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Deloitte.

Decarbonization White Paper

Accelerating the Green Transformation
of the China's Forestry, Pulp and Paper Industry

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CONTENTS

01
Introduction

02

The Impact of Dual Carbon Policies on China's Pulp and Paper Industry

03

Decarbonization Pathways in the Pulp and Paper Industry

04

Insights from Global DecarbonizationBest Practices

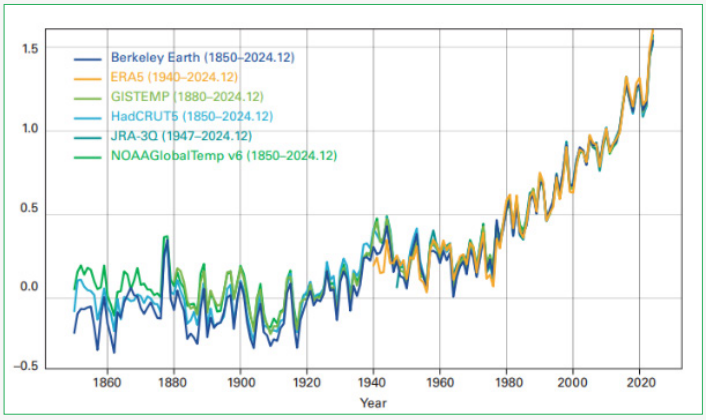
Industry Outlook

Introduction

Global Climate Change Challenges and the Global Consensus on Decarbonization

The global impacts of climate change are unfolding at an unprecedented pace and scale. According to the World Meteorological Organization (WMO)'s 2024 Global Climate Status Report[1], 2024 has become the warmest year on record. Based on aggregated data from six major temperature datasets, including Berkeley Earth and the European Centre for Medium-Range Weather Forecasts, as shown in the right figure, the global average temperature has increased by 1.55 ± 0.13 ℃ above pre-industrial levels (1850-1900). The frequent occurrence of extreme weather events and ecosystem degradation caused by global warming has also had significant negative impacts on the global economy. A study in 2024 projected that the ongoing trend of global warming could result in a cumulative income loss of 19% for the global economy over the next 26 years, underscoring that the cascading effects of climate change have evolved into a systemic crisis that threatens both human well-being and economic stability[2].

Global Mean Temperature 1850-2024
Difference from 1850-1900 average



Source: World Meteorological Organization

At the same time, the urgency of global climate action is becoming increasingly apparent. The United Nations Environment Programme's Emissions Gap Report 2024 underscores that countries must collectively commit in their next round of national climate action plans, known as "Nationally Determined Contributions (NDCs)", to reduce annual greenhouse gas emissions by 42% by 2030 and by 57% by 2035. Furthermore, countries must act swiftly to support this goal, otherwise the objectives of the Paris Agreement (to limit global temperature rise to 1.5 ℃) will not be achieved[3]. Moreover, as the world's largest economy and second-largest emitter of carbon, the US plans to withdraw from the Paris Agreement in 2026 and lift all carbon emission restrictions, which would severely impede global efforts to meet emission reduction and temperature control targets[4].

At the 29th Conference of the Parties (COP29) to the United Nations Framework Convention on Climate Change (UNFCCC), nations reached several key agreements, including improvements to the global carbon market mechanism, the establishment of climate financing targets, and the enhancement of NDCs. These efforts culminated in the adoption of the Baku Climate Unity Pact[5], marking a significant step forward in advancing the global carbon market framework. China played a pivotal role in the conference, actively fostering international collaboration and knowledge exchange, and offering Chinese insights and strategies to support global climate governance. The 2025 COP30 conference, to be held in Brazil, will focus on reviewing updates to and the implementation of countries' climate action plans, as well as assessing global progress toward emission reductions to ensure the achievement of the Paris Agreement's climate goals.

Under the common challenge of global climate change, decarbonization has become a consensus and pursuit among countries worldwide, with the vast majority of nations having clearly and publicly announced their goals for achieving net-zero emissions.

