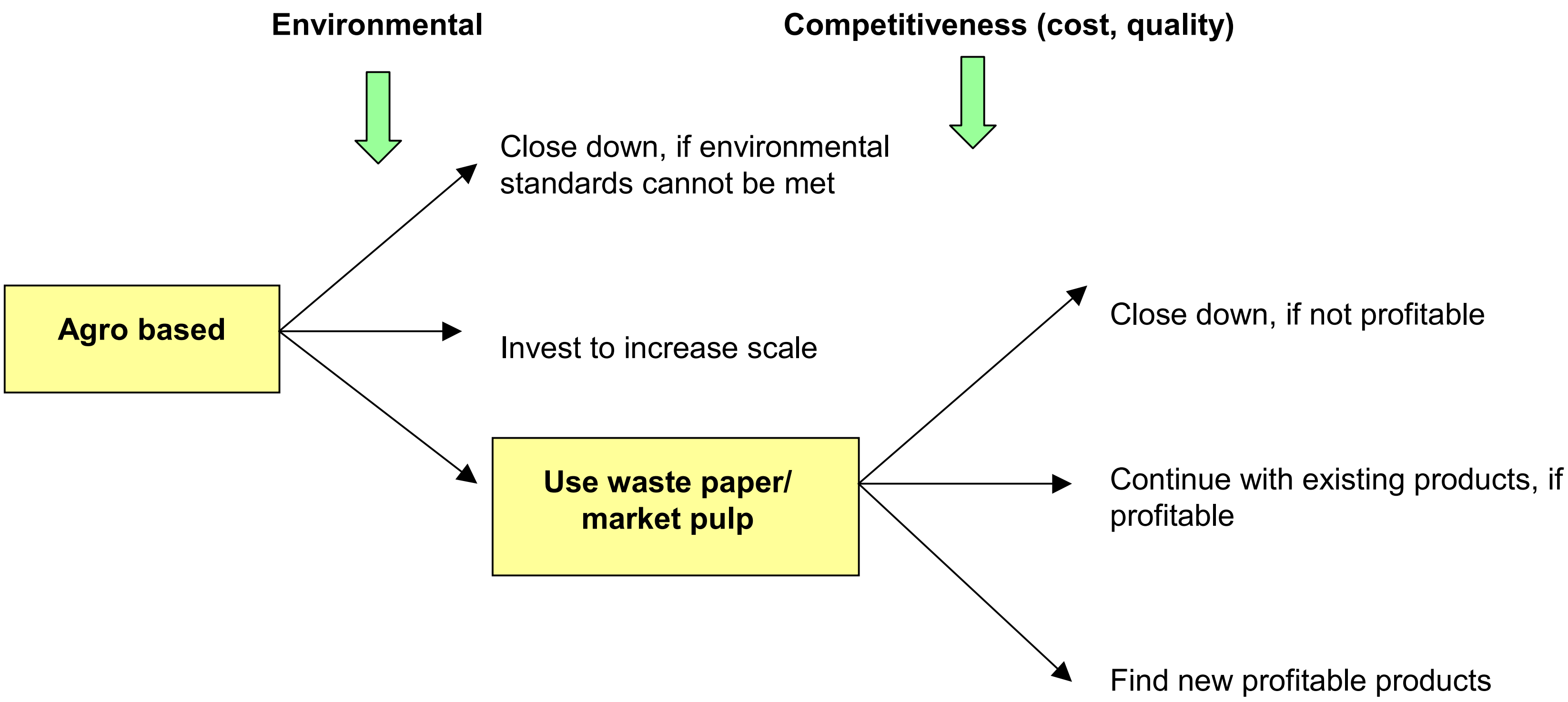
Excise duty development

- The excise duty of agro based mills was NIL until 1993, but since then it has been gradually rised to the same level as the duty for wood based mills.
- However, in 2001-02 the Excise Duty is NIL for initial 3500 tons and thereafter 16%

