INDUSTRIES OF INDIA

Paper

Source Companion

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Paper: Source Companion

Industries of India - companion to “Paper: Fibre, Web, World” - Ketineni Ramarao - November 2026

This companion is the evidence record for the Paper volume. It lists every source consulted, what was read, which chapters each source supports, and the verification status of every load-bearing figure. Page numbers refer to the printed pages of the book’s first edition (PDF export of 1 November 2026), so any claim in the book can be located precisely: find the chapter below, go to its page, and match the claim to the sources listed for that chapter.

How to read this companion

Read levels, in descending order of strength: PRIMARY (read at the owning organization’s own page, filing or press release); STUDY (the research publication or its official summary was read); TRADE (read in specialist trade press); AGGREGATOR (read at a third party compiling the owner’s data, and phrased conservatively in the book); BACKGROUND (encyclopedia reference used for chronology and narrative, not for statistics). Entries marked “highlights read” were read in excerpted form on the source’s own page; nothing in the book leans on a source beyond what was actually read.

Where each chapter sits in the book

- p.8 - Prologue: The Sheet in Your Hand
- p.11 - Before Paper: Writing on Everything Else
- p.14 - Papyrus: The First Paper That Wasn’t
- p.17 - Parchment: The Surface That Outlasted Empires
- p.19 - The Weight of Bamboo
- p.22 - Cai Lun and the Recipe
- p.27 - The Craft Perfected: Xuan, Korea, Japan
- p.29 - Samarkand: Paper Comes West
- p.32 - Baghdad: The Paper Capital
- p.35 - The World the Arabs Made of Paper
- p.37 - Xativa and Fabriano: Europe Learns the Sheet

- p.41 - The Rag Economy
- p.43 - The Vatman’s Tools
- p.45 - Gutenberg’s Appetite
- p.48 - The Reading Explosion
- p.50 - The Rag Famine
- p.54 - Two Men and a Tree
- p.56 - The Chemical Mill
- p.59 - White Gold
- p.61 - Mill Towns
- p.63 - The Endless Web
- p.67 - Anatomy of a Paper Machine
- p.69 - The Machine Builders
- p.74 - The Longest Molecule
- p.76 - Engineering a Sheet
- p.78 - The Paper That Read the News
- p.81 - The Sixpenny Revolution
- p.84 - The Rational Sheet
- p.86 - The Box That Ate the World
- p.88 - Paper Goes to Market
- p.90 - The Cup of Common Sense
- p.92 - The Softest Machines
- p.94 - The Small Brilliant Papers
- p.96 - Paper as Instrument
- p.98 - The Papers That Refuse to Commoditize
- p.101 - The Second Harvest
- p.103 - The Sword Falls
- p.105 - Twenty-Five Lives
- p.107 - The Managed Forest
- p.110 - The Thirsty Machine
- p.111 - The Plastic Question
- p.115 - The Four Hundred Million Tonne Economy
- p.117 - The Companies
- p.119 - The Turn
- p.123 - The Third Dimension

- p.125 - The Smallest Fibre
- p.127 - The Conductive Sheet
- p.129 - The Archive
- p.131 - Epilogue: The Sheet That Stayed
- p.135 - Appendix: The Paper Industry at a Glance

Chapter-to-source map

- Prologue (p.8); ch.1 Before Paper: Writing on Everything Else (p.11); ch.2 Papyrus: The First Paper That Wasn't (p.14); ch.3 Parchment: The Surface That Outlasted Empires (p.17); ch.4 The Weight of Bamboo (p.19); ch.5 Cai Lun and the Recipe (p.22): P-A1, P-A2. Archaeological fragments (Fangmatan, Dunhuang) and the Book of the Later Han report as documented in those entries.
- ch.6 The Craft Perfected: Xuan, Korea, Japan (p.27); ch.7 Samarkand: Paper Comes West (p.29); ch.8 Baghdad: The Paper Capital (p.32); ch.9 The World the Arabs Made of Paper (p.35): P-A1, P-A3.
- ch.10 Xativa and Fabriano: Europe Learns the Sheet (p.37); ch.11 The Rag Economy (p.41); ch.12 The Vatman's Tools (p.43): P-A1, P-B1.
- ch.13 Gutenberg's Appetite (p.45); ch.14 The Reading Explosion (p.48); ch.15 The Rag Famine (p.50): P-A4, P-A1, P-C1.
- ch.16 Two Men and a Tree (p.54); ch.17 The Chemical Mill (p.56); ch.18 White Gold (p.59); ch.19 Mill Towns (p.61): P-C1, P-C2, P-D2.
- ch.20 The Endless Web (p.63); ch.21 Anatomy of a Paper Machine (p.67); ch.22 The Machine Builders (p.69): P-D1, P-D2, P-D3, P-D4, P-D5, P-D6.
- ch.23 The Longest Molecule (p.74); ch.24 Engineering a Sheet (p.76): P-E1, P-C2.
- ch.25 The Paper That Read the News (p.78); ch.26 The Sixpenny Revolution (p.81); ch.27 The Rational Sheet (p.84): P-I8, P-F16, P-F9, P-A1.
- ch.28 The Box That Ate the World (p.86); ch.29 Paper Goes to Market (p.88); ch.30 The Cup of Common Sense (p.90): P-F2, P-F3, P-F1, P-F11.
- ch.31 The Softest Machines (p.92); ch.32 The Small Brilliant Papers (p.94); ch.33 Paper as Instrument (p.96); ch.34 The Papers That Refuse to Commoditize (p.98): P-F4, P-F5, P-F6, P-F7, P-F8, P-F10, P-F17, P-F19, P-F20, P-F18, P-F21.
- ch.35 The Second Harvest (p.101); ch.36 The Sword Falls (p.103); ch.37 Twenty-Five Lives (p.105): P-V2, P-G2, P-G1, P-G3, P-G4, P-G5.
- ch.38 The Managed Forest (p.107); ch.39 The Thirsty Machine (p.110); ch.40 The Plastic Question (p.111): P-F18, P-H1, P-H2, P-V3.
- ch.41 The Four Hundred Million Tonne Economy (p.115); ch.42 The Companies (p.117); ch.43 The Turn (p.119): P-V1, P-V4, P-I1, P-I2, P-I3, P-I4, P-I6, P-F14, P-F15, P-

