PAPER THROUGH TIME

Tracking the industry's progress

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FOREWORD

The idea of the Green Rating Project (GRP) was born in the mid-1990s when the founder-director of Centre for Science and Environment (CSE), Anil Agarwal, first read about the work of a US-based non-government organisation, Centre for Environment Protection (CEP). CEP, as an independent assessor of environmental performance of companies, was pushing businesses to voluntarily become responsible. With India having just entered the era of industrialisation, the idea of a green rating of its industrial sectors to safeguard the interests of the environment took root. The objective, rigorous and transparent nature of the rating along with the public disclosure of its findings made CSE's GRP one of a kind in the country. Since its inception in 1997, the GRP has rated five major industrial sectors: pulp and paper (1999 and 2004), automobile (2001), chlor-alkali (2002), cement (2005), and iron and steel (2012).

The pulp and paper industry was the very first sector to be rated under the GRP in 1999. Since then the Indian pulp and paper industry has come a long way. Being the first sector to go through the rigorous Green Rating exercise, companies were slow to participate. It took nearly a year of persistent follow-up to gather a reasonable number of companies to be a part of the project. When CSE decided to rate the sector for the second time in 2004, there was a marked difference in the attitude of the companies: 90 per cent of the respondents voluntarily participated.

With almost a decade gone by since the last ratings, CSE has decided to take stock of the pulp and paper sector. This time, the response from the industry has been as phenomenal: a single phone call was all that was required for 90 per cent participation. But the idea behind the current survey is different from the past exercises. The intention is not to rate individual companies, but to provide a picture of the industry's overall environmental performance. To do this, we picked 12 large-scale integrated wood-based plants from the companies that responded. For the sake of convenience, in various instances in this document, the three studies done by CSE have been titled GRP 1, GRP 2 and GRP 3. This does not mean the survey done this time, for the period between 2012-2013, is a rating exercise.

This study tells us how the paper industry has progressed in terms of key parameters: industry growth (capacity, demand and production); resource utilisation (raw material, water and energy); process (technology and chemical use); and pollution load. We realise that the data presented in the report may allow comparison across companies for individual parameters; however, we reiterate, our focus is to understand the overall progress of the industry. There are major learnings from this exercise and we hope that these will be internalised by the industry and the government for charting a sustainable future for the industry.

The sample

The 12 integrated mills we chose for this study accounted for 21 per cent of the total production of the industry in 2012-13 and are spread over 10 states. The oldest mill is Ballarpur Industries Limited (BILT)-Shree Gopal which was established in 1936, and the newest is BILT-Sewa. All the mills had participated in the previous Green Ratings of the pulp and paper industry carried out in 1999 and 2004. The mills in the sample use wood predominantly, as their raw material. Large wood-based integrated mills were found to be among the most resource-intensive and polluting mills in the Indian paper industry during the previous rating. Therefore, the performance of the mills in our sample highlights not only their individual progress, but that of the industry as a whole.

Map 1: Locations of the sample mills

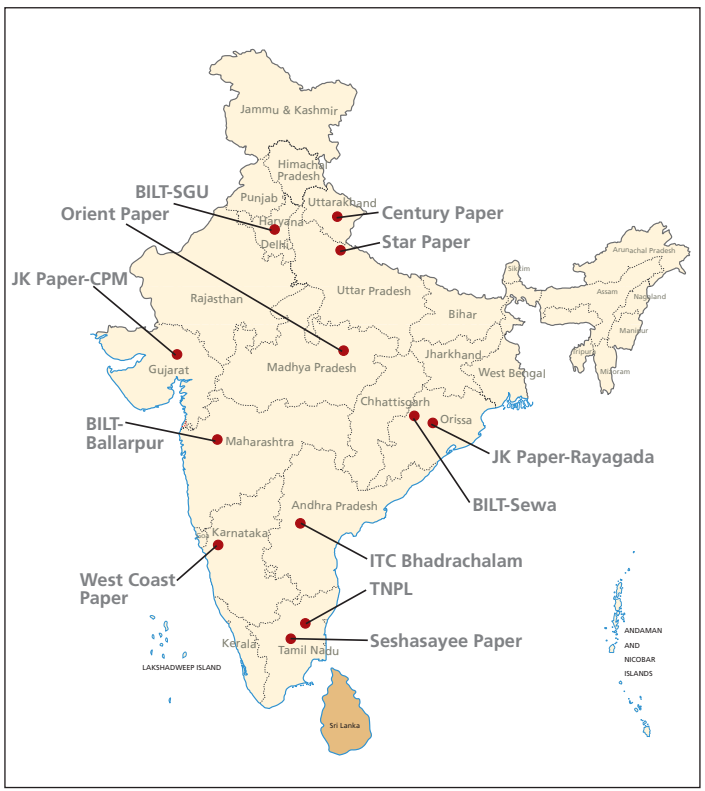


Table 1: The 12 mills account for 21 per cent of India's production

Name of mill	Location	Year of establishment
BILT-Shree Gopal Unit (BILT-SGU)	Yamunanagar, Haryana	1936
BILT-Ballarpur	Ballarshah, Maharashtra	1953
BILT-Sewa	Gaganpur, Odisha	1991
Tamil Nadu Papers Ltd (TNPL)	Karur, Tamil Nadu	1984
JK Paper Ltd-Central Pulp Mills (JKP-CPM)	Tappi, Gujarat	1966
ITC Ltd-Bhadrachalam Unit (ITC Ltd)	Bhadrachalam, Andhra Pradesh	1979
Seshasayee Paper	Erode, Tamil Nadu	1960
Orient Paper	Shahdil, Madhya Pradesh	1965
Star Papers	Saharanpur, Uttar Pradesh	1938
Century Pulp and Paper	Nainital, Uttarakhand	1984
West Coast Paper Mills (WCPM)	Dandeli, Karnataka	1955
JKP- Rayagada	Rayagada, Orissa	1962

CAPACITY

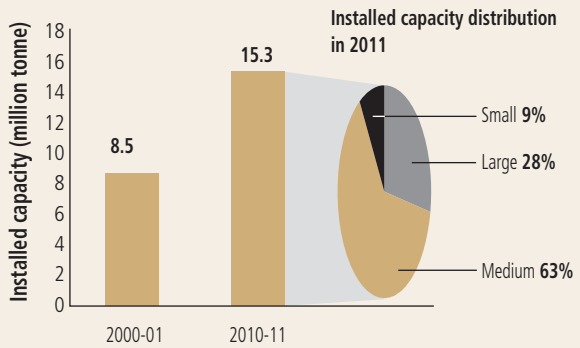
Paper industry: The growth trajectory

From just 17 mills in 1951 with a capacity of 0.14 million tonne (MT), the industry has grown to 825 mills with a capacity of 15.3 MT. Since 2001, the total installed capacity of the industry has grown at a compounded annual growth rate (CAGR) of 6 per cent.

Large-scale mills (with capacity greater than 100,000 tonne per annum or TPA) constitute only 5 per cent of total number of mills. However, they contribute to 28 per cent of the installed capacity. While medium-scale mills (with capacities between 10,000 to 100,000 TPA) contribute to 63 per cent of the industry's capacity, the contribution from the large number of small-scale mills (with capacity below 10,000 TPA) is only 9 per cent.[1]

Essentially, the industry is fairly concentrated, notwithstanding the presence of a large number of small-scale mills. In 2012, around 88 mills in the industry with capacities higher than 50,000 TPA contributed to 53 per cent of the industry's total capacity. This characteristic has been long-standing: In 2002, mills with capacities higher than 50,000 TPA produced nearly 59 per cent of the India's total pulp and paper.

Graph 1: Installed capacity – 6 per cent growth since 2001



[1] Anon 2011, *Inpaper-Directory of Indian Paper Manufacturers and Allied Industries*, Indian Agro & Recycled Paper Mills Association, New Delhi

Installed capacity of the sample mills

The growth trajectory of the mills in the study has been similar to the rest of the paper and pulp industry. The combined capacity of the sample mills has increased at a CAGR of 5.4 per cent since 1995. ITC Ltd is the largest integrated paper manufacturing plant in the country. From 1995 onwards, it has grown at an average rate of 12 per cent and in 2013, it had a capacity of 4.7 lakh tonne. The plants in the sample have registered increases in capacities at varying rates depending partly on access to raw materials. Orient Paper is the only plant that has not increased its capacity.

Graph 2: Installed capacity in sample mills

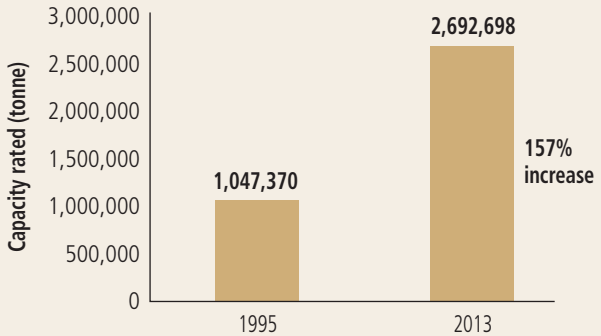


Table 2: Mill-wise increase in capacity

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP -Rayagada	Total installed capacity (tonne)
1995	70,000	105,000	30,000	180,000	47,000	62,500	60,000	85,000	46,200	151,920	119,750	90,000	1,047,370
2013	85,068	299,500	72,000	400,000	139,000	470,000	187,000	85,000	75,000	265,130	320,000	295,000*	2,692,698
% increase	**22**	**185**	**140**	**122**	**196**	**652**	**212**	**0**	**62**	**75**	**167**	**167**	**157**
CAGR	**1.1**	**6.0**	**5.0**	**4.5**	**6.2**	**11.9**	**6.5**	**0.0**	**2.7**	**3.1**	**5.6**	**6.8**	**5.4**

Note: **JKP Rayagada's capacity is as of August 2013*

PRODUCTION AND CONSUMPTION

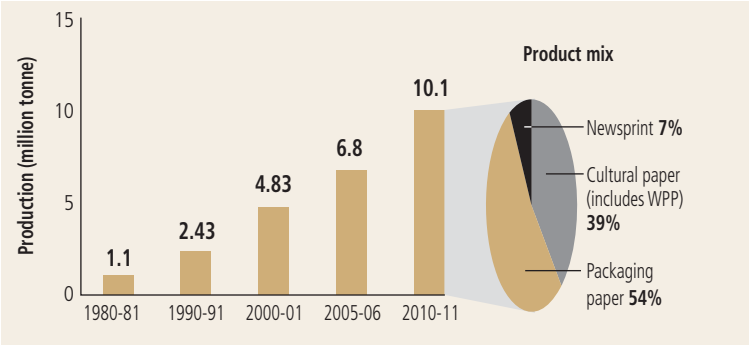
Production trends

In 2011, India produced 10.1 MT of paper, which was 2.6 per cent of the 394 MT of paper produced in the world. The Indian pulp and paper industry's production has increased at a CAGR of 7.7 per cent from 4.8 MT in 2001; however, the per capita consumption of paper in India continues to be low by global standards. In 1995, consumption stood at 3 kg and by 2003 it was just 5 kg. In 2011, it stood at 9.3 kg, much lower than that of other Asian countries such as Indonesia (22 kg) and China (42 kg). Domestic production has historically fallen short of demand for paper; overall, around 10 per cent of consumption, mostly comprising newsprint, is met by imports.