Excise duty development

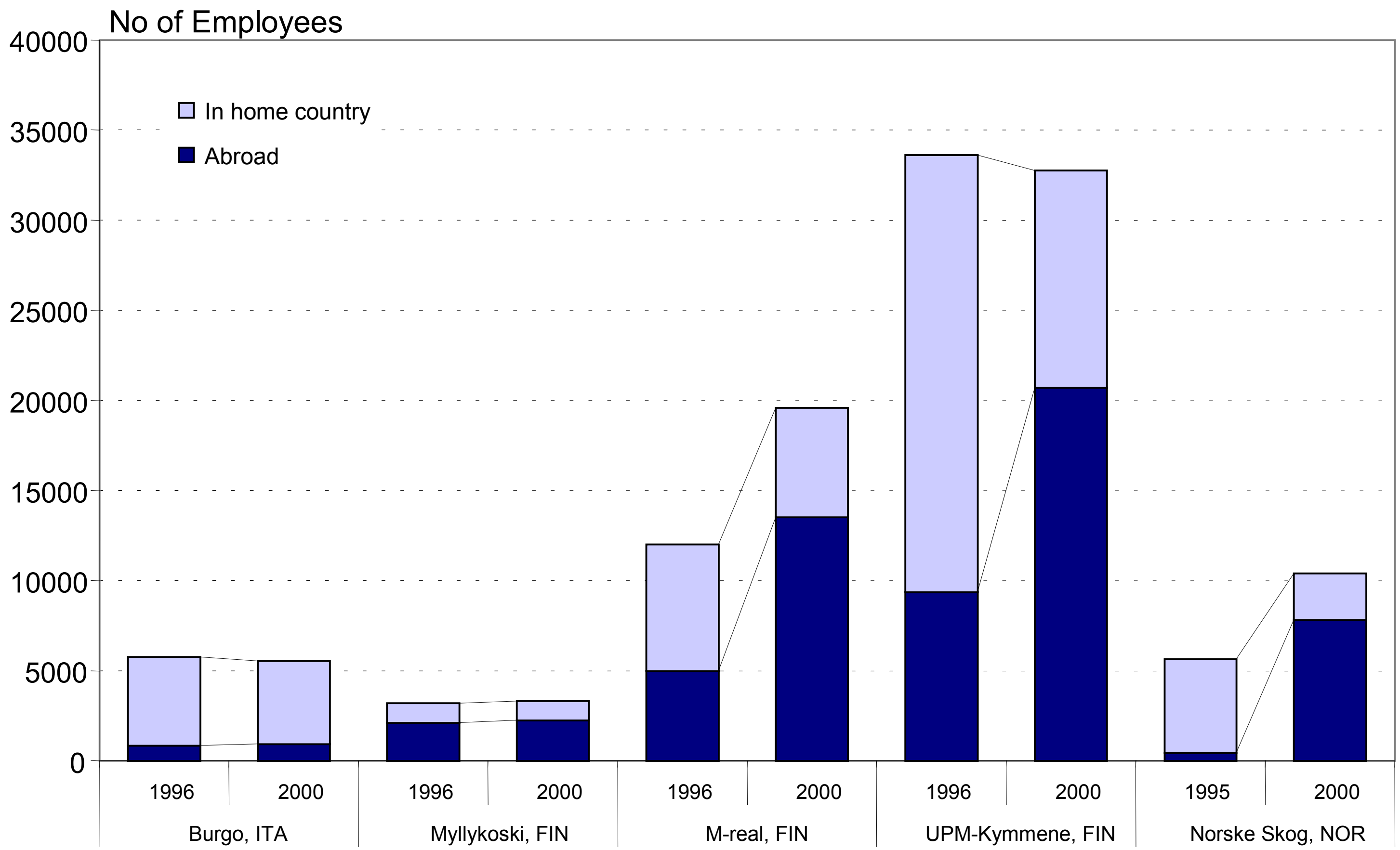


Small Scale Industry – development options



Globalization of Leading Companies

Large industry players are getting global fast with a greater share of employees being located abroad. The graph below illustrates the development based on the data from Nordic companies. For example, the personnel in the home country with UPM-Kymmene has dropped from 24 000 in 1996 to 12 000 in year 2000 and at the same time personnel with foreign operations has doubled to 21 000.