I10, P-I7, P-I11, P-I9.

- ch.44 The Third Dimension (p.123); ch.45 The Smallest Fibre (p.125); ch.46 The Conductive Sheet (p.127): P-J1, P-F13.
- ch.47 The Archive (p.129); ch.48 Epilogue (p.131); Appendix: The Paper Industry at a Glance (p.135): P-A1, P-C2, P-V1, P-V2, P-V3, P-V4, P-G3.

Load-bearing figures and their status

Claim in the book	Figure used	Source	Status
World paper and paperboard production 2024, total	about 420 million tonnes, phrased “about”	FAOSTAT data read at a third-party compile (P-I1: 423.02 Mt in 2024, all-time high 423.25 Mt in 2021, 77.07 Mt in 1961)	AGGREGATOR
Growth of world paper and paperboard production 2024	up 4 to 5 percent in 2024	FAO Newsroom, read in full on the FAO page (P-V1)	PRIMARY
World wood pulp production 2024	189 million tonnes	FAO Newsroom (P-V1)	PRIMARY
World recovered paper consumption 2024	243 million tonnes	FAO Newsroom (P-V1)	PRIMARY
US recycling 2024	60-64% of paper, 69-74% of cardboard; 46 million tons; recycled fibre 44.4% of mill furnish	AF&PA press release (P-V2)	PRIMARY
Europe recycling 2024	75.1%	Cepi / EPRC (P-G2)	PRIMARY (association release)
Fibre recycling durability	still serviceable after 25 controlled cycles; practical ceiling set by collection	TU Darmstadt / ProCarton 25-Loops (P-G3)	STUDY

Claim in the book	Figure used	Source	Status
Suzano Cerrado mill	2.55 Mt/yr eucalyptus pulp; about USD 4.3bn; startup 21 July 2024; largest single line	Suzano company release (P-V3)	PRIMARY
International Paper FY2024	net sales USD 18.619 billion; about 37,000 employees; DS Smith completed January 2025	IP 8-K exhibit, SEC EDGAR (P-V4)	PRIMARY
Smurfit Westrock	about USD 21 billion combined revenue; formed 2024	Company reports via reference entry (P-I6)	BACKGROUND, widely reported and internally consistent
Nine Dragons capacity	over 13 million tonnes	Company via reference entry (P-I4)	BACKGROUND
Newsprint demand	about 38 Mt (2000) to about 12 Mt (2024)	IndexBox market data (P-I8)	AGGREGATOR
Containerboard demand	about 100 Mt (2000) to about 200 Mt (2024)	EMGE outlook (P-I10)	TRADE
Paper's share of industrial energy	about 5-6%	IEA (P-H1, P-H2)	PRIMARY (agency)
India: share of world production (book and appendix use "about 6 percent")	6% of world production, 2024	FAO production shares, read on fao.org (P-I2)	PRIMARY (agency page, highlights read)
India: fibre mix, growth, jobs	waste paper 74-76%, wood 18-20%, agro 6-8%; fastest-growing market; 500,000 direct jobs	IPMA overview (P-I11)	TRADE (industry association). NOTE: IPMA's own framing puts India at about 5% of world production on its year basis; the one-point gap vs FAO's 6% (2024) reflects source and year differences,

Claim in the book	Figure used	Source	Status
			and the book follows the FAO figure throughout
Historical chronology (105 CE, 751, c.1280 Fabriano, 1798-1807 machine, 1843/1846 wood pulp)	dates as printed	P-A1, P-A2, P-C1, P-D2	BACKGROUND, consistent across sources

Claims that could not be supported from a read source were cut during drafting (for example: exact Oji Holdings revenue, a precise national recovery rate for India, per-country 2024 tonnages beyond the top level).