In terms of product mix, the percentage of industrial paper has gradually increased in the last decade. Packaging paper contributed to 48 per cent of the total paper manufactured in 2000 and has increased to 54 per cent in 2011. The share of WPP (writing and printing paper) has been more or less stable during the same period. In 2000, WPP share of the total production was 40 per cent and in 2011 it was 39 per cent. Newsprints' share on the other hand decreased from 12 per cent in 2000 to 8 per cent in 2011. Going forward, the paper industry expects the share of packaging paper to increase along with an increase in industrial production.

In 2011, India produced 3.9 MT of WPP, 5.41 MT of packaging paper and .79 MT of newsprint paper. Demand growth for WPP and packaging paper has ranged around 7-8 per cent. Most of the production of WPP and packaging paper was consumed domestically; net imports contributed to around 5 per cent of consumption. The demand for newsprint has been increasing at an average of 6 per cent per annum in the last five years, according to the Indian Newsprint Manufacturers Association. Historically, a large share of the newsprint demand in the country has been met by imports: In 2000, 46 per cent of the total consumption was met by imports; in 2011, this figure was around 55 per cent.[2]

Graph 3: Pulp and paper production in India



Production trends in sample mills

The combined production of the integrated mills in our sample has increased at a CAGR of 5.6 per cent since 1995. This is lower than the industry's growth rate largely because of an increase in production by RCF-based mills. Also, access to raw material has played a role in the mills' growth. For instance, some mills such as ITC-Bhadrachalam, JK Papers-Rayagada and West Coast Paper Mills Ltd (WCPM)-Dandeli which proactively promoted farm forestry, were able to grow at a faster rate compared to other integrated wood-based mills in our sample. ITC Ltd has had the highest rate of increase in production at a CAGR of 10 per cent. From an average 0.89 lakh tonne of pulp and paper between 1995-96, the mill's production increased more than five times to 4.9 lakh tonne in 2013. Tamil Nadu Newsprint and Papers Limited (TNPL) and WCPM have also recorded an increase in production of more than 7 per cent per annum since 1995-96. BILT-SGU and Orient Papers, the two mills with little or no capacity enhancement, have had a declining production trend.

[2] Source for 2000 data: Anon 2002, *Global Competitiveness of the Indian Paper Industry*, study by Jaakko Poyry Consulting for Central Pulp and Paper Research Institute, Saharanpur; Source for 2011 data: Anon 2011, Working Group on Pulp and Paper Sector for the 12th Five Year Plan

Graph 4: Pulp and paper production in sample mills

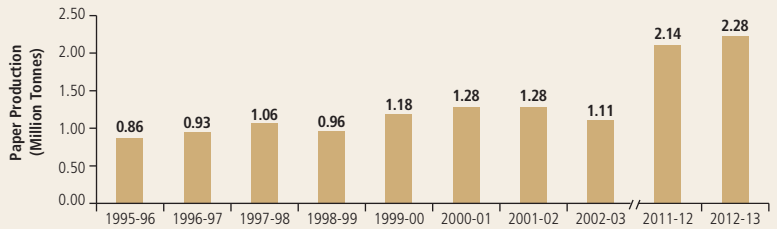


Table 3: Product mix in sample mills (in per cent)

	GRP 1	GRP 2	GRP 3
Writing and printing	65	69	70
Packaging paper and paper board	22	18	24
Industrial paper	2	2	2
Newsprint	4	4	0.03
Speciality papers	3	0.28	1
Market pulp	4	6	2
Others	1	1	1

Product mix in sample mills

The sample mills continue to manufacture predominantly WPP, followed by packaging paper and paper boards. The first rating showed that of the total production, WPP accounted for 65 per cent while packaging and paper board accounted for 22 per cent. The share has remained more or less the same: in 2012-13, 70 per cent of the total production was WPP while 24 per cent was packaging paper and paper board.

On an average, about 4 per cent of the product mix manufactured during 1995-98 was newsprint, all of it produced by TNPL. With TNPL moving towards writing and printing paper, a negligible 0.03 per cent of the product mix of the sample is newsprint.

Table 4: Mill-wise pulp and paper production

Production trends	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JK Paper-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Total Production (tonnes)
1995-96	91,299	99,541	20,331	101,161	40,653	89,057	58,737	68,380	52,957	74,747	88,255	79,578	861,617
1996-97	85,355	100,714	21,272	153,460	41,688	86,041	58,552	64,020	52,590	104,815	94,107	75,069	932,637
1997-98	85,250	153,561	26,590	170,618	41,322	84,148	58,898	65,783	53,395	131,392	111,375	82,616	1,059,324
1998-99	67,387	93,225	36,121	162,869	43,618	127,948	56,277	59,461	53,269	95,296	109,645	57,778	963,569
1999-00	72,273	130,778	41,546	165,456	46,608	172,872	57,190	67,459	58,547	147,932	105,770	97,578	1,164,432
2000-01	72,041	133,702	45,728	177,445	45,481	193,468	78,334	70,546	60,039	145,155	112,997	131,692	1,268,133
2001-02	75,598	135,721	43,994	172,114	50,397	197,812	96,976	66,741	60,196	144,399	113,075	111,438	1,270,890
2011-12	77,647	236,683	67,065	323,286	140,912	466,385	132,079	61,626	53,620	162,851	294,360	131,151	2,147,665
2012-13	78,114	239,411	65,100	352,398	149,712	495,055	139,017	59,972	60,784	216,918	304,910	128,206	2,289,596
% increase	**-14**	**141**	**220**	**248**	**268**	**456**	**153**	**-12**	**13**	**190**	**245**	**61**	**166**
CAGR	**-0.9**	**5.0**	**6.7**	**7.2**	**7.5**	**10.0**	**5.3**	**-0.7**	**0.7**	**6.1**	**7.1**	**2.7**	**5.6**

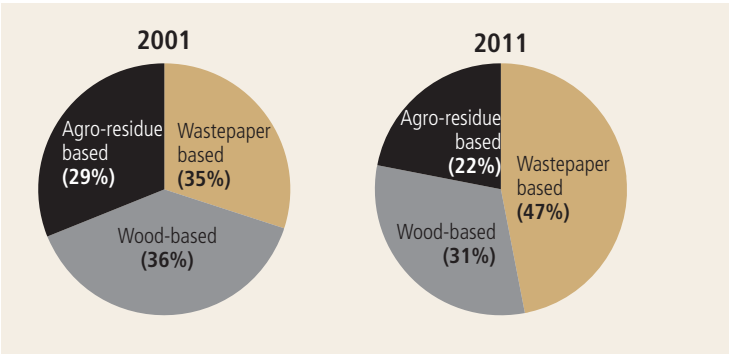
Raw material consumption

In 2001, paper production from different raw materials was more or less equally distributed with production from waste paper at 35 per cent, from agro-residue at 29 per cent and wood at 36 per cent. The share of wood in the total raw material mix has been steadily declining in the Indian industry since the 1970s. From 84 per cent in 1970, it came down to 36 per cent in 2001 and was 31 per cent in 2011.

Production from wastepaper, on the other hand, has jumped from 7 per cent in 1970 to 35 per cent in 2001, and to 47 per cent in 2011. This growth has been driven by an increase in the number of small- and medium-scale mills that rely largely on wastepaper.[3]

In the early 2000s, it looked like the share of wood-based paper would plummet given the industry was predicting an imminent "wood drought". This did not prove to be true. In fact, the percentage of pulp and paper from wood continues to stand at a substantial 31 per cent. In 2001, the industry produced around 1.7 MT of pulp and paper from 3.4 MT of wood and bamboo. In 2011, 3.1 MT of paper was manufactured from approximately 6.5 MT of wood, a bulk of which was produced by large-scale integrated mills. Clearly, the two-fold increase in consumption of wood has been possible as these mills had opted to take the farm forestry route. This move is bringing the industry closer to a sustainable model of wood sourcing.

Graph 5: Fibre use – share of wood still stands at 31 per cent



Raw material distribution in the sample mills

Forest-based raw materials, namely wood and bamboo, have continued to dominate in CSE's sample mills over the last 18 years. Wood consumption has increased because of three reasons: First, total production of paper by sample mills has increased substantially. Second, bamboo's share has dropped from 30 per cent of total raw material used during the first rating to a mere 5 per cent today, with a corresponding increase in the use of wood. Third, companies such as ITC Ltd which used significant amounts of recyclables are now reliant predominantly on wood.

ITC Ltd has increased its wood consumption by almost six times in the last 18 years. Similarly, mills such as TNPL, WCPM and Seshasayee Papers have also increased their wood consumption substantially. These mills, which consumed around 17.4 lakh tonne of wood in 1995, increased their consumption to 32.6 lakh tonne in 2012. While there was talk of shortage 10 years ago, the companies have found a way around the wood crunch by investing in farm forestry.