Carbon Neutrality Commitments of Major Global Economies

2050

EU	European Climate Law Legislation
Canada	Enhanced Climate Plan - A Healthy Environment, A Healthy Economy Policy
Australia	Climate Change Act 2022
Japan	Green Growth Strategy
Brazil	"Nationally Determined Contribution" commitment
UK	Climate Change Act 2008

2060

China	Dual-Carbon Goals

2070

India	Climate Commitments at COP26

Source: Deloitte China, government documents, and public materials

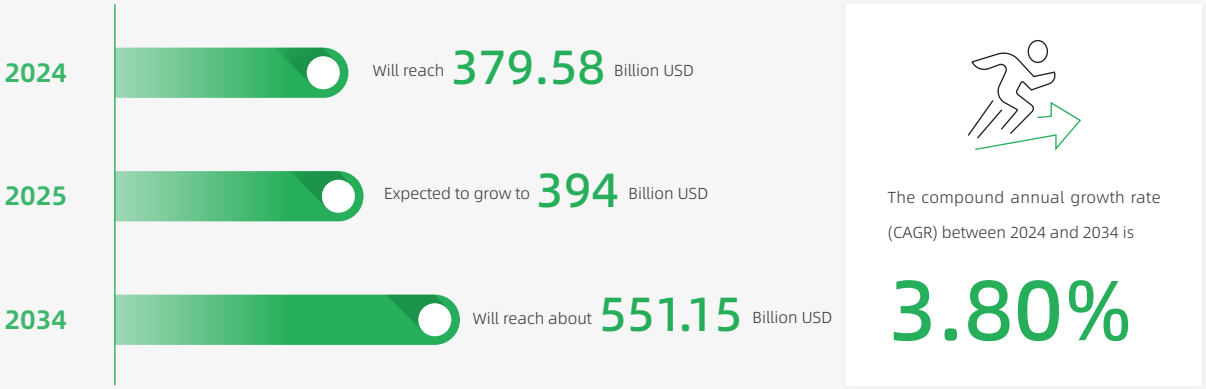
According to the 2024 Global Carbon Neutrality Annual Progress Report released by the Tsinghua University Institute for Carbon Neutrality, as of 2024, 151 countries have proposed carbon neutrality goals. Among these, 120 countries have established their goals through laws or policy documents, and 86 countries have formulated detailed implementation roadmaps[6]. As the world's largest carbon emitter, China proposed the Dual-Carbon Goals of "Peaking Carbon Emissions by 2030 and Achieving Carbon Neutrality by 2060" in 2021. These goals have been integrated into China's national strategic framework to ensure steady progress toward their realization.

The Importance of the Pulp and Paper Industry in Global Carbon Emission Reduction

Global demand for the industry continues to rise

The global demand and consumption of pulp and paper are continuously rising, primarily due to the surge in logistics packaging materials driven by the expansion of global e-commerce, the continuous increase in household tissue consumption spurred by changes in the global population structure and enhanced hygiene awareness, and the acceleration of industrialization in emerging economies, which is releasing demand for pulp and paper. According to Precedence Research, the Asia-Pacific region accounted for 39% of the global pulp and paper market revenue share in 2023. The growing demand for paper-based products in developing countries such as China and India, driven by economic growth, accelerated industrial transformation and urbanization, is the main driving force behind the global market's rise. The study estimates that the global pulp and paper market size will reach $379.58 billion in 2024, is expected to grow to $394 billion in 2025, and will reach approximately $551.15 billion by 2034, with a compound annual growth rate (CAGR) of 3.80% from 2024 to 2034[7].

Global Pulp and Paper Market Size



Source: Precedence Research

One of the key industries for global carbon reduction

The pulp and paper industry is one of the key sectors closely watched in the carbon reduction efforts of various countries. According to statistics from the United States Environmental Protection Agency, the total carbon emissions from the pulp and paper industry were approximately 32 Mt CO_2 in 2023[8]. Additionally, the total carbon emissions from pulp and paper industry facilities recorded in the EU Emissions Trading System (EU ETS) in 2023 were approximately 18 Mt CO_2[9]. As a resource and chemical-intensive industry, the production process of pulp and paper manufacturing requires a large amount of natural resources such as wood, water, and energy, and relies on various chemicals and auxiliary materials. According to the annual survey by the Food and Agriculture Organization (FAO) of the United Nations, the pulp manufacturing industry has consistently consumed about 15% of the global industrial wood volume. The pulp and paper industry is also a major consumer of water, with studies indicating that the water footprint for each ton of pulp can range from hundreds to thousands of tons, meaning that the water consumption for producing an average A4 sheet of paper could be between 2 to 13 liters. Furthermore, the pulp and paper industry still heavily depends on fossil fuels like coal and oil, leading to significant greenhouse gas emissions, with this portion of carbon emissions typically accounting for over 80%. With the anticipated growth in paper production and the approaching global carbon targets, the pulp and paper industry has become a critical sector for achieving global carbon neutrality.

Decarbonization of the industry is extremely urgent