Source registry

ANCIENT / BEFORE PAPER

[P-A1] Wikipedia, “History of paper” https://en.wikipedia.org/wiki/History_of_paper - First true papermaking documented in China, Eastern Han (25-220 CE), attributed to Cai Lun. - Papyrus = lamination of pith strips (Cyperus papyrus); not true paper; paper = fibres macerated/disintegrated before forming. - Papyrus used in Egypt as early as 3rd millennium BCE; fragile, moisture-sensitive, scrolls max 30-35 ft; grew only in Egypt (and Sicily); Arabs tried growing it north of Baghdad in 830s, failed. - Paper displaced papyrus in Muslim world by end of 9th c.; in Asia/Africa by mid-10th c.; papyrus gone from Europe by 11th c. - Word “paper” derives from “papyrus” (Greek). - Shang/Zhou China wrote on bone and bamboo strips: heavy, awkward. - Earliest extant paper fragment: Fangmatan, Gansu, part of a map, dated 179-141 BCE. Dunhuang fragments 65 BCE; Yumen pass 8 BCE. - Invention attributed to Cai Lun dated 105 CE, “recorded hundreds of years after it took place”. - Cai Lun’s innovation: mulberry + other bast fibres, fishing nets, old rags, hemp waste - cut cost vs rag-only paper. - “inspired by wasps and bees” claim (traditional attribution, per this article). - He submitted process to emperor in first year of Yuan-Hsing (105 CE), received praise. - Spread: Vietnam 3rd c., Korea 4th c., Japan 5th c.; Damjing’s 610 trip to Japan often cited as official start there; Korean paper prized glossy white for calligraphy. - Al-Tha’alibi (11th c. Persian historian): Chinese prisoners from Battle of Talas 751 introduced paper manufacturing to Samarkand. Archaeology: paper used in Samarkand decades before 751. - Records: Gilgit 6th c., Samarkand 751, Baghdad 793, Egypt 900, Fes ~1100. - Hodud al-Alam (10th c.) oldest manuscript mentioning Samarkand papermaking industry; Egyptian ministers ordered paper from Samarkand. - Baghdad: districts allocated to paper manufacturing; Suq al-Warraqin = Paper Market, 100+ paper and booksellers’ shops. -

Near Eastern paper sized with starches (rice, gum tragacanth, wheat, white sorghum). - Ibn Khaldun: parchment rare, correspondence grew, Grand Vizier Al-Fadl ibn Yahya ordered paper made to replace parchment (8th c. Baghdad). - 9th-12th c.: libraries of Cairo, Baghdad, Cordoba larger than China's, dwarfed Europe's. - First recorded Iberian paper mill: Xativa 1056; Toledo by 1085; firmly established Xativa by 1150; King Peter III decree: royal hydraulic "molendinum" at Xativa run by Mudejar community. - Italy late 13th c.: Amalfi, Fabriano, Treviso mills; paper price fell to 1/6 of parchment. - Fabriano: stamping hammers for pulp, animal-glue (gelatin) sizing, watermarks via wire on mould. - Troyes France 1348; Holland ~1340-50; Nuremberg 1390 (Ulman Stromer); Switzerland 1432; England: John Tate ~1490 Hertford; first commercially successful English mill John Spilman 1588 Dartford, Kent. - By 1880 America largest paper producer; IP held 60%+ of continent's newsprint in 1898; Holyoke MA made 80% of US writing paper; American Writing Paper Co. world's largest fine-paper producer by 1920. - Matthias Koops, London: 1801 book "Historical account of the substances…" printed on straw paper, covers on wood paper. [P-A2] Wikipedia, "Cai Lun" https://en.wikipedia.org/wiki/Cai_Lun - Cai Lun (c. 50-62 - 121 CE), courtesy name Jingzhong; Eastern Han eunuch court official; born Guiyang Commandery (modern Leiyang, Hunan); died Luoyang 121. - At court by 75 CE; Xiao Huangmen under Zhang; under Emperor He (88): Zhongchang shi (highest eunuch post) + Shangfang Ling (Palace Workshop, instruments/weapons). - Earlier paper forms since 3rd c. BCE: contribution = innovation, not invention. Addition of pulp via tree bark and hemp ends enabled large-scale manufacture and spread. [P-A3] Wikipedia, "Washi" https://en.wikipedia.org/wiki/Washi - Washi: hand-made from inner bark of gampi, mitsumata (Edgeworthia chrysantha), paper mulberry (kozo). Used in origami, shodo, ukiyo-e; clothes, household goods, toys, Shinto vestments, Buddha statues; wreaths at 1998 Winter Paralympics. - UNESCO Intangible Cultural Heritage inscription 2014 (9th session; announced 27 Nov 2014). - Mitsumatagami used to print Japanese paper money since Meiji period, still used. [P-A4] Wikipedia, "Gutenberg Bible" https://en.wikipedia.org/wiki/Gutenberg_Bible - Latin Vulgate printed by Gutenberg in Mainz, 1450s. 158 or 180 copies printed (both figures in a 1455 letter); 49 survive at least substantially complete; earliest dated copies: rubrication completed 24 Aug / 15 Aug 1456 by Henricus Cremer. - Copies on both vellum and paper; Goettingen vellum copy on UNESCO Memory of the World Register 2001.

MEDIEVAL CRAFT

[P-B1] Wikipedia, "Hollander beater" https://en.wikipedia.org/wiki/Hollander_beater - Hollander beater: Dutch; metal blades, macerating action, shorter cellulose fibres, weaker paper vs stamp mills (stamping gave longer, more hydrated, more fibrillated fibres, stronger paper). - Beater roll with bars + grooved bedplate; wheel and plate never touch; gap adjusts pressure.