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Annex I

Demand Forecasting Methodology

Demand forecasting mehtodology

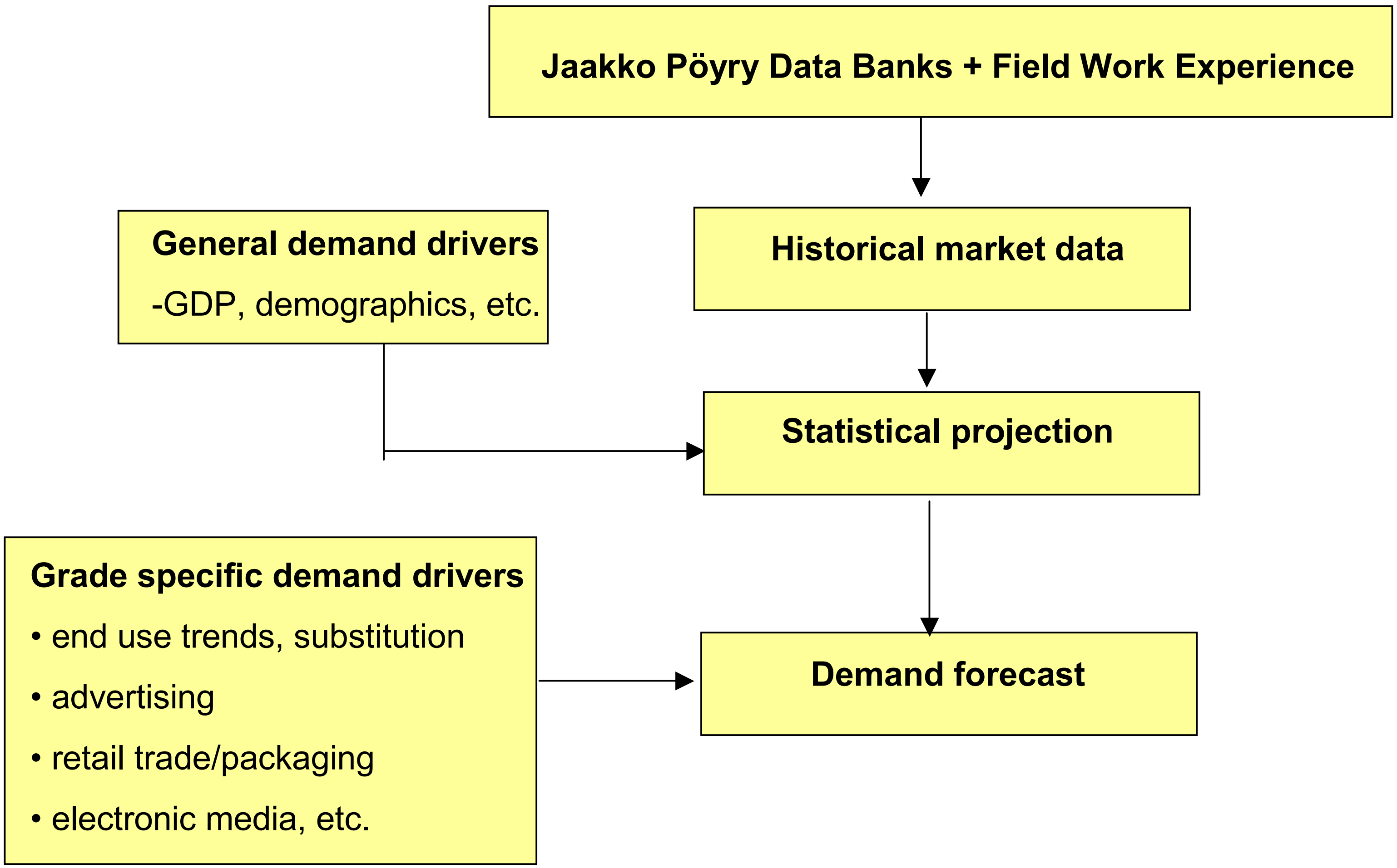
Basic approach

JPC's approach to forecasting paper consumption involves a number of techniques, models and analyses that are inter-linked with each other throughout a phased testing and adjustment process. Strictly quantitative forecasting techniques are typically employed for estimating the first-round projections of demand, supply and trade. The results of these projections are reviewed by an expert panel with the objectives of fine-tuning the key assumptions of the forecasts, and introducing additional factors into the analysis relating to certain paper grades or other subsets of data. Comparisons are made between countries in different phases of the paper consumption and income levels.

The available data obviously condition the structure of paper consumption models. The global consistency of main economic and demographic indicators and paper demand allows the use of pooled cross-section and time series analysis for major grade groups such as newsprint, printing and writing papers, tissue and packaging papers and paperboards.

Demand forecasting methodology

Jaakko Pöyry demand forecast is a combination of statistical projection combined with end use analysis



Stages of demand forecast

The demand analysis consists of seven stages:

1. Identification of demand drivers by main grade
2. Estimation of historical relationships between paper consumption and economic/demographic development by main grade using pooled cross-section and time series data
3. Establishment of forecast values for the explanatory variables
4. Estimation of first-round forecasts for paper demand by main grade
5. Estimation of second-round forecasts for paper demand by grade by introducing more detailed grade and country specific variables into the demand analysis
6. Expert panel review of the second-round results
7. Finalisation of demand forecasts by grade

Demand forecasting methodology

First round forecasts

The first-round forecasts for future paper and paperboard demand by main grade are based on pooled cross-section and time series analysis. About 170 countries over the period 1980-2000 are used as a comparative base. The estimation of historical relationships between paper consumption and GDP per capita are made by main grade, including newsprint, printing and writing papers, tissue and packaging papers and paperboards. The general form of the model can be expressed as follows:

$\log C_{it} = \log a + \beta \log G_{it} + \Sigma D_i + e_{it}$, where

Cit = consumption per capita in year t and country i

Git = GDP per capita in year t and country i

Di = dummy variable for country i

eit = error term

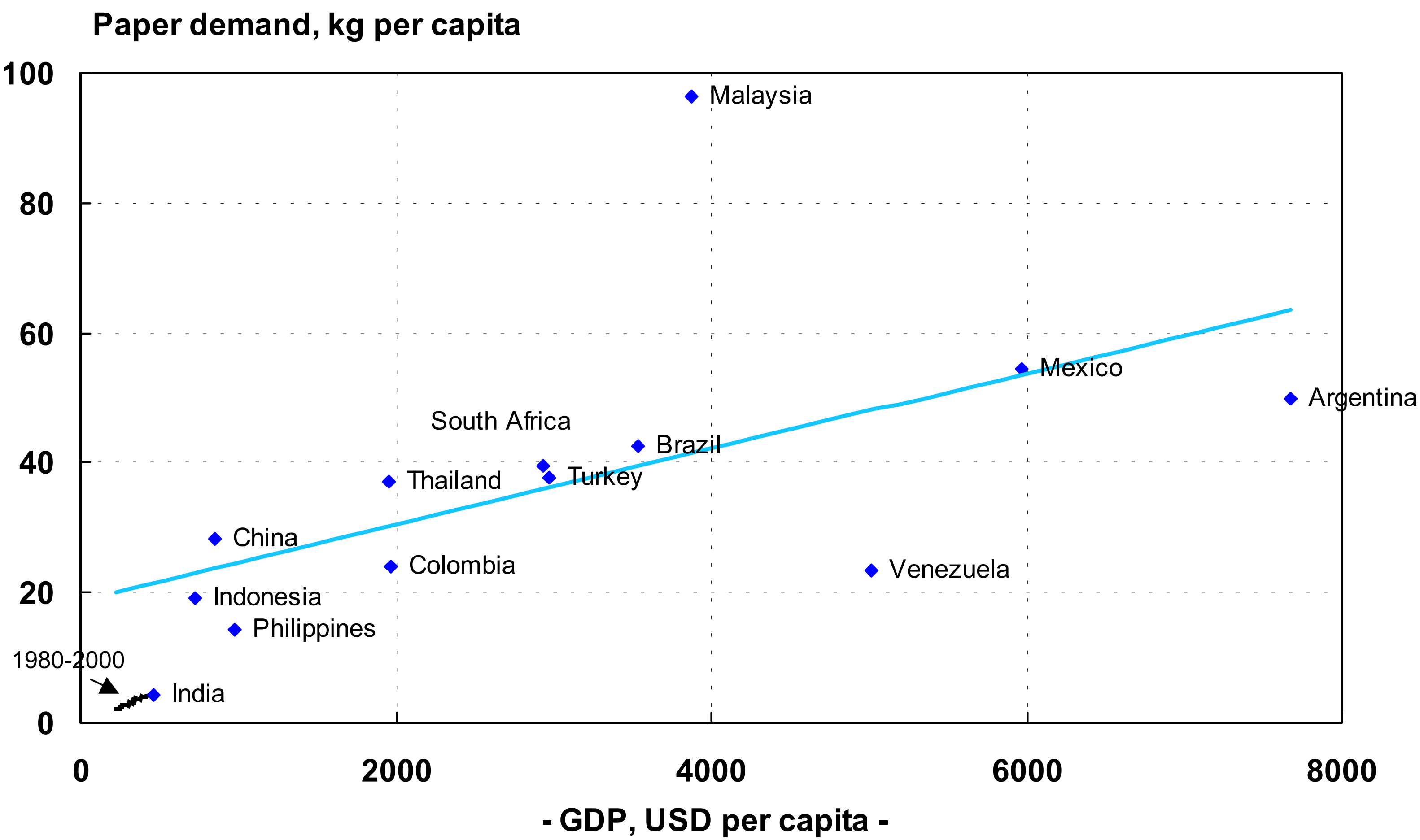
The main advantages of the above approach are the simplicity and the general applicability of the model. However, econometric models represent only an extrapolation of historical relationships that may not hold in the future. Under these circumstances, considerable judgement – taking into account grade specific demand drivers and substitution effects - will be necessary to adjust the first and second round projections into final consumption forecasts.

Final demand forecast is a synthesis and combination of statistical and end use based forecasts.