[3] Source for 2001 data: Anon 2002, *Global Competitiveness of the Indian Paper Industry*, study by Jaakko Poyry Consulting for Central Pulp and Paper Research Institute, Saharanpur; Source for 2011 data: Anon 2011, Working Group on Pulp and Paper Sector for the 12th Five Year Plan

TNPL: Wood contributed to 10 per cent (0.5 lakh tonne) of the total raw material consumed in 1995. This proportion increased to an average of 19 per cent (1.7 lakh tonne) for the period 1998-2002. In 2011-12, hardwood consumption constituted 42 per cent (3.1 lakh tonne) of the total raw materials used by the mill.

Seshasayee Paper: An average of 50 per cent of the mill's raw material (0.9 lakh tonne) was forest-based during 1998-2002. In 2011-12, 83 per cent (2.3 lakh tonne) of the raw material was wood.

WCPM: Wood has contributed to more than 90 per cent of the raw material requirement of the mill since 1995. With a capacity increase of nearly 170 per cent and wood contributing to 95 per cent of the total fibre furnish, the wood consumption has increased sharply from 2.7 lakh tonne in 1995 to 6.7 lakh tonne in 2012.

Graph 6: Forest-based raw materials have the highest share in sample mills

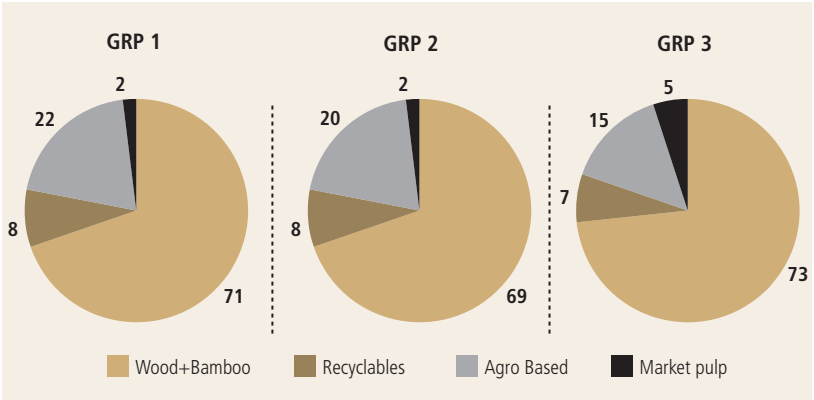


Table 5: Consumption of forest-based raw materials in sample mills – 88 per cent more wood and bamboo consumed in 2012

Production trends	BILT-SGU*	BILT-Ballarpur	BILT-Sewa	TNPL	JK Paper-CPM	ITC Ltd	Seshasayee Paper	Orient Paper*	Star	Century	WCPM	JKP-Rayagada	Total (tonnes)
1995-96	190,500	234,000	71,079	48,754	84,875	111,296	72,617	200,422	NA	269,310	266,159	189,880	1,738,892
1996-97	166,754	235,462	85,952	61,218	103,884	139,047	85,913	172,619	NA	123,270	276,485	171,564	1,622,169
1997-98	155,222	227,200	106,225	55,390	110,971	111,462	71,904	168,081	148,817	157,361	283,672	178,832	1,775,137
1998-99	81,891	190,571	76,746	51,880	84,275	147,976	78,054	126,474	73,385	117,772	196,908	134,285	1,393,394
1999-00	103,144	256,552	100,667	58,798	102,046	156,822	78,443	173,081	102,962	202,568	160,010	226,944	1,740,257
2000-01	116,921	255,091	105,682	62,546	108,003	150,190	90,265	180,330	91,491	163,048	205,081	251,184	1,813,556
2001-02	130,231	256,551	98,363	69,358	110,384	177,261	102,429	163,156	100,553	235,142	215,630	251,821	1,967,592
2011-12	61,244	285,323	136,786	313,229	119,743	732,690	232,822	155,572	58,660	231,145	672,168	270,368	3,269,750
% Change	**-68**	**22**	**92**	**542**	**41**	**558**	**221**	**-22**	**-61**	**-14**	**153**	**42**	**88**
CAGR	**-6.5**	**1.2**	**3.9**	**11.6**	**2.0**	**11.7**	**7.1**	**-1.5**	**-6.0**	**-0.9**	**5.6**	**2.1**	**3.8**

Note: **BILT-SGU and Orient have increased the use of veneer waste (from a large number of plywood industries in the plant's vicinity) in its raw material.*

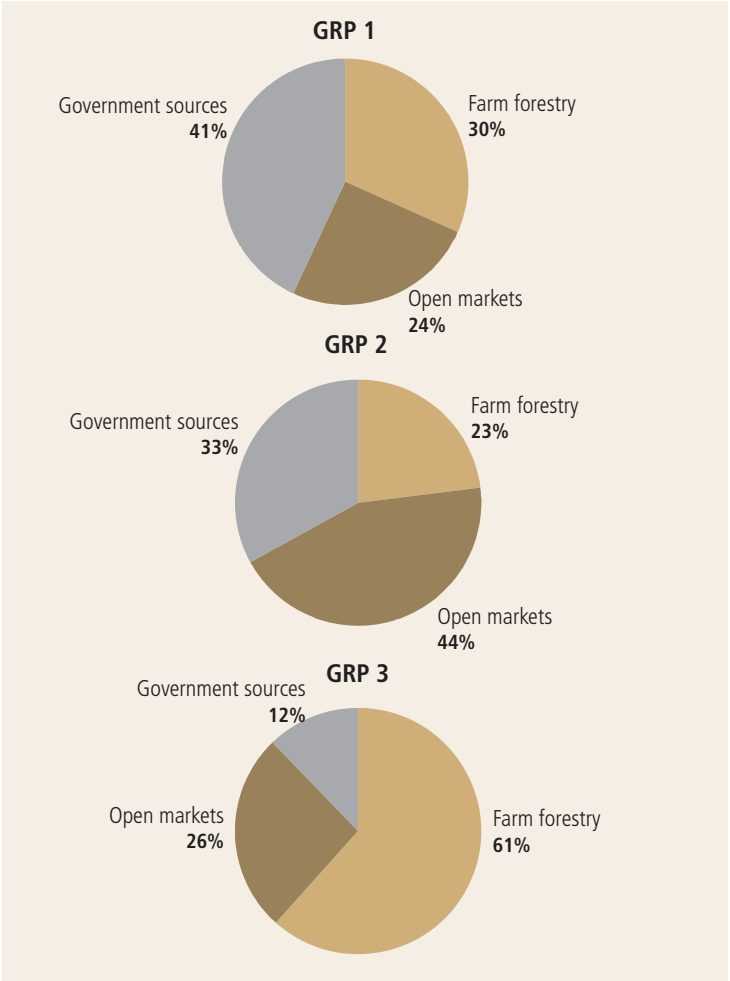
Wood and bamboo: Sourcing patterns

Till the late 1970s, the government heavily supported the paper industry's increasing wood needs by offering raw materials at extremely low rates from the state-owned forests. The resultant indiscriminate felling led to large-scale deforestation. The growing environmental and social concerns over the loss of forests saw the beginning of India's first social forestry programme. In the 1980s, reduced import duty on pulp led to a collapse of the farm forestry experiment. In addition, cheap pulp wood from state forests led to a crash in the open market price of wood. However, a combination of factors – pressure from environmentalists, restriction on farming in forest land by the government and increasing fear of an impending raw material crunch by the industry – changed the fibre sourcing patterns in the country.

During the first rating, up to 40 per cent of the wood procured by the mills in the sample was from government sources. Mills such as BILT-Ballarpur, TNPL, and JKP-CPM procured almost 100 per cent of their wood from various government sources while JKP-Rayagada, Century and Star Papers sourced between 30 to 70 per cent. Today, the mills source an average of 61 per cent of wood from farm forestry. ITC Ltd uses farm forestry for more than 95 per cent of its wood requirements (*see Box: ITC's and JK Paper's farm forestry*). Others like Star, JKP-Rayagada, Westcoast Papers and BILT-Ballarpur source more than 80 per cent of their wood through farm forestry, while TNPL sourced around 50 per cent from farm forestry in 2011-12.

Government forests contribute to only 12 per cent of the total share of the wood and bamboo sourced. Open market had a share of 26 per cent in 2013, a drop from the 47 per cent in 2004. While the percentage decline is high, the actual reduction in quantity of wood sourced is far less. The mills sourced around 9 lakh tonne of wood from the open market in 2002; in 2012, the quantity was 8.3 lakh tonne. The open market volume has remained more or less constant. This, coupled with reduction in contribution from government forests, shows that farm forestry has expanded to almost single handedly service the increase in wood demand.

Graph 7: Sustainable sourcing – sample mills sourced 61 per cent of wood from farm forestry



ITC'S AND JK PAPER'S FARM FORESTRY

A major portion of ITC Ltd's raw material used to be wastepaper until 2004. Despite having the oldest farm forestry programme, ITC had not yet embraced it due to its unreliability. Today, ITC's Bhadrachalam unit relies predominantly on wood and sources more than 95 per cent of it from its farm forestry initiatives.

ITC Ltd has remained the largest paper plant in the country since 2000. Its capacity has increased at a rate of 12.6 per cent per annum — from 0.6 lakh tonne in 1995 to 4.9 lakh tonne in 2013. Since it has become primarily a wood-based unit, its wood consumption has risen by almost six times — from 1.1 lakh tonne in 1995-96 to 6.4 lakh tonne in 2013. ITC's farm forestry initiatives, which began in 1989, further expanded to meet its increased consumption.

From 1992 to 2013, the company has promoted plantations over an area of 1.6 lakh hectare and has distributed 7,880 lakh saplings in partnership with 80,000 farmers. The plantations are predominantly in Andhra Pradesh (AP) spread over all 23 districts of the state. Additionally, they have plantations in Tamil Nadu, Maharashtra, Chhattisgarh, Odisha, Kerala, Uttar Pradesh, Madhya Pradesh, Punjab and Haryana. While bi-partite agreements with farmers are no longer the norm, the company offers it to those who ask for it in order to obtain loans from banks. Despite the fact that the farmers who have been initiated under the programme are free to sell the wood in the open market, ITC Ltd has been able to ensure a reliable supply by putting in place a number of extension services.