WOOD PULP AND CHEMISTRY

[P-C1] Wikipedia, “Friedrich Gottlob Keller” https://en.wikipedia.org/wiki/Friedrich_Gottlob_Keller - Keller (27 June 1816 - 8 Sep 1895), machinist/inventor, Hainichen, Saxony; weaver and heddle-maker’s son; kept an “idea-book”. - Inspired by Reaumur, who suggested paper from trees/wasps but never tried (1742 quote: “I am ashamed not yet to have tried this experiment…”). - 1841: idea-book entry for wood-cut grinding machine; worked 1841-44; 1844 produced pulped-wood paper; sent sample to German government - no support. - Charles Fenerty (Nova Scotia) worked on wood paper simultaneously; both announced, both met indifference. Keller patented; Fenerty did not. [P-C2] Wikipedia, “Kraft process” https://en.wikipedia.org/wiki/Kraft_process - Kraft/sulfate process: dominant industrial wood-to-pulp process; pulp = almost pure cellulose fibres. Name from Swedish/German “kraft” = strength. - White liquor = NaOH + Na2S; dissolves/degrades lignin and hemicellulose; pH 13-14; digester. - Yields: unbleached 65-70%, bleached ~50%, overall below 45% in some cases. - First kraft paper: Munksjo mill, Jonkoping, Sweden, to C.F. Dahl’s patent (Danzig), usually dated 1884/85 (sometimes 1890). - Dahl began substituting sodium sulfate for soda ash in 1879; earlier US patents of A.K. Eaton 1870/71 on sulfide use. - Discovery lore: digester “blown” prematurely; mill manager processed the undercooked chips anyway -> dark, far stronger paper. - Dahl credited with chemical recovery process - “perhaps more important than the kraft cooking process” (per this article).

MACHINE

[P-D1] Frogmore Paper Mill, “The Fourdrinier Paper Machine” https://frogmorepapermill.org.uk/archive/the-fourdrinier-paper-machine/ - Nicolas-Louis Robert, accountant at Essonnes paper mill, invented/patented hand-operated machine making paper up to 12 feet long. - Rights sold to employer Leger Didot; John Gamble took English patent October 1801; Henry and Sealy Fourdrinier (stationers Bloxham & Fourdrinier) financed for one-third of rights. - 1802: John Hall of Dartford contracted to build; brother-in-law Bryan Donkin took charge, rapid progress. - Fourdriniers built Donkin an engineering works in Bermondsey; leased Frogmore Mill, Apsley, Hertfordshire 1803; first improved Robert machine installed later 1803. - Process: dilute pulp onto endless wire cloth; water drains; press section transfers sheet to continuous felt; rollers press; reeled; cut and loft-dried. - 1805: improved machine at Two Waters mill. Further patents 1803 and 1807.

SCIENCE

[P-E1] Wikipedia, “Anselme Payen” https://en.wikipedia.org/wiki/Anselme_Payen - Payen: discovered diastase and cellulose. 1838 memoir, Comptes rendus vol.7 pp.1052-1056; appendices Dec 1838 / Feb 1839. - 1839 Dumas report to French Academy coined “cellulose”, noting empirical formula like starch/dextrine.

GRADES AND PRODUCTS

[P-F1] Wikipedia, “Paper bag” https://en.wikipedia.org/wiki/Paper_bag - 1852: Francis Wolle, Pennsylvania schoolteacher, first mass-production paper bag machine; patented with brother; Union Paper Bag Company. - 1871: Margaret E. Knight designed machine for flat-bottomed paper bags. - 1883: Charles Stilwell patented square-bottom pleated-side bag machine. - 2015 EU directive 2015/720: cut single-use plastic bags to 90/person by 2019, 40 by 2025. [P-F2] Wikipedia, “Corrugated fiberboard” https://en.wikipedia.org/wiki/Corrugated_fiberboard - Corrugated (pleated) paper patented England 1856, tall-hat liner. - Corrugated boxboard for shipping patented 20 Dec 1871, Albert Jones, NYC: single-face, for wrapping bottles and glass lantern chimneys. - Robert Gair, Brooklyn printer/paper-bag maker, 1870s: creasing ruler slipped and cut seed bags -> cutting + creasing in one operation -> prefabricated paperboard boxes; applied to corrugated. [P-F3] Wikipedia, “Corrugated box” https://en.wikipedia.org/wiki/Corrugated_box - >95% of all products in the US shipped in corrugated boxes. Corrugated = more than half of all paper recycled in the US. - Corrugating line can be football-field size; single-wall = one fluted layer + two liners. [P-F4] Wikipedia, “Kleenex” https://en.wikipedia.org/wiki/Kleenex - WWI: Cellucotton Co crepe-paper gas-mask filter; modified thinner/softer -> 1924 “Kleenex” as cold-cream remover; first ads 1925. - 1930s slogan “Don’t Carry a Cold in Your Pocket” -> disposable handkerchief use. Trademark filed 12 July 1924, Neenah, Wisconsin. Made in 78 countries. [P-F5] Wikipedia, “Toilet paper” https://en.wikipedia.org/wiki/Toilet_paper - Joseph Gayetty: modern commercial US toilet paper, 1857: flat sheets watermarked with his name, sold into 1920s. - 1930s: Northern Tissue “splinter free”. Flush-toilet spread increased use. [P-F6] Wikipedia, “Post-it Note” https://en.wikipedia.org/wiki/Post-it_Note - 1968: Spencer Silver (3M) aimed for super-strong adhesive; got low-tack reusable pressure-sensitive adhesive. Promoted internally 5 years - “solution without a problem”. - 1974: Art Fry, choir bookmark; 3M “permitted bootlegging” time. Canary yellow = scrap paper colour from next-door lab. - Boise Blitz 1978: free samples in Boise, Idaho; >90% of recipients would buy. US launch as Post-it Notes 1980. [P-F7] Wikipedia, “Tea bag” https://en.wikipedia.org/wiki/Tea_bag - 1903: Roberta Lawson & Mary McLaren, Milwaukee, US patent 723287 “Tea Leaf Holder” (filed 1901). - Thomas Sullivan, NY tea/coffee importer, marketed silk tea bags ~1908 worldwide. - 1929: Adolf Rambold’s Pompadour for Teekanne, 35 gauze bags/min. 1949: Constanta dual-chamber, 160/min. - 1930: William Hermanson patented heat-sealed paper-fibre tea bag. Rectangular bag 1944. PG Tips tetrahedral 1997. - 2021 study: 15 of 22 tested “cellulose” tea bags contained polyester/PE/PP shedding microplastics. [P-F8] Wikipedia, “Melitta” https://en.wikipedia.org/wiki/Melitta - Melitta Bentz (1873-1950), Dresden; drip-brew paper coffee filter; German patent 8 July 1908, “Filter Top Device lined with Filter Paper”. - 1930s: cone + ribs. 1992: oxygen-bleaching for white filter paper without chlorine. Group ~3,300 employees (2015). [P-F9] Wikipedia, “Paper size” https://en.wikipedia.org/wiki/Paper_size - ISO 216 from DIN 476 (1922); A series aspect ratio sqrt(2) ~1.41421; two A(n) fit on A(n-1); A4 folds to A5. - sqrt(2) advantage noted