GDP and Paper Consumption per Capita 2000

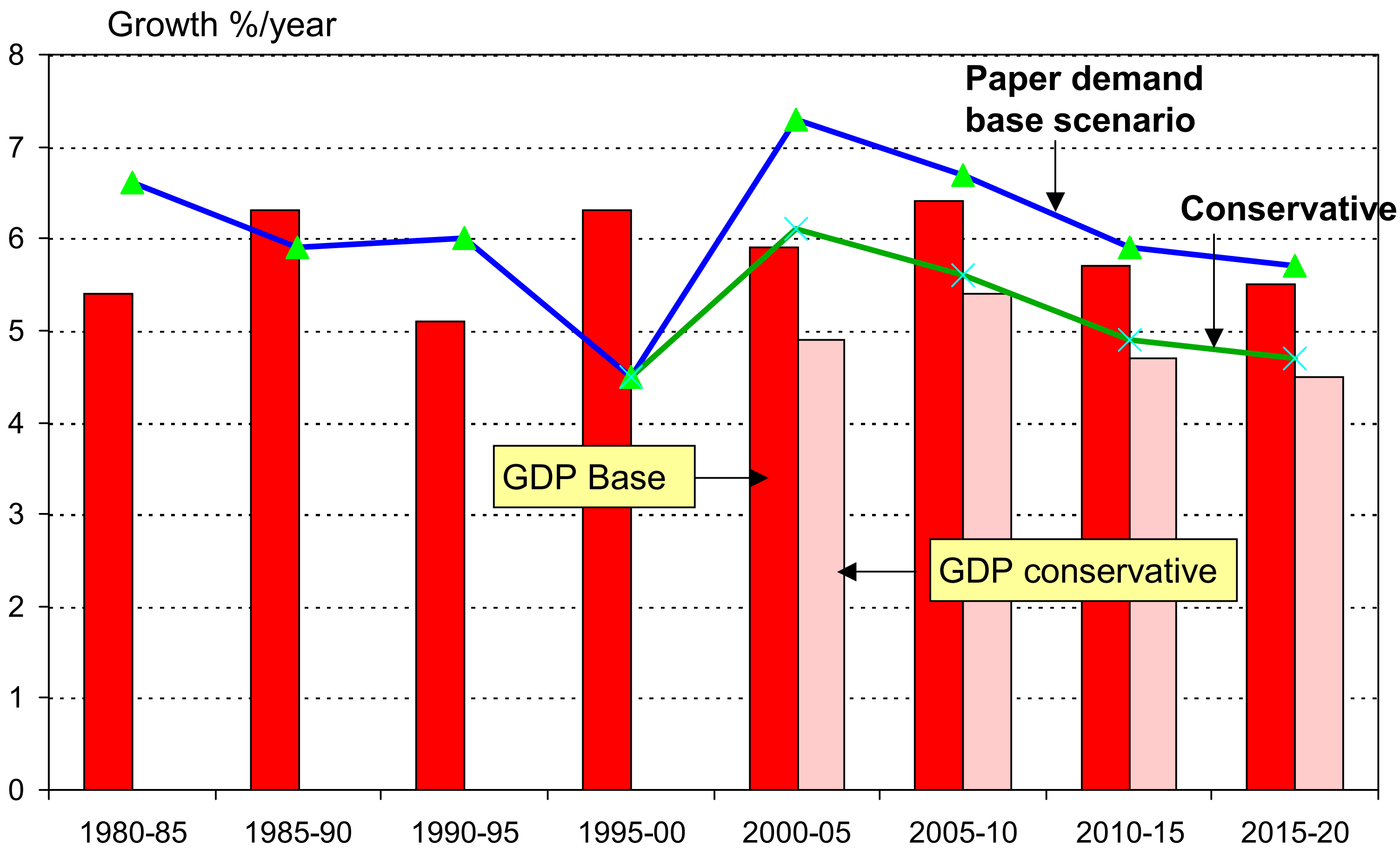
Project Number 52A0087

In selected low and medium-income countries



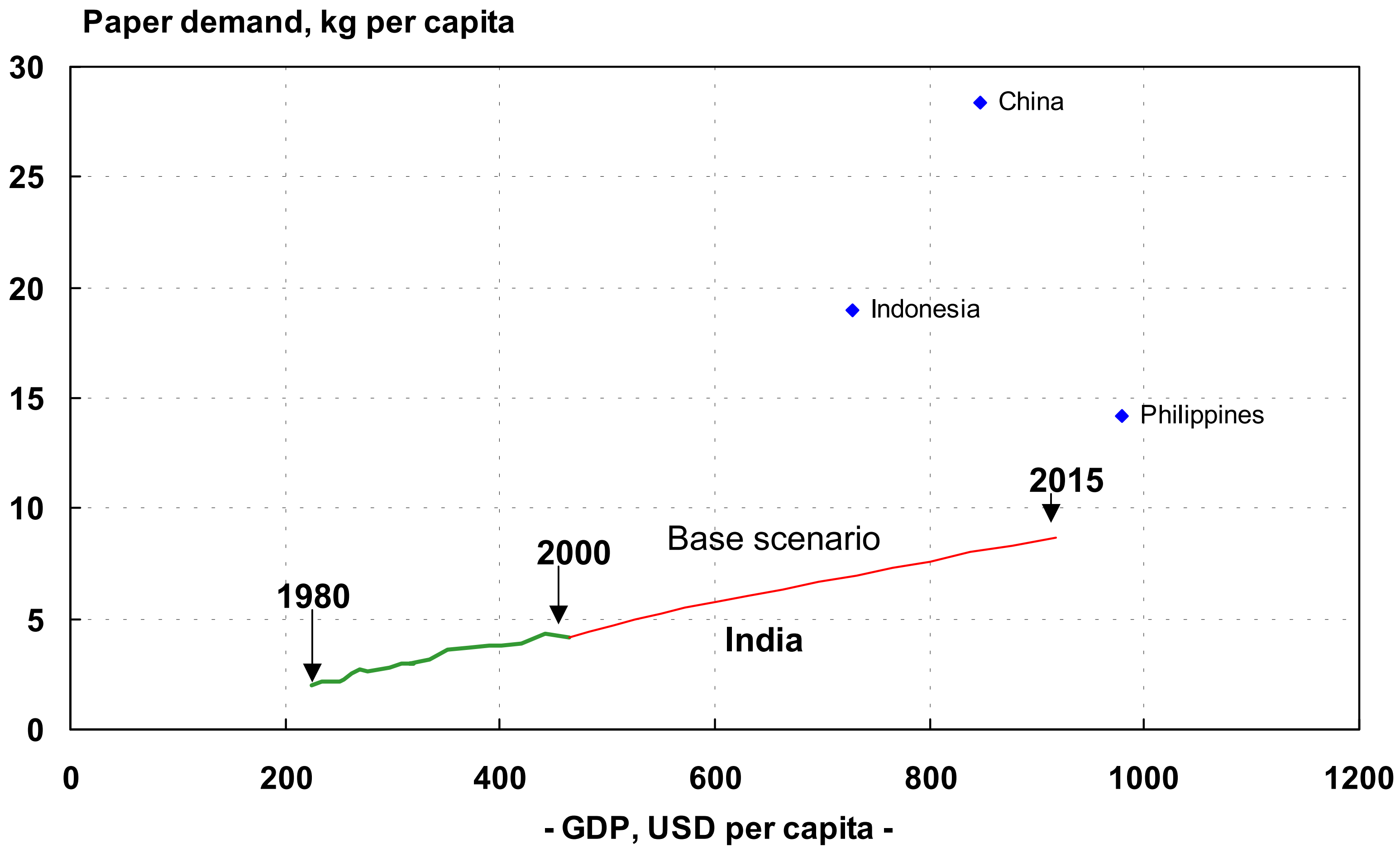
Paper demand forecast – basic assumptions

Two demand scenario were made based on different GDP growth assumptions



GDP and Paper Consumption per Capita 2000

In selected low and medium-income countries



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Demand forecasting methodology

Second round forecasts

The role of the expert panel is to convey the visions of the industry and end uses into the forecasting process so that the essence of semi-quantitative and qualitative market information available from recent field studies and industry interviews are taken into consideration and utilised to the extent possible. This includes the evaluation of the most up-to-date information on the following market related issues:

- End-use trends in specific grades
- Shifts in advertising and media mix trends
- Raw material potential (like lack of suitable raw material for LWC paper in India)
- Changes in trade barriers and their impact on market patterns
- Changes in institutionally imposed market regulations
- Impact of new technology and innovations with particular reference to their impact on manufacturing costs and product pricing
- Substitution trends between different paper grades and between paper and other materials and systems

Grade specific demand drivers, end use and substitution trends are discussed in section 1.2. of the report.

Annex II

Cost Estimation Methodology

Cost estimation methodology

The cost structures of the existing mills have been estimated with the Mill Model developed by Jaakko Pöyry Consulting Oy. The estimation is based on the technical analysis of the mill and on the economic analysis of the region in which the mill is situated. The costs are divided into variable, fixed and distribution costs and capital charges.

Technical Analysis

The technical analysis is based on the following input data for each mill.