Procurement of wood from plantations outside Khammam district in AP, where the mill is located, is done through contractors. A network of 25 depots has been set up to reduce transportation hassles in these cases. The company has set up a transparent system which ensures the farmers are paid on delivery either at the company weigh-bridge in Bhadrachalam, or at the depots. In 2013, the mill paid Rs 4,935 per tonne of wood procured. The combination of all of its extension services coupled with competitive rates has enabled the ITC-Bhadrachalam unit to sustainably as well as reliably source its raw material.

JK Papers Ltd's Rayagada unit has a similar story. The company sources more than 85 per cent of its wood from farm forestry. However, this has not always been the case. Before 1994, the company depended on government forests in Odisha and Gujarat for bamboo. JK Paper Ltd began its farm forestry programme in 1991. The mill provides the high yield planting material and free technical advice with assurance to buy back from farmers. To minimise transport costs, the company's farm forestry now focuses on areas within 200 km from its mills. Like ITC, JK Papers has started a 'gate purchase scheme' in 2009 enabling farmers to deliver wood and be paid at the company's gates. JK Papers has set up its own network of 10 depots for farmers who bring wood from 75-200 km from the plant. Since its inception, the programme has promoted plantation in around 1.1 lakh hectare of farmland covering 20 districts in four states.

PROCESS TECHNOLOGY AND CONSUMPTION

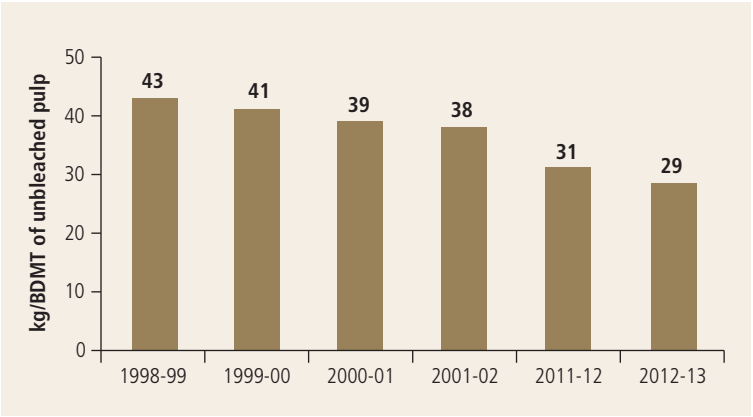
Pulping

Pulping is carried out to extract cellulose – the fibrous content of the raw material used in paper making – from other components such as lignin, resins and hemi-cellulose. The most commonly used pulping technique and the most effective one is the chemical or Kraft cooking process. In the mills in our sample, chemical consumption in the pulping process was quite high, at an average of 45 kg of caustic soda equivalent per Bone Dry Metric Tonne (BDMT) of unbleached pulp (during the period 1998-2002). The global best practice during the same time period was only 12 kg/BDMT of unbleached pulp. This time around, the average specific chemical consumption has reduced to 29 kg per BDMT of unbleached pulp, an improvement, but still a long way from the global best practices.

Specific lime consumption: Causticising is a process where the primary pulping chemical (sodium carbonate) is converted into active cooking chemical, sodium hydroxide (NaOH), by reacting it with calcium oxide or lime. This reaction generates lime mud or calcium carbonate. The lime mud can be burnt to regenerate calcium oxide, a process normally carried out in lime kilns. In theory, 100 per cent of lime used in paper mills is recoverable.

During the first and the second rating of the sector, lime kilns were uncommon features. Huge volumes of lime mud were dumped by the mills and consequently, the specific consumption of lime was extremely high – at an average of 200 kg/BDMT of product. By the second rating, four of the 12 mills had installed lime kilns to recover lime. By 2012, every mill in the sample had installed a lime kiln leading to an overall reduction in consumption of lime; however, the mills continue to consume unacceptably high levels of lime. In 2012-13, the consumption of lime in the sector was an average 96 kg/BDMT of product, while the global best practice stands at around 5 kg/BDMT.

Graph 8: Pulping chemicals – dipping consumption



Graph 9: Lime consumption – unacceptably high

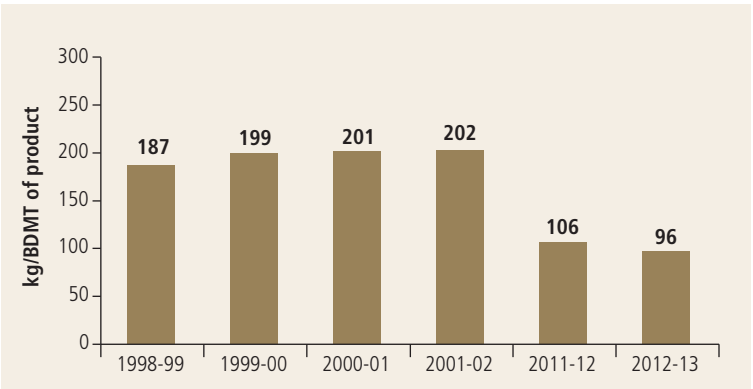


Table 6: Specific pulping chemical consumption as equivalent NaOH (kg/BDMT of unbleached pulp)

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL8	JKP-CPM	ITC Ltd	Seshasayee Paper*	Orient Paper	Star	Century*	WCPM	JKP-Rayagada	Weighted average
1998-99	44	45	42	38	35	30	48	62	33	31	57	59	43
1999-00	38	39	58	39	47	29	47	45	31	37	42	60	41
2000-01	35	35	52	38	42	28	64	50	28	38	46	57	39
2001-02	31	35	43	29	42	27	55	51	32	38	41	58	38
2011-12	31	35	40	24	27	30	20	85	53	33	22	35	31
2012-13	27	39	28	20	28	21	22	89	59	26	26	38	29
% change	**-39**	**-12**	**-33**	**-47**	**-21**	**-30**	**-54**	**44**	**77**	**-17**	**-55**	**-36**	**-33**
CAGR	**-3.2**	**-0.9**	**-2.7**	**-4.2**	**-1.6**	**-2.4**	**-5.0**	**2.5**	**3.9**	**-1.2**	**-5.1**	**-2.9**	**-2.6**

Note: **The pulping chemical consumption pertains only to Kraft wood pulping so that data is comparable across all 12 paper mills. TNPL, Seshasayee and Century use both wood and baggase as raw materials.*

Table 7: Specific lime consumption (kg/BDMT of product)

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Weighted average
1998-99	307	239	265	92	255	290	260	235	54	NA	92	395	187
1999-00	314	230	237	106	274	294	267	213	44	63	98	345	197
2000-01	317	226	248	111	273	282	257	203	45	57	91	343	196
2001-02	303	229	236	131	284	286	229.	210	45	67	74	350	200
2011-12	123	94	71	125	153	110	87	175	42	66	18	286	106
2012-13	120	73	80	127	105	112	98	146	36	63	19	223	96
% change	**-61**	**-69**	**-70**	**37**	**-59**	**-61**	**-62**	**-38**	**-33**	**1**	**-80**	**-44**	**-48**
CAGR	**-6.1**	**-7.6**	**-7.7**	**2.1**	**-5.7**	**-6.1**	**-6.3**	**-3.1**	**-2.6**	**0.1**	**-10.1**	**-3.7**	**-4.3**

Pulping technology: The pollution load of a paper mill is dependent on its pulping process and the technology used. The previous ratings had found the industry's pulping technology to be outdated at least by a decade. The current survey indicates that the industry appears to have caught up to an extent.

This time, we looked at two key technology changes in the pulping section: *extended/modified cooking* and *oxygen delignification* (ODL). During pulping the raw material is cooked in a sodium-based alkaline solution so that its lignin content, denoted by the 'kappa number', is reduced. The cooked pulp has residual lignin which has to be removed in order to make the finished paper bright. Bleaching is carried out to remove this residual lignin. A higher kappa number after cooking translates into higher chemical consumption during the bleaching phase, leading to increased pollution load. Extended/modified cooking can substantially lower the kappa number. ODL, carried out after the cooking of pulp, is yet another process that reduces this number. Here, oxygen works selectively on the lignin, breaking it down and lowering the kappa number.

Technology upgradation: While there were no mills with extended or modified cooking technologies during the first rating, the second rating saw one mill, JK Paper-Rayagada, with the state-of-the-art Rapid Displacement Heating (RDH) cooking process in the country; additionally, three mills had implemented oxygen delignification. Today, more than 70 per cent of the unbleached pulp production from the mills in our sample is through extended or modified cooking.

Similarly, while none of the mills had ODL during the first rating, two mills (JKP-Rayagada and ITC Ltd) adopted it during the second. Today, nine out of the 12 mills carry out ODL before bleaching.

Table 8: Cooking technologies – 70 per cent of unbleached pulp produced is through extended cooking, which keeps the kappa number low

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Percentage
Capacity of digesters with conventional cooking (TPD)	180	360	175	750*			100*	240	210	412.50			
– % of total cooking capacity	100	100	100	68.8			20.0	100	100	100.00			30
Capacity of digesters with modified cooking (TPD)				340	150	1000	450				725	313.2	
– % of total cooking capacity				31.2	100	100	82.0				100	100	70

Note: **In the case of mills like TNPL and Seshasayee, agro-waste like baggase in their raw material is cooked in continuous digesters without modification. Given that the conventional cooking time is around 15-20 minutes only, extending or modifying the cooking process is not relevant.*

Bleaching

Bleaching is carried out to make the paper bright by removing leftover lignin components in the pulp after cooking. This section of the mill contributes the most to the overall pollution load. By 2001, paper mills in the developed world had already phased out the most common bleaching chemical—chlorine—due to the environmental hazards it poses (The carcinogenic adsorbable organochlorines, collectively known as AOX, discharged during bleaching with chlorine do not degrade and enter the food chain easily.). In the Indian paper industry, chlorine remains a common bleaching chemical as it is effective and cheap.

With neither environmental standards nor facilities to check the presence of organochlorides in effluents, there was no control over the industry's bleaching process. Inefficient use of chlorine exacerbated the situation, leading to its high specific consumption. Today, Indian paper units have begun to slowly move towards Elemental Chlorine Free (ECF) bleaching, which uses chlorine dioxide as a primary bleaching chemical; however, elemental chlorine has not been phased out completely. Meanwhile, European mills have moved further ahead to Total Chlorine Free (TCF) bleaching (which uses ozone, oxygen or peracetic acid and peroxide) to completely eliminate organochlorides from their effluents. In addition, closure of the bleaching section is possible with TCF, unlike with ECF where recycling the chlorine dioxide in the process corrodes equipment.