1786 by Georg Christoph Lichtenberg. [P-F10] Wikipedia, “Carbonless copy paper” https://en.wikipedia.org/wiki/Carbonless_copy_paper - NCR microencapsulation history: Barrett K. Green and Lowell Schleicher, NCR, 1950s. [P-F11] Wikipedia, “Dixie Cup” https://en.wikipedia.org/wiki/Dixie_Cup - Aug 1908: Prof. Alvin Davison (Lafayette College) “Death in School Drinking Cups”, Technical World Magazine; Easton PA schools; reprinted by Massachusetts State Board of Health. - Lawrence Luellen, Boston: ice-cooled water-vending machine with disposable cups; with Hugh Moore; American Water Supply Company of New England 1908; states banned shared public cups; became Individual Drinking Cup Co, later Dixie Cup Corp (name from Dixie Doll Co); Wilson PA factory with cup-shaped water tank. [P-F12] Wikipedia, “Nokia” https://en.wikipedia.org/wiki/Nokia - Established as pulp mill 1865 (Fredrik Idestam), Tammerkoski rapids near Tampere, Grand Duchy of Finland; second pulp mill 1868 near town of Nokia (hydropower); 1871 Nokia Company with Leo Mechelin. [P-F13] Wikipedia, “E Ink” https://en.wikipedia.org/wiki/E_Ink - Co-founded 1997, Billerica MA; microencapsulated electrophoretic displays (“electronic paper”); “ink on paper” look. - Acquired by PVI 24 Dec 2009 ($215M, eventually ~$450M). Tech used in Sony Reader, Nook, Kindle, Kobo; 2015 Sydney E Ink road traffic signs (first in signage).

RECYCLING

[P-G1] Recycling Today (2025-08-12), “US paper recycling rate, exports down in ‘24” https://www.recyclingtoday.com/news/afpa-announces-2024-united-states-paper-recycling-rate/ - AF&PA 2024 US: paper 60-64% recycled; cardboard 69-74% (2023: 65-69% / 71-76%). 46 million tons recycled 2024. - Recovered fibre share of US mill feedstock: 36.6% (2005) -> 37.7% (2015) -> 44.4% (2024). - US mills used 32.7M tons recovered fibre 2024 (+1.29M vs 2023). Since 2021 ~4M tons mostly-100%-recycled containerboard/packaging capacity online. [P-G2] Cepi press release (2025-07-11), EPRC 2024 https://www.cepi.org/press-release-european-paper-recycling-council-reports-strong-recycling-rates-for-2024/ - Europe 2024 paper recycling rate 75.1%; target 76% by 2030. North America 68.2%. Paper packaging 83.1% - highest among packaging materials. “Paper is the most recycled material in the EU” (EPRC chair). [P-G3] MM Group (2019) + TU Darmstadt study https://mm.group/news/board-paper/paper-fibres-can-be-recycles-nearly-indefinitely-proven-by-a-new-scientific-study/ and ProCarton 25-Loops https://www.procarton.com/wp-content/uploads/2022/01/25-Loops-Study-English-v3.pdf - Old rule: fibres recycle 4-7 times - based on mass balances, not fibre capability. - TU Darmstadt (Putz/Schabel): corrugated mix (20% virgin, 80% recycled), 25 cycles, no significant fibre-length/stability change; strength losses 5-12%; biggest changes in first 2-4 cycles. - Real limit = collection rate and impurity separation. “Design to recycling”. [P-G4] USITC Executive Briefing, “China’s Recycled Wastepaper Import Policies: Part 2” https://www.usitc.gov/publications/332/executive_briefings/ebot_trade_in_wastepaper.pdf (highlights read) - China 2018: ban on mixed paper, 0.5% contaminant limit on OCC/old newspapers. US was largest wastepaper exporter, China its biggest market. - Wastepaper prices plummeted; flows diverted to India and Indonesia, US mills,