Mill Parameters

- total capacity
- production lines and capacities
- start-up years

Pulping Process Parameters

- pulping processes, capacities and ages of pulping lines
- bleaching method and age of equipment
- drying machine capacities and ages
- recovery boiler capacities and ages

Paper and Paperboard Mill Parameters

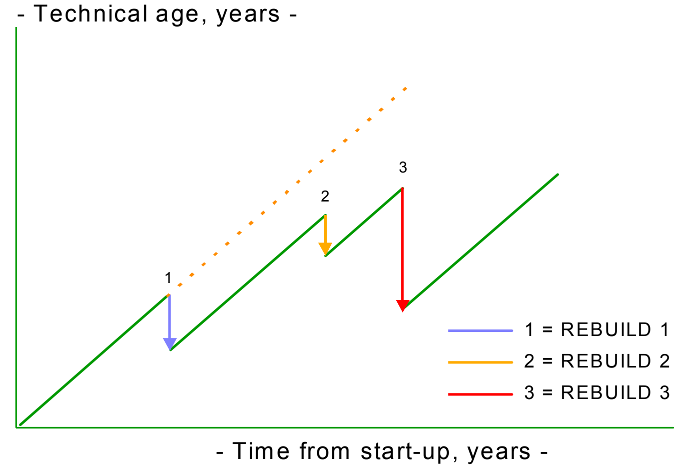
- furnish and product mix by machine
- capacity and age by machine
- degree of rebuilds per machine

Cost estimation methodology (cont.)

Rebuilds can significantly change the technical age and consumption figures of a machine. A theoretical parameter, "technical age", has therefore been defined. This parameter reflects the timing and nature of any rebuilds. Several consumption figures are assumed to be functions of technical age.

The paper machine technical age is calculated using the timing and nature of rebuilds carried out in individual machine sections. The paper machine gets older linearly over time, and the technical age is assumed to be reduced by rebuilds as shown in the figure below. The maximum technical age in the model is, however, limited to 30 years.

TECHNICAL AGE
"REBUILDS REJUVENATE MACHINE"



Cost estimation methodology (cont.)

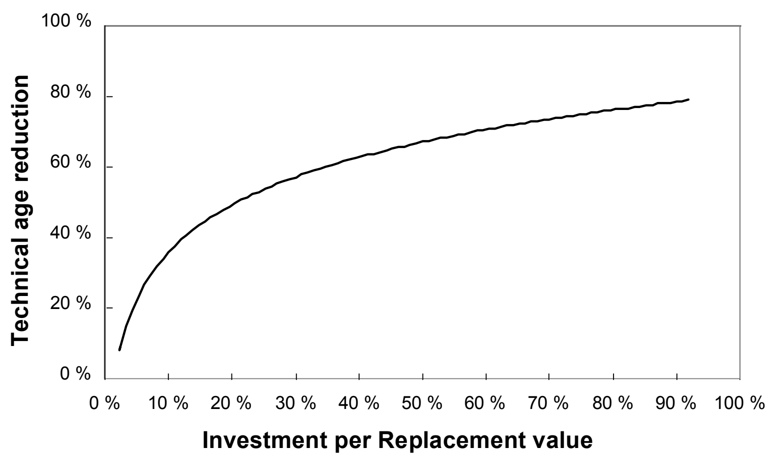
The basic method used to evaluate the technical age of a BM is directly based on the rebuild measures carried out. The BM is divided into functional sections (wire, press, etc.) and the scope of the rebuild in each section determines the reduction of technical age. Each rebuild measure has a weighting coefficient and the total reduction of the technical age as a consequence of the rebuild is calculated as shown in the equation below.

T = Technical age reduction

x_i = Weight for single rebuild measure

n = Number of single measures

The figure below shows the estimated average relationship between technical age reduction and investment cost.



Cost estimation methodology (cont.)

Production Costs

Material flows and energy balances as well as personnel requirement are estimated based on the technical analysis. Manufacturing costs are then calculated using regional average unit prices. Manufacturing costs consist of variable costs (fibre, chemicals, energy, operating materials and packaging) and fixed costs (personnel, maintenance materials and general overhead).