While none of the mills in the sample had ECF technology at the time of the first rating, one mill had adopted it by the second rating. Today, five of the 12 plants have moved to ECF bleaching with ITC Ltd being the first plant to make the change in 2004. It is also the only plant that uses ozone in its bleaching sequence, thus reducing chlorine dioxide consumption. Another six mills have replaced chlorine partially with chlorine dioxide. Consequently, a small consolation is that the specific consumption of chlorine has dropped. Star Paper is the only mill that continues to use elemental chlorine in its entire production line.

TWO WAYS TO IT: THE MOVE TO ECF

Chlorine dioxide has replaced chlorine in four of the biggest paper manufacturing facilities in the country. The four companies have opted for different types of chlorine dioxide manufacturing technologies; each, they claim, has its benefits.

ITC Ltd and Seshasayee Papers use a non-integrated process which uses methanol to reduce sodium chlorate ($NaClO_3$) to chlorine dioxide at high levels of acidity. The process produces a double salt, sodium sesquisulphate, as a by-product. This by-product is recovered by the units and is added as make-up sodium sulphate along with black liquor in the digesters. Compared to the integrated process, this process is less capital-intensive and consumes less energy. However, this benefit is offset by higher operating costs. The raw materials sodium chlorate, hydrochloric acid (HCl) and methanol need to be purchased; sodium chlorate is particularly expensive with one tonne costing around Rs 50,000.

TNPL and WCPM, on the other hand, use integrated chlorine dioxide production plants. Here the plant produces two intermediate products: sodium chlorate ($NaClO_3$) and HCl. Sodium chlorate is produced by electrolytic method where current is passed through a brine solution. The hydrogen gas produced as a by-product is in turn used for producing HCL. The chlorine requirement here, however, has to be met by adding chlorine gas separately. Chlorine dioxide is then produced by combining the strong chlorate and HCl. The by-products produced are weak chlorine gas, which is used as make-up in the HCL section and NaCl or salt, which is used to make the brine solution for the $NaCLO_3$ sections. This process is more capital-intensive as well as more energy-intensive as it manufactures the intermediate products as well.

The weighted average consumption of elemental chlorine for the sample has declined appreciably to 19 kg/BDMT of bleached pulp in 2012-13 from 58 kg/BDMT of bleached pulp in 1995-96. However, the average reduction is the result of a shift to ECF bleaching by four mills. Elemental chlorine consumption by the rest of the eight mills remains indefensibly high.

The total use of bleaching chemicals indicates the efficiency of a company's bleaching process. On the whole, the total bleaching chemical consumption in the sample mills has reduced by only 20 per cent since 1995: from 100 kg/BDMT of bleached pulp to 85 kg/BDMT. This is a dismal performance, given that the best achievable bleaching chemical consumption is about a fourth of this level.

Graph 10: Bleaching chemicals – consumption higher than global standards

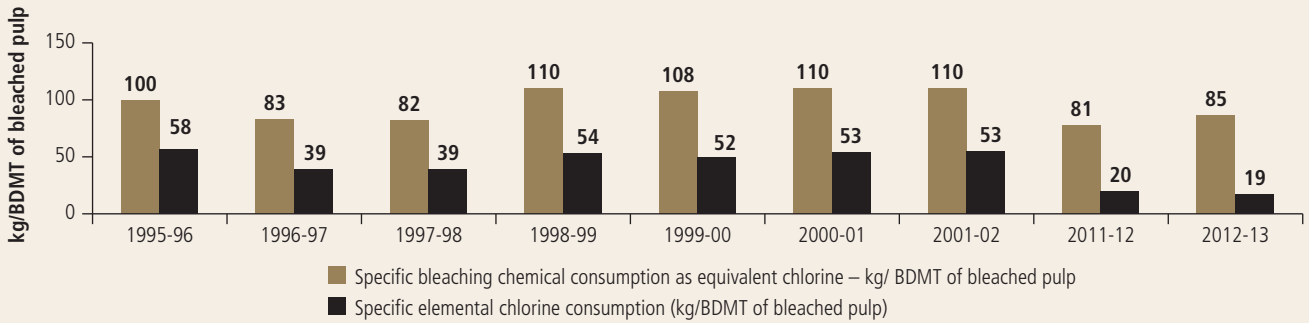


Table 9: Snail-paced move towards ECF – only five out of 12 mills have made the shift in 18 years

	BILT-Yamuna Nagar	BILT-Ballarpur*	BILT-Sewa	TNPL	JKP-CPM	ITC	Seshayee Paper	Orient Paper	Star	Century	West Coast Paper	JKP Rayagada
GRP 1	CEP HH	CDE-O-HH-D	CEH	CEH	C-EP-H-H	C-D-E-O-H-H-D	CE/P HH	C-E-H-D	C-E-H-H	Wood: C/D-E/P-HH-D Baggase C/D- Eo- D RGP C-E-H-H-D	CE/P HH	CD-EoP-D
GRP 2	CD-EoP-D-D	C/D- EoP- H-H- D	C-EP-H-H-D	Wood : C-EP-H-H Baggase: C-EP-H	CD-EoP-D	DO-EoP-D1	Wood: C-EP-H-H Baggase: C-EP-H	C-EP-H-D	C-EP-HH	Wood : C-E-H-H-D Baggase: C/D-Eo-D RGP C-E--H-H-D-S	C-EP-H-H	CD-EoP--D
GRP 3	CD-EoP-D1-D2	CD- EoP- H & D	CD-EOP-H-D	Wood DHT-EoP-D1 Baggase D0-EoP-D1	CD-EoP-D	DO-Ze-D1-P	Wood: O-D0-EoP-D1 Baggase: D0-EoP-D1	CD-EoP-H-D	C-EoP-H1 H2	Kraft: CD-EP-H-D RGP: C-EoP-H-D1-D2-SO2	Dhot EoP DnD	CD-EoP-D

Note: ** BILT Ballarpur has changed its sequence to ECF in 2013-14.*

Table 10: Specific elemental chlorine consumption (kg/BDMT of bleached pulp)

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL*	JKP-CPM	ITC Ltd	Seshasayee Paper*	Orient Paper	Star	Century*	WCPM	JKP-Rayagada	Weighted average
1995-96	33	55	98	36	68	46		67	74	71			58
1996-97	39	52	85	33	64	40	132	67	74	63	56	96	39
1997-98	41	56	95	35	62	37		67	70	51			39
1998-99	69	62	73	43	66	40	50	73	109	48	37	45	54
1999-00	70	55	58	43	71	50	42	60	95	51	41	34	52
2000-01	61	49	57	69	66	47	43	66	95	41	41	32	53
2001-02	52	49	54	72	65	49	54	64	108	34	39	33	53
2011-12	52	42	54	0	56	0	0	42	88	26	0	38	20
2012-13	50	45	47	0	48	0	0	54	89	25	0	45	19
% change	**54**	**-19**	**-52**	**-100**	**-29**	**-100**	**-100**	**-19**	**21**	**-65**	**-100**	**-53**	**-69**
CAGR	**2.4**	**-1.1**	**-4.0**	**-100**	**-1.9**	**-100**	**-100**	**-1.2**	**1.1**	**-5.7**	**-100**	**-4.2**	**-6.4**

Table 11: Specific bleaching chemical consumption as equivalent chlorine (kg/BDMT of bleached pulp)

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL*	JKP-CPM	ITC Ltd	Seshasayee Paper*	Orient Paper	Star	Century*	WCPM	JKP-Rayagada	Weighted average
1995-96	145	131	116	73	129	93		148	82	134	NA		100
1996-97	151	129	106	72	121	79	132	146	87	127	NA	128	83
1997-98	132	135	117	75	118	76		147	80	104	NA		82
1998-99	117	131	152	88	120	98	86	134	203	119	81	73	110
1999-00	111	118	122	90	133	107	85	114	184	130	84	61	108
2000-01	113	106	112	126	124	114	63	123	184	114	87	59	110
2001-02	104	104	103	131	122	117	68	139	210	112	87	64	110
2011-12	107	87	127	85	116	56	84	97	119	71	68	93	81
2012-13	103	99	127	83	120	59	88	131	114	61	78	110	85
% change	**-29**	**-25**	**9**	**14**	**-7**	**-36**	**-33**	**-12**	**38**	**-54**	**-4**	**-14**	**-20**
CAGR	**-1.9**	**-1.6**	**0.5**	**0.7**	**-0.4**	**-2.5**	**-2.2**	**-0.7**	**1.8**	**-4.2**	**-0.3**	**-0.9**	**-1.2**

Note: ** The bleaching chemical consumption and the elemental consumption pertain only to Kraft wood pulping so that the data is comparable across all mills. TNPL, Seshasayee and Century use baggase wood and baggase as raw materials.*

RESOURCE EFFICIENCY

Energy efficiency

The pulp and paper industry is extremely energy-intensive, with energy costs accounting for nearly 25 per cent of the paper manufacturing costs. On the other hand, a pulp mill can be 100 per cent self-sufficient in terms of heat energy by utilising the internally generated biomass. In fact, pulp mills in Sweden send the surplus heat to their district heating networks. But in order to be reliant predominantly on the internally generated biomass, energy consumption of a mill's processes should be low.

The energy consumption in the sample mills has shown a decreasing trend but the rate of improvement has been inadequate. In 2012-13, the specific primary energy consumption was 45 GigaJoules (GJ)/BDMT of product dropping from 62 GJ/BDMT of product in 1995, a 1.8 per cent per annum reduction. TNPL and ITC Ltd have reduced their energy consumption the most. From an average specific energy consumption of 107 GJ/BDMT of product during the years 1995-98, TNPL has reduced its consumption to 45 GJ/BDMT of paper produced in 2012-13. ITC Ltd has reduced its energy consumption from an average of 74 GJ/BDMT of product during 1995-98 to 31 GJ/BDMT of product in 2012-13. JKP-Rayagada and Orient Paper are the only mills that seem to have increased energy consumption. It may be noted here that factors such as change in product mix and capacity utilisation play a part in the energy consumption trends.