landfill/incineration. China weighed full import ban by end-2020. [P-G5] U Chicago study, “China’s Waste Import Ban and US Solid Waste Management” https://www.journals.uchicago.edu/doi/10.1086/729899 (abstract read) - Ban from 2018 raised US landfill disposal, cut postconsumer recycling; >20% of displaced scrap paper went to other importers.

ENVIRONMENT / ENERGY

[P-H1] IEA news (2022), Brazil pulp & paper benchmarking https://www.iea.org/news/iea-deepens-cooperation-with-brazil-with-new-benchmarking-report-on-the-pulp-and-paper-sector - Pulp and paper = 5.3% of final industrial energy consumption globally (2020); Brazil 16% (2020). [P-H2] EPE/IEA “Pulp and Paper Industry in Brazil and in the World” (2022) https://www.epe.gov.br/sites-en/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-234/Pulp%20and%20paper_EPE+IEA_ENGLISH_2022_01_25_IBA.pdf (highlights read) - Black liquor (“lye”) grew 15% -> 52% of Brazil sector energy matrix over 50 years; cogeneration; sector exports renewable electricity; pulp plants 1-2 Mt/yr; integrated mills avoid pulp-drying energy.

INDUSTRY TODAY

[P-I1] FAO Forest Products Statistics via statizoid (2024) https://environment.statizoid.com/stat/paper-and-paperboard-production-2/world/ - World paper & paperboard production 2024: 423.02 Mt. All-time high 423.25 Mt (2021). 1961: 77.07 Mt. - Countries 2024 (Mt): China 140.30; US 62.46; India 22.36; Japan 21.89; Germany 19.19; Indonesia 11.95; Brazil 11.32; Korea 10.98; Russia 10.75; Canada 8.35; Sweden 8.07; Italy 7.98; Finland 6.93; France 6.64. [P-I2] FAO shares 2024 (fao.org/forestry/statistics/data/en, highlights read) - Production: China 34%, US 14%, India 6%, Japan 5%, Germany 4%. - Pulp-for-paper consumption: China 31%, US 19%, Sweden 4%, Japan 4%, India 4%, Brazil 4%. - Recovered paper consumption: China 31%, US 12%, Germany 6%, Japan 6%, India 5%. [P-I3] Wikipedia, “International Paper” https://en.wikipedia.org/wiki/International_Paper - Incorporated 31 Jan 1898, merger of 17 mills NE US + E Canada; founders Russell & Chisholm; HQ Memphis TN. - At founding supplied 60% of US newsprint. - 2024 revenue US$18.6B; ~37,000 employees. DS Smith acquisition US$7.2B completed Jan 2025. Past: Hammermill 1986, Union Camp 1999, Champion International 2000. [P-I4] Wikipedia, “Nine Dragons Paper” https://en.wikipedia.org/wiki/Nine_Dragons_Paper_Holdings_Limited - SEHK:2689; est. 1995; CEO/largest shareholder Zhang Yin. Largest paperboard producer in Asia; 9 factories China+Vietnam; ND Paper US (4 mills + box plant). - 1998: 200,000 t kraftliner machine -> >13 Mt global production; primarily recycled fibre; recycles >10 Mt fibre/yr; Dongguan = world’s largest concentrated paper mill, 15 machines, 5.25 Mt; 1,400+ MW power. [P-I5] Suzano press release, world’s largest pulp line startup https://www.suzano.com.br/en/news-post/suzano-starts-operation-of-the-worlds-largest-pulp-production-line - World’s largest market pulp producer. Cerrado Project, Ribas do