Distribution costs

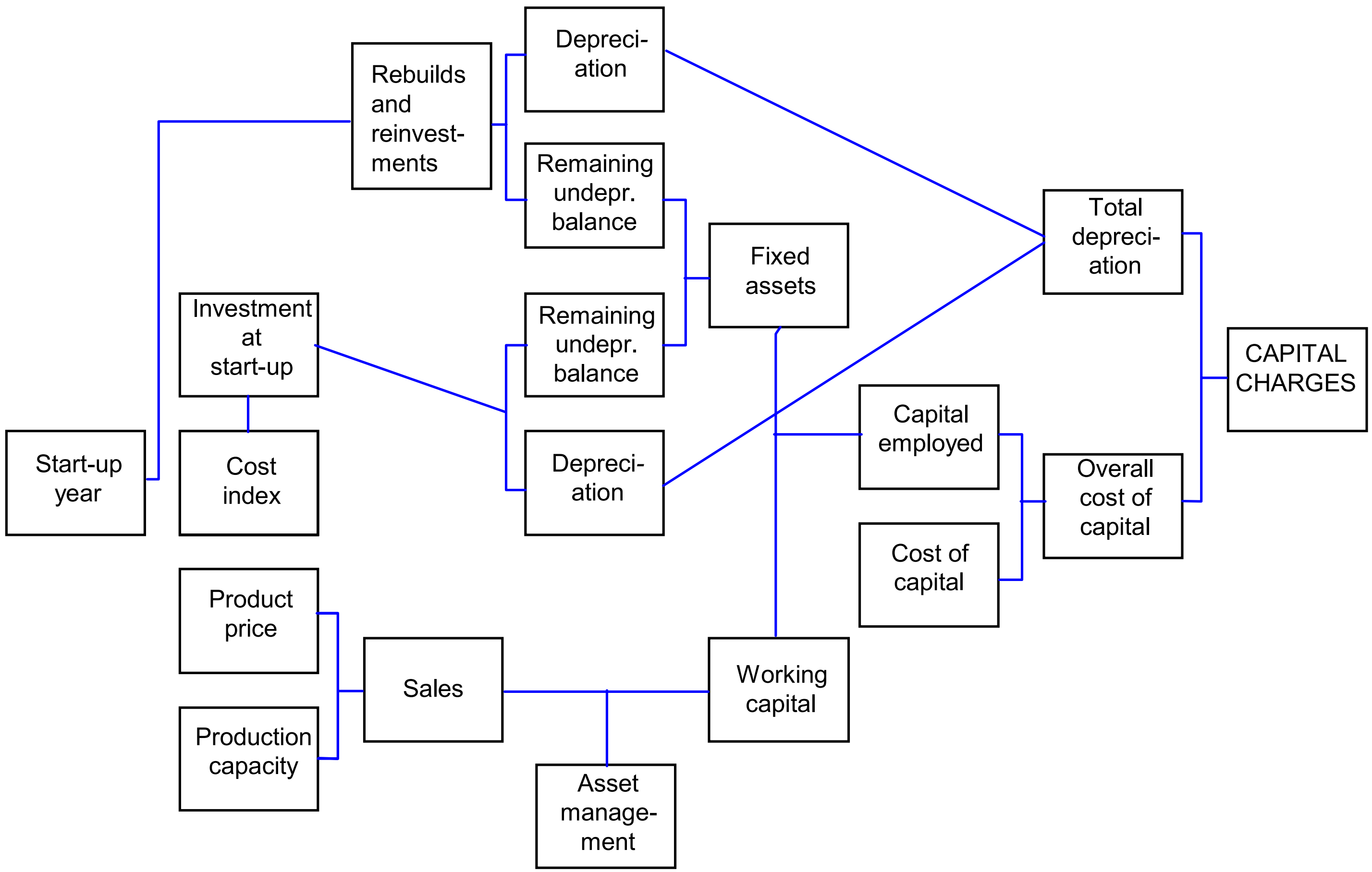
The transport cost consists of inland and sea freights, handling costs and insurances. In addition, a sales commission of approximately 2.5-3% is added.

Capital Charges

The method of calculating the capital charges is presented in the figure on the next page.

Cost estimation methodology (cont.)

CAPITAL CHARGES OF A MACHINE



Cost estimation methodology (cont.)

Replacement value is the amount of capital needed to replace the existing machine with a new one with the same dimensions. The mill size and the number of the production lines are taken into consideration.

The cost index is used to estimate the start-up and rebuild investments.

Reinvestments are investments that are too small to be considered rebuilds, i.e. they are investments necessary to keep the mill running without any production increase. The reinvestments are assumed to increase as the mill or the production line gets older. They increase from 1% of the replacement value for a new mill to 2% for a 30-year-old mill.

The working capital is estimated as a percentage of sales.

Depreciations are based on straight-line depreciation during 15 years for machinery and during 30 years for buildings.

Interests have been calculated as return on capital employed (ROCE). Capital employed includes start-up and rebuild investments plus working capital and reinvestment minus cumulative depreciations.

Cost estimation methodology (cont.)

Jaakko Pöyry Cost Estimation Method