Though benchmarking energy consumption is difficult given the variations in terms of raw material mix, processes, reporting methods, final product etc, we estimate that the industry continues to underperform when compared to mills globally. International Papers, for example, consumes secondary energy of 10 GJ/t of paper produced. The sustainability report by the Confederation of European Paper Industries (CEPI) pegs the average energy consumption of European mills at 14 GJ/t of product (around 50 per cent of the total paper produced by the mills in CEPI was from recycled fibre).

The Indian pulp and paper industry's main source of energy continues to be coal, which contributes to more than 50 per cent of the total energy consumed, a state of affairs that has seen no change in the last 18 years.

[3] Around 50 per cent of the total paper produced by the mills in CEPI was from recycled fibre.

Graph 11: Energy consumption – very little has changed in the mills through the years

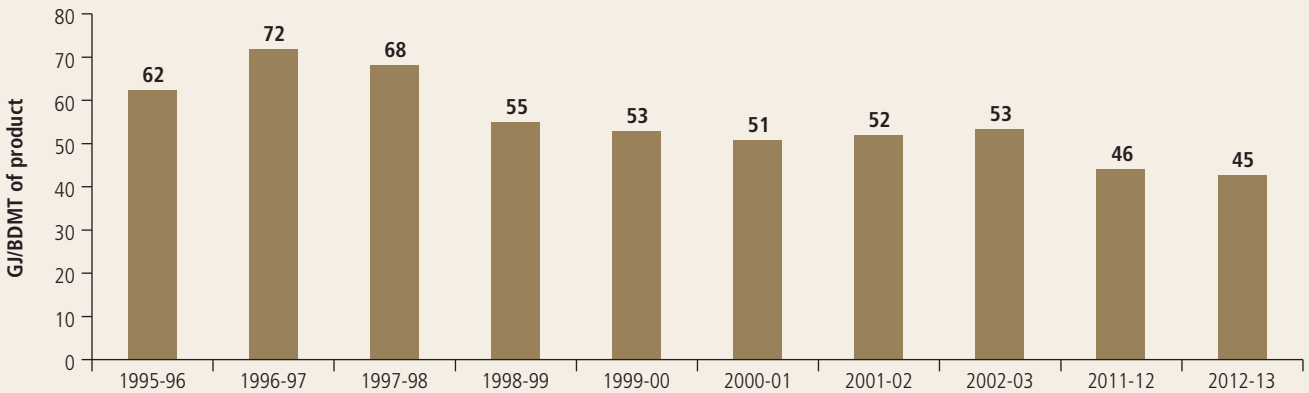


Table 12: Specific energy consumption (GJ/BDMT of product)

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Weighted average
1995-96	79	67	79	99	54	65	67	NA	53	74	53	44	62
1996-97	65	65	85	127	49	67	69	81	NA	75	55	53	72
1997-98	60	59	83	96	47	90	69	86	NA	66	58	66	68
1998-99	75	59	68	35	52	43	87	83	56	52	44	68	55
1999-00	74	56	63	40	50	37	85	77	54	47	45	60	53
2000-01	72	53	67	42	53	34	70	76	51	50	45	55	51
2001-02	69	51	70	52	45	37	61	80	50	48	42	54	52
2002-03	69	53	71	67	48	39	48	79	45	52	NA	51	53
2011-12	63	44	62	48	35	32	53	86	54	48	46	50	46
2012-13	58	42	61	45	34	31	51	91	45	55	45	49	45
CAGR	**-1.7**	**-2.5**	**-1.4**	**-4.3**	**-2.5**	**-4.1**	**-1.5**	**0.7**	**-0.9**	**-1.6**	**-0.9**	**0.6**	**-1.8**

Table 13: Specific coal consumption (MT of coal/BDMT of product)

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Weighted average
1995-96	2.3	2.8	2.7	1.0	1.6	1.7	2.6		1.2	2.2	1.5	1.3	1.7
1996-97	2.2	2.8	2.7	1.5	1.7	1.8	2.7	2.4	1.3	1.9	1.5	1.6	1.9
1997-98	2.2	1.7	2.7	1.2	1.5	2.4	2.7	2.8	0.0	1.5	1.3	2.1	1.7
1998-99	2.6	2.1	2.2	0.9	1.5	1.7	0.4	2.9	0.9	1.4	1.0	2.5	1.6
1999-00	1.8	2.0	2.1	1.2	1.5	1.4	0.8	2.7	0.7	1.3	1.0	2.0	1.5
2000-01	1.7	1.8	2.5	1.3	1.7	1.2	0.6	2.7	0.6	1.4	1.0	1.4	1.5
2001-02	1.7	1.7	2.7	1.5	1.3	1.2	0.5	2.9	0.6	1.5	0.8	1.7	1.4
2011-12	2.3	1.8	1.8	1.2	1.1	1.0	1.4	3.0	0.8	1.4	1.0	1.6	1.3
2012-13	2.1	1.7	1.8	1.1	1.0	1.0	1.3	3.5	0.5	1.6	1.0	1.6	1.3

Graph 12: Coal consumption in sample mills

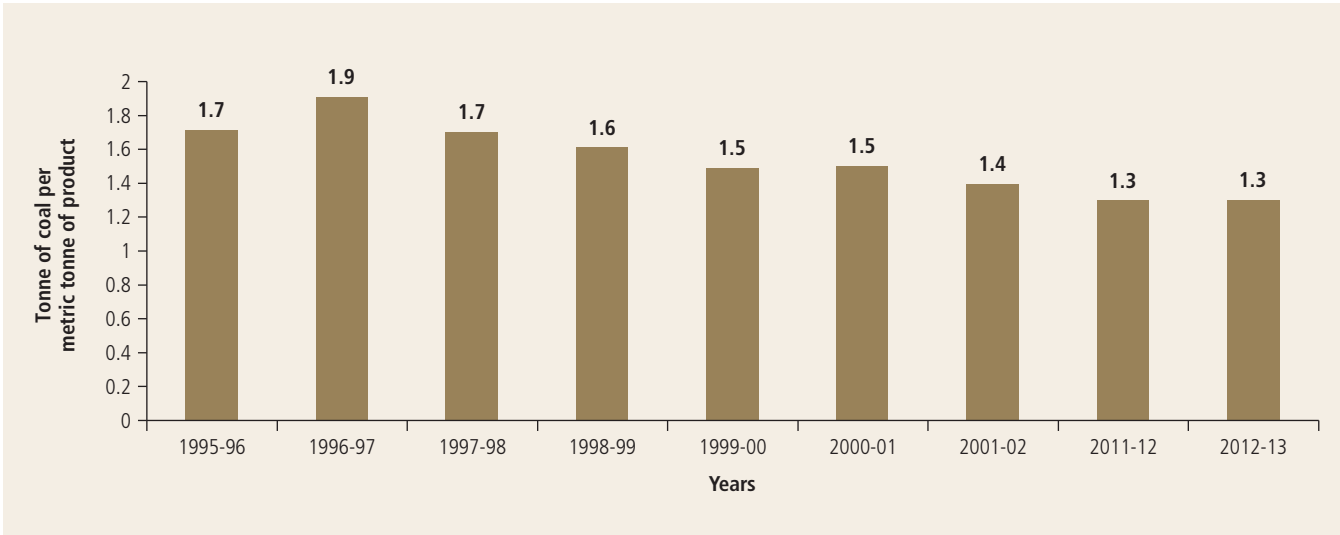


Table 14: Energy from coal

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Weighted average
1995-96	71	75	63	35	55	71	75	NA	49	57	55	62	56
1996-97	84	75	59	43	63	71	76	NA	NA	50	53	67	49
1997-98	86	73	60	26	61	75	76	52	NA	45	53	73	55
1998-99	77	64	50	71	54	71	35	67	41	53	46	63	56
1999-00	76	65	56	65	54	72	41	67	35	53	44	58	58
2000-01	75	63	58	62	58	74	41	68	33	55	45	54	57
2001-02	74	61	56	65	51	76	45	68	32	59	37	53	57
2011-12	65	70	57	51	66	44	52	62	29	59	47	59	54
2012-13	61	70	60	51	68	46	51	67	24	57	49	57	55

Self-sufficiency index: The self-sufficiency index is a measure of the sustainability of the energy sourcing practices in a paper mill. It takes into account the percentage of energy used by the mill from renewable energy, internally generated biomass and other bio-fuels. With the considerable dependency on fossil fuels, the sustainability index of the mills has not improved.

Table 15: Self-sufficiency index – the mills depend more on coal

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Weighted average
1998-99	22	35	39	38	42	26	46	33	45	46	36	34	36
1999-00	23	35	37	36	44	26	49	33	49	46	36	38	36
2000-01	25	37	34	34	41	25	45	31	49	44	37	41	35
2001-02	26	39	33	32	48	23	45	31	49	39	44	44	36
2011-12	34	26	37	43	33	53	43	36	54	37	46	41	42
2012-13	34	27	34	44	32	52	44	32	64	39	46	43	42

Water consumption

Integrated wood-based paper mills are known to be water guzzlers. The first rating had revealed that Indian mills' water consumption was far higher than the global best. By the second rating of the industry, a decreasing trend in water consumption became noticeable. With rising water scarcity, mills have adopted various water conservation measures reducing their specific water use by a CAGR of 7 per cent during 1995-2013. This is a 73 per cent reduction from the mills' admittedly very high water consumption in 1995. In terms of total quantity of water consumed, the mills used 30 per cent lesser water in 2012-13 to produce 170 per cent more pulp and paper than they manufactured in 1995-96. A number of mills like JKP-CPM, JKP-Rayagada, ITC Ltd, TNPL and BILT-Ballarpur have substantially reduced their water consumption.

Though the reduction in consumption is impressive, there is immense scope for further lowering it. For instance, CEPI's sustainability report pegs the average freshwater consumption of European mills at 35 cubic metre (m^3) of water per tonne of product. Further reduction in water use is imperative as a number of units are located in severely water-stressed areas that have witnessed conflicts with local communities *(see Box: Water water everywhere?)*. Indian paper mills need to take immediate and proactive steps towards water conservation; most plants only seem to take aggressive steps only when water shortage hits their production.