Rio Pardo, MS: startup 21 July 2024; 2.55 Mt/yr eucalyptus pulp; total 13.5 Mt/yr (+20%); R$22.2B (~US$4.3B); 180 MW/month avg surplus green power; forest-to-mill 65 km avg; self-sufficient in sulfuric acid and hydrogen peroxide; +1.5 Mt/yr paper capacity. [P-I6] Wikipedia, “Smurfit Westrock” https://en.wikipedia.org/wiki/Smurfit_Westrock - Smurfit Kappa + WestRock merger (2024); CEO Anthony Smurfit; 2024 revenue US$21.1B; op. income $1.01B; assets $43.8B. [P-I7] Cepi (2025), Europe 2024 https://www.cepi.org/press-release-europes-pulp-and-paper-sector-has-shown-resilience-in-2024-but-high-energy-prices-and-macro-economic-uncertainties-remain-an-issue/ (highlights read) - Europe 2024: consumption +7.5%, production +5.2% (after 2023 -13%); graphic demand +5.2% (first growth since 2010); tissue +5.8%; energy prices 2x pre-Covid. [P-I8] IndexBox, Newsprint Market https://www.indexbox.io/search/newsprint-market/ - World newsprint consumption 2024: 12 Mt (+3%, first rise since 2012); peaked 31 Mt 2012 (their series); market $9.8B 2024 vs $23.7B 2012; forecast ~12 Mt by 2030. - Nieman Lab 2013 (longer arc): world peak 38 Mt 2000 -> 29 Mt 2012; North America peak 13.1 Mt 1999 -> 4.9 Mt 2012 (-62%). https://www.niemanlab.org/2013/11/the-newsonomics-of-the-surprisingly-persistent-appeal-of-newsprint/ [P-I9] Japan NSK (2025-01) https://www.pressnet.or.jp/news/headline/250128_15717.html (Japanese; highlights read) - Japan 2024 newsprint domestic demand 1,531,085 t, -8.9% YoY; 41% of 2006 peak; imports zero 6th year; 43g share 44.3%, 40g share 49.4%. [P-I10] EMGE World Containerboard Outlook 2030 ToC https://www.emge.com/wp-content/uploads/2025/08/EMGE-World-Containerboard-Market-Outlook-2030-ToC.pdf (highlights read) - Containerboard demand: just under 100 Mt in 2000; doubled by 2024 (~200 Mt). Drivers: e-commerce, sustainability, plastic transition. [P-I11] IPMA overview https://ipmaindia.org/overview-2/ - India ~5% of world production; turnover >INR 1,00,000 crore; exchequer >INR 5,000 crore; direct jobs 500,000; indirect ~1.5M. - Raw material: ~18-20% wood, 74-76% recycled fibre, 6-8% agro-residue. - Per capita ~16 kg vs world 57 kg (developed 200+ kg per IPMA world-class page). Fastest-growing market; +1 kg/capita = +1 Mt demand. - IPMA Myths vs Realities: consumption projected 24 Mt in 2024-25 from ~20 Mt. https://ipmaindia.org/wp-content/uploads/2022/05/Myths-versus-Realities-1-1.pdf - IPPTA: consumption 8.5 Mt FY2012 -> 13.05 Mt FY2017; CAGR 6% (2012-13..2022-23) vs world 3%; per capita ~14 kg. https://ippta.co/wp-content/uploads/2025/07/Paper-industry-apr23-1.pdf

FUTURE / MATERIALS

[P-J1] PMC review, “Commercial application of cellulose nano-composites” https://pmc.ncbi.nlm.nih.gov/articles/PMC6389799/ (highlights read) - Nanocellulose: CNC, CNF, bacterial nanocellulose; non-toxic, biodegradable, biocompatible; low thermal expansion, high aspect ratio, high tensile strength. - Applications: papermaking/coating additives, food packaging, flexible screens, transparent films, ballistic protection, auto windows, drug delivery, sutures/stents, membranes (ultrafiltration, ion exchange, fuel cells).

MACHINE (cont.)

[P-D2] Robert R. H. Clapperton / Georgia Tech Paper Museum, “The Advent of the Paper Machine” https://paper.gatech.edu/advent-paper-machine - Robert (1761-1828) invented prototype 1798; French patent 18 Jan 1799; proofreader for Didot, then accountant at St. Leger Didot’s Essonnes mill; motive: urgent need for banknotes after the Revolution. - Gamble English patent 2487 April 1801; Fourdriniers + Donkin further improved machine 1807. - Fourdriniers invested up to GBP 60,000, received no royalties due to a patent error; Donkin the only one with financial security: by 1851 designed 191 machines (83 British, 105 Europe, 1 India, 2 US). - First US fourdrinier imported and erected Saugerties NY 1827; first American-built by Spafford & Phelps, May 1829, sold to Amos Hubbard for $2,426. - Cylinder machine introduced by John Dickinson 1809 (Hertfordshire). [P-D3] Wikipedia, “Paper machine” https://en.wikipedia.org/wiki/Paper_machine - Tissue machines operate at up to 2,000 m/min. Sections: forming (wet end/wire), press, dryer. Whitewater recirculated by fan pump through headbox from wire pit etc. [P-D4] Wikipedia, “Voith” https://en.wikipedia.org/wiki/Voith - 1825: Johann Matthaus Voith takes over father’s locksmith workshop in Heidenheim (5 employees), repairing water wheels and paper mills. - From 1856: builds mechanical wood grinders for Heinrich Voelter, based on Keller’s 1846 patent. - 1867: Friedrich Voith takes over; specialises in paper machines, water wheels, turbines. 1869: first Voith patent for wood grinder with toothed loading roller. - 1903: world’s largest turbines (12 x 12,000 HP Francis) for Niagara Falls. 1911: fastest, widest newsprint machine (St. Polten). 1953: fastest paper machine in Europe (newsprint, Feldmuehle). 1961: Europe’s largest newsprint machine, wire width 8.3 m, Ahlstrom, Warkaus, Finland. Pioneer of flotation deinking. - Today: family-owned, ~22,000 employees, sales EUR 5.2 billion, 60+ countries. [P-D5] Wikipedia, “Valmet” https://en.wikipedia.org/wiki/Valmet - Finnish engineering group; industrial roots 200+ years in Finnish state-supported shipbuilding and textile manufacturing; today full-line paper/board/tissue machine supplier. [P-D6] Wikipedia, “Beloit Corporation” https://en.wikipedia.org/wiki/Beloit_Corporation - Bought by four employees 1885, became Beloit Iron Works; renamed Beloit Corporation 1962; major US paper-machine builder; bankruptcy at turn of the millennium.