WATER WATER EVERYWHERE?

From consuming more than 200 m^3 of water per tonne of paper produced, TNPL has reduced its consumption by 70 per cent to 58 m^3 of water, owing to large-scale water conservation measures implemented by the plant.

TNPL, situated in Karur, Tamil Nadu, is dependent on water from the Cauvery river. With the failure of the south-west monsoons in 2012-13, the area faced severe water scarcity. The summer of 2013 saw widespread agitations in nearly 25 villages around TNPL's unit, demanding reduced water withdrawal by the paper mill and diversion of this water from the river to the villages. The mill had to relent to the villagers' demand that it halve its water consumption; this hit the company's production.

During this period, the mill implemented a slew of water conservation initiatives. The management constituted a team to identify possible areas of water conservation for both short and long term and to implement and conduct regular overviews of these initiatives to reduce their water intake. These included the replacement of freshwater with a) clear water for dilution of fillers in a paper machine, b) cooling water in a recovery boiler's spout cooling system, c) pump seal water in chlorine dioxide plants and d) pump seal water in causticiser and lime kiln and reusing clarified paper machine effluent in raw material preparation. The extensive reuse of water, for example, recirculation of hydraulic cooling water within the ECF plant, return of Induced Draft (ID) and Forced Draft (FD) cooling water, feed pump cooling water and lime kiln support roller bearing cooling water to water treatment plants have also been carried out to effectively run the plant with the water available.

In the two most severe months of drought in 2013 (May-June), the unit implemented extremely stringent water saving measures: as a result, specific water consumption dropped to as low as 34 m^3. The mill asserts that such measures, however, cannot be sustained all the year round. However, TNPL has been able to reduce the specific water consumption to 48 m^3 per tonne of paper post-June 2013, lower than the consumption of 58 m^3 per tonne of paper in 2012-13.

Graph 13: Reducing water use – average consumption has dropped by 73 per cent

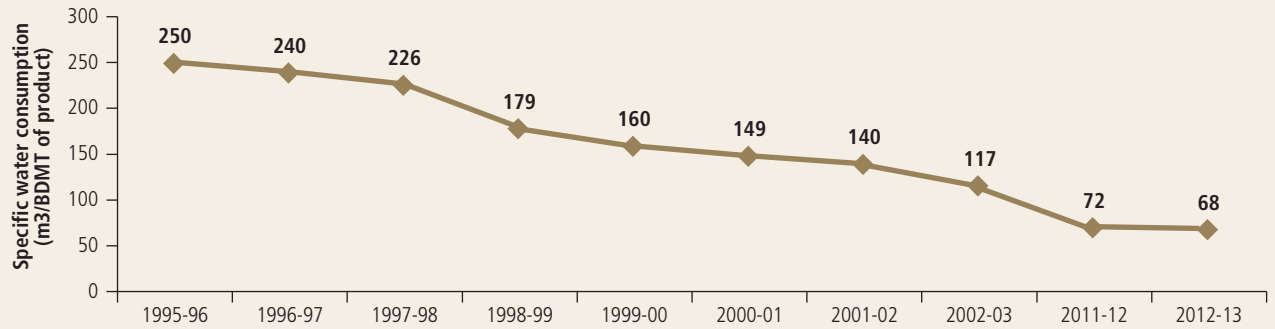


Table 16: Specific water consumption (m^3/BDMT of product)

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Weighted average
1995-96	396	205	220	216	151	283	221	275	242	219	327	147	250
1996-97	414	162	204	231	198	285	219	258	222	179	298	148	240
1997-98	433	153	202	193	244	334	201	251	212	150	288	118	226
1998-99	276	165	175	121	197	140	208	226	194	150	246	169	179
1999-00	247	166	162	117	194	106	202	175	180	134	231	136	160
2000-01	223	146	129	100	193	98	169	177	172	134	267	109	149
2001-02	182	132	134	104	178	97	128	194	175	122	244	110	140
2002-03	188	137	137	113	143	82	97	167	144	130	NA	93	117
2011-12	126	58	110	65	45	46	79	101	129	85	98	59	72
2012-13	127	59	105	58	42	42	74	135	109	77	91	58	68
% change	**-68**	**-74**	**-52**	**-73**	**-72**	**-85**	**-67**	**-51**	**-55**	**-65**	**-72**	**-60**	**-73**
CAGR	**-6.1**	**-7.2**	**-4.0**	**-7.0**	**-6.9**	**-10.0**	**-5.9**	**-3.9**	**-4.3**	**-5.6**	**-6.9**	**-5.0**	**-7.0**

POLLUTION

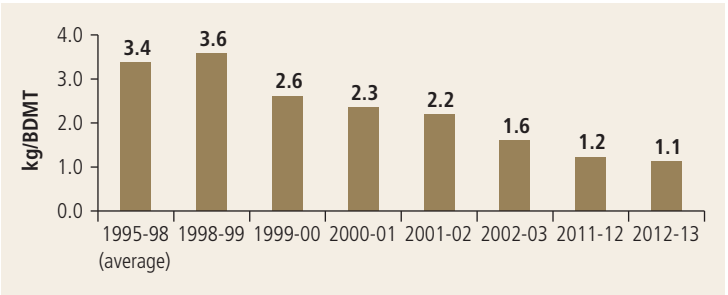
Wastewater

Wastewater discharge: Reduced water consumption (as has been detailed in the previous section) and increased water recycling measures have brought about a reduction in the quantum of wastewater discharged by mills into the environment. All the sample mills have reduced their wastewater discharge by at least 50 per cent, at a CAGR of 7.4 per cent, since 1995. TNPL discharges the lowest amount of specific wastewater (average 28 m^3 per tonne of paper) into the environment. The mill also discharges the lowest quantum of water as percentage of specific water consumed (at 45 per cent), given the extensive recycling and reusing measures it has employed.

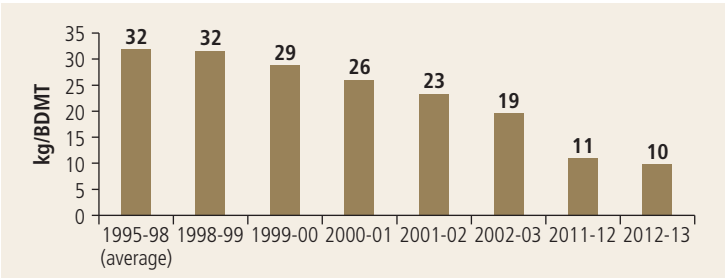
Wastewater pollution load: The sample mills have implemented a number of process changes in the bleaching and the pulping sections specifically. These changes have led to a reduction in the pollution load in the effluent; however, the data disclosed by the mills has wide variations and the reasons have not been fully explained (for example, the effluent quality is a function of the effluent treatment plant in place). Overall pollution load has dropped substantially with biological oxygen demand (BOD) and chemical oxygen demand (COD) reducing by 69 per cent and total suspended solids (TSS) by 75 per cent since 1995. Also, despite a few inexplicable variations, there has been a substantial reduction in AOX levels. A reduction in the pollution load, especially AOX levels, is seen in mills which have adopted ECF bleaching. The pollution loads disclosed by the mills are well within the standards prescribed by the Central Pollution Control Board. However, they fall short when compared with international standards. The Indian mills' average BOD levels have been noted at 1.2 kg/BDMT of product, while the COD levels stood at 11 kg/BDMT of product. The European mills, on the other hand, reported an average BOD of 0.89 kg/ tonne of product and COD of 6.26 kg/tonne of product.

Graph 14: Wastewater characteristics

Specific BOD



Specific COD



Specific TSS

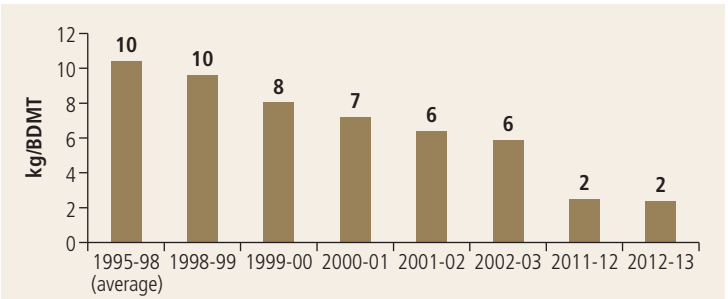
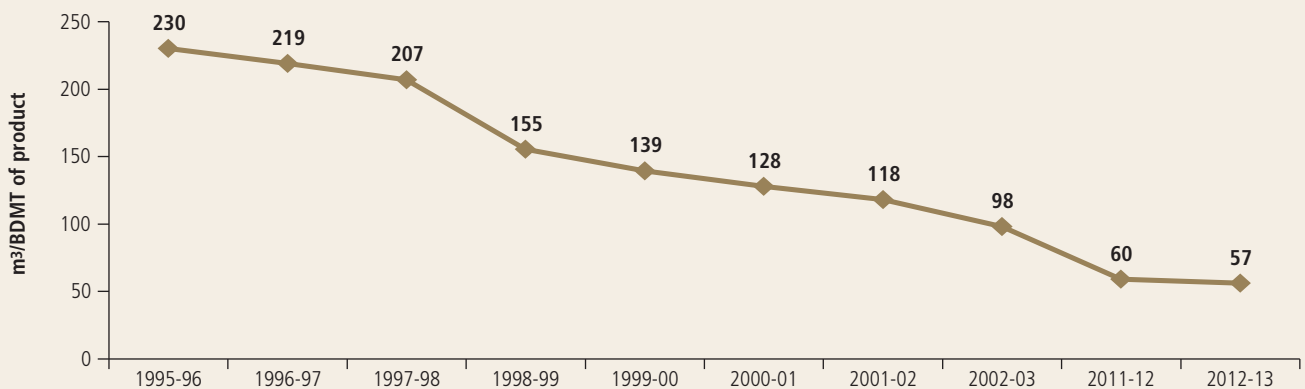


Table 17: Wastewater discharge in sample mills

	BILT-SGU	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshasayee Paper	Orient Paper	Star	Century	WCPM	JKP-Rayagada	Weighted average
1995-96	357	227	198	194	136	255	199	247	218	203	294	133	230
1996-97	372	180	184	208	178	257	197	232	200	170	268	133	219
1997-98	389	169	182	174	219	300	181	226	191	143	259	107	207
1998-99	264	157	157	104	193	113	191	158	181	135	198	141	155
1999-00	224	158	146	98	190	87	182	138	168	121	190	101	139
2000-01	202	132	116	86	185	82	159	133	161	121	199	91	128
2001-02	165	119	121	79	168	81	115	140	162	110	189	86	118
2002-03	171	123	110	74	137	73	94	104	134	117	NA	79	98
2011-12	113	52	93	30	41	44	71	88	114	63	96	53	60
2012-13	109	52	90	28	38	41	67	115	97	58	87	52	57
% change	**-69**	**-75**	**-55**	**-86**	**-72**	**-84**	**-66**	**-54**	**-55**	**-71**	**-70**	**-61**	**-75**
CAGR	**-6.4**	**-7.4**	**-4.3**	**-10.2**	**-6.8**	**-9.7**	**-5.9**	**-4.2**	**-4.4**	**-6.7**	**-6.5**	**-5.1**	**-7.4**

Graph 15: Reduced water discharged due to reduced water use



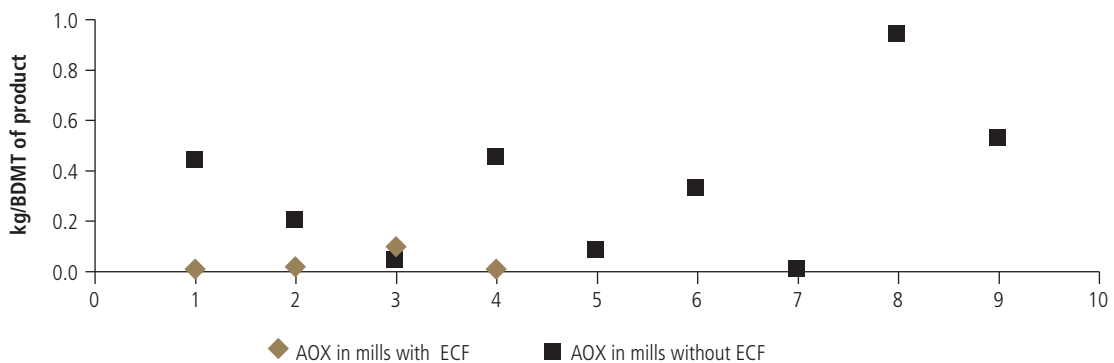
ELEMENTAL CHLORINE-FREE BLEACHING AND POLLUTION LOADS

The toxic Adsorbable Organic Halides or AOX are formed when bleaching is done using elemental chlorine. Adopting ODL reduces the bleaching chemical consumption. This consequently reduces the AOX levels in the final effluent. However, completely eliminating elemental chlorine in the bleaching cycle is the solution to reducing AOX to negligible levels.

The four mills that use ECF bleaching reported the lowest levels of AOX: between 0.003 kg to 0.1 kg/BDMT of paper. The mills that had partially replaced chlorine and were also using ODL reported higher levels of AOX: between 0.2 kg to 0.5 kg/BDMT of paper. The remaining mills that used elemental chlorine or did not use ODL reported the highest levels of AOX.

All the mills in the sample reported AOX levels within the CPCB norms (1 kg/BDMT of paper), which was surprising, given the use of elemental chlorine by eight of them. We believe this indicates inadequate monitoring and reporting of the most toxic of the pollutants by the paper mills.

Graph 16: AOX levels in sample mills



Air emissions

Clearly discernible foul odour is a characteristic quality of air emissions from a pulp and paper mill, more so in the kraft pulping process where sulphur-content emissions are high. Power boilers and lime kilns are the main emitters of the oxides of sulphur and nitrogen, collectively grouped as SO_X and NO_X. In the absence of norms for these parameters, their monitoring and reporting was irregular and unreliable during the previous ratings. Today, there are still no norms for SO_X and NO_X emissions and the reliability remains questionable. However, based on available data, the average specific SO_2 emissions in the sample mills stand at 1.94 kg/BDMT of product and the NO_X levels at 0.32 kg/BDMT of product. SPM has been reported at 1.4 kg/BDMT of product, a reduction by 63 per cent from the levels reported in 1999.

The pulp and paper industry's substantial use of carbon-neutral biomass as fuel reflects in its carbon dioxide (CO_2) emission profile. With reducing energy consumption and a slight increase in the share of biomass in the fuel mix, the greenhouse gas (GHG) emissions of a paper mill have dropped by 23 per cent, from 3.4 tonne/BDMT of product to 2.6 tonne/BDMT of product. In comparison, European mills reported an average 0.24 tonne/BDMT of product produced in 2012, nearly one-tenth the level of their Indian counterparts.

Graph 17: Specific particulate matter

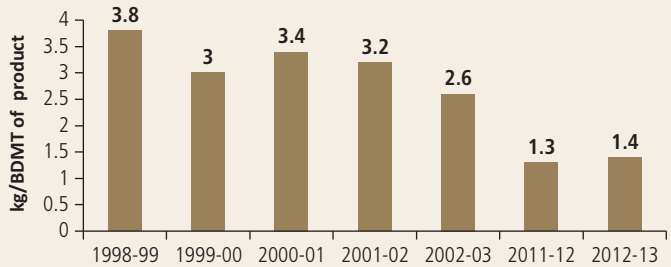


Table 18: GHG emissions in sample mills (tonne/BDMT of product)

	BILT-Yamuna Nagar	BILT-Ballarpur	BILT-Sewa	TNPL	JKP-CPM	ITC Ltd	Seshayee Paper	Orient Paper	Star	Century Pulp & Paper	West Coast Paper	JKP-Rayagada	Weighted average
1998-99	5.4	3.6	3.9	2.4	3.0	3.0	4.0	5.2	3.6	2.7	2.7	4.5	3.4
1999-00	5.3	3.4	3.8	2.7	2.8	2.5	4.5	4.8	2.8	2.5	2.7	3.7	3.3
2000-01	5.0	3.1	3.8	2.9	2.9	2.4	3.9	4.9	2.6	2.7	2.8	3.2	3.1
2001-02	4.7	2.9	3.9	3.4	2.2	2.7	3.6	5.2	2.5	2.9	2.3	3.0	3.2
2011-12	4.2	3.2	4.0	2.7	2.4	1.6	3.1	5.6	3.0	3.0	2.5	2.9	2.7
2012-13	4.0	3.0	4.2	2.5	2.5	1.5	2.8	6.1	2.0	3.3	2.5	2.8	2.6
% change	**-26**	**-17**	**8**	**3**	**-18**	**-50**	**-30**	**18**	**-45**	**23**	**-10**	**-37**	**-23**
CAGR	**-2.0**	**-1.2**	**0.5**	**0.2**	**-1.3**	**-4.5**	**-2.4**	**1.1**	**-4.0**	**1.4**	**-0.7**	**-3.1**	**-1.7**

Conclusion

The two green ratings of the pulp and paper industry carried out in 1998 and 2004 and the survey carried out in 2013 have helped to benchmark the performance of the industry over the years. The previous ratings showed that in many aspects, the industry was behind the global standards by at least a decade. Since the last rating, the industry has shown consistent improvement across several parameters. However, it still has to catch up with the developed world.

The first and second ratings highlighted a number of important indicators which exhibited improving trends: water management, raw material sourcing, environment management and cleaner technologies in the bleaching and pulping sections being the key ones. The current survey of the integrated plants in our sample shows commendable improvements in all of the above mentioned indicators.

The most heartening indicator is the further improvement in raw material sourcing. On an average, the mills in our sample were sourcing between 24 per cent and 30 per cent of wood from farmers during the first and second ratings. The sample is now sourcing 59 per cent of its wood from farmers and 26 per cent from open markets. The share of wood from government plantations has reduced substantially and captive plantations are all but non-existent.

On the energy front, consumption remains sharply higher than global standards. Given that several pulp mills around the globe are now energy "surplus" and European integrated mills consume around 14 GJ/tonne of product, the energy consumption of the mills in our sample at 45 GJ/tonne has immense scope for reduction. The higher levels of consumption also inevitably result in greater dependence on fossil fuels. With coal contributing to more than 50 per cent of the fuel used, the mills' self-sufficiency index, defined as the percentage contribution of biofuels, remains low.

As in the second rating, water consumption continues to decrease. Better water management and recycling practices have led to a reduction in the water usage. From an average 226 m^3 of water consumed for every tonne of paper made in 1998, the usage dropped to an average 140 m^3 of water in 2002. In 2013, the average specific water consumption of the sample mills stood at 68 m^3. While this indicates a 73 per cent reduction in consumption from 1995 levels, we note that this is still a long way from the standards in the developed world. European mills have brought their water usage levels down to 35 m^3 per tonne of product produced.

The mills' performance on pollution front is disappointing. Chlorine is yet to be completely phased out in the Indian pulp and paper industry. Mills across the world have completely phased out both chlorine and chlorine dioxide as primary bleaching chemicals and are now moving towards TCF bleaching. In contrast, elemental chlorine use in several mills in our sample remains inordinately high.

Chemical recovery measures have been implemented in every single plant reducing their overall chemical consumption. Lime consumption, however, remains inexplicably high at an average 96 kg/BDMT of unbleached pulp. This is despite all the mills in the sample having lime kilns.

In balance, we believe, there is an increased environmental consciousness in the industry. The industry has taken some encouraging steps with positive results in raw material sourcing. It has shown considerable improvement in water usage, but still has some ground to cover. Energy efficiency is steadily improving, albeit at a less than desirable rate. It is in chemical consumption, specifically chlorine use, where the industry has fallen below our expectations. While some companies in our sample have done away with elemental chlorine, TCF bleaching remains a distant goal.

Finally, we are encouraged by the industry's willingness to come forward with data, which indicates their confidence in their progress on the sustainability front. It is also a reminder that being a responsible business is inextricably linked to voluntary public disclosure.

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