MORE COMPANIES / PRODUCTS

[P-F14] Wikipedia, “Stora Enso” https://en.wikipedia.org/wiki/Stora_Enso - World’s oldest preserved share certificate: 1/8 share of Stora Kopparberg mine, 16 June 1288; some observers consider Stora Enso the oldest limited liability company in the world. Acquired Consolidated Papers (North America) 2000 for EUR 4.9B. [P-F15] Wikipedia, “Asia Pulp & Paper” https://en.wikipedia.org/wiki/Asia_Pulp_%26_Paper - Sinar Mas Group subsidiary; founded as Tjiwi Kimia 1972 by Eka Tjipta Widjaja (coconut-oil refiner turned commodities); APP officially formed 1994 combining Tjiwi Kimia and PT Indah Kiat Pulp & Paper. [P-F16] Wikipedia, “Penguin Books” https://en.wikipedia.org/wiki/Penguin_Books - First Penguin paperbacks launched 30

July 1935 at sixpence, “the same as a packet of cigarettes”; Allen Lane; Woolworths order of 63,000 books paid for the project; one million Penguins printed by March 1936; floated on London Stock Exchange 20 April 1961. [P-F17] Wikipedia, “Kimberly-Clark” https://en.wikipedia.org/wiki/Kimberly-Clark - Founded Neenah, Wisconsin 1872 by John A. Kimberly et al. with $42,000 capital. Brands: Kleenex, Kotex, Cottonelle, Scott, Andrex, Wypall, KimWipes, Huggies. WWI cellucotton: army nurses used cellu-cotton pads; six years later company introduced Kotex, first disposable feminine hygiene product. Closed its last paper mills in 2012 (HQ Irving, Texas since 1985). [P-F18] Wikipedia, “Forest Stewardship Council” https://en.wikipedia.org/wiki/Forest_Stewardship_Council - FSC: global forest certification system; logo signifies product from environmentally, socially and economically responsible sources (per the council). [P-F19] Wikipedia, “Litmus” https://en.wikipedia.org/wiki/Litmus - Litmus: dye from lichens (Roccella etc.); word from Old Norse litmosi, “colour moss”. Circa 1300 Arnaldus de Villa Nova used litmus to study acids and bases. Blue litmus turns red in acid; red turns blue in base. [P-F20] Wikipedia, “Chromatography” https://en.wikipedia.org/wiki/Chromatography - Method developed by botanist Mikhail Tsvet 1901-1905 (Kazan, Warsaw). Martin & Synge developed partition chromatography in 1940s-50s -> 1952 Nobel Prize in Chemistry; their work spurred paper chromatography, gas chromatography, HPLC. Paper can serve as the stationary phase. [P-F21] Wikipedia, “Essity” https://en.wikipedia.org/wiki/Essity - Spun off from SCA (Svenska Cellulosa) 2017; listed Stockholm 15 June 2017; operates in ~150 countries, serves >1 billion people; name from “essentials” and “necessity”; personal care, consumer tissue, professional hygiene, medical.

Primary-source verification (read 1 November 2026)

[P-V1] FAO Newsroom, “Global forest products trade and production show signs of recovery in 2024” https://www.fao.org/newsroom/detail/global-forest-products-trade-and-production-show-signs-of-recovery-in-2024/en - VERIFIED on the FAO page (re-read 2 November 2026): paper and paperboard production grew between 4 and 5 percent in 2024; wood pulp production climbed 3 percent to 189 million tonnes; global consumption of recovered paper edged up 1 percent to 243 million tonnes. - LIMIT: the page states growth rates, pulp and recovered-paper totals only. It does not state the world paper and paperboard tonnage itself; the about-420 Mt total used in the book comes from the FAOSTAT compile at P-I1 (AGGREGATOR). [P-V2] AF&PA press release, “Paper Industry Announces 2024 U.S. Paper Recycling Rates” https://www.afandpa.org/news/2025/paper-industry-announces-2024-us-paper-recycling-rates - VERIFIED: 60-64% of paper, 69-74% of cardboard recycled in US 2024; 46 million tons recycled; US mills used 32.7 Mt recycled paper; recycled fiber share of US mill furnish 44.4% (2024), up from 36.6% (2005). [P-V3] Suzano company release https://www.suzano.com.br/en/news-post/suzano-starts-operation-of-the-worlds-largest-pulp-production-line - VERIFIED: Cerrado mill, Ribas do Rio Pardo, startup announced 21 Jul 2024; 2.55 Mt/yr eucalyptus pulp; raises Suzano capacity >20% to 13.5 Mt/yr; total

investment R$22.2bn (~USD 4.3bn); largest single pulp production line in the world; Suzano = world's largest market pulp producer. [P-V4] International Paper 8-K exhibit, full-year 2024 results (SEC EDGAR) https://www.sec.gov/Archives/edgar/data/51434/000005143425000004/nextgenip-20241231ex991.htm - VERIFIED: FY2024 net sales USD 18.619bn (2023: 18.916bn); net earnings USD 557m; ~37,000 employees; Georgetown SC pulp mill closure announced; DS Smith acquisition integration ("welcoming the DS Smith team", completed Jan 2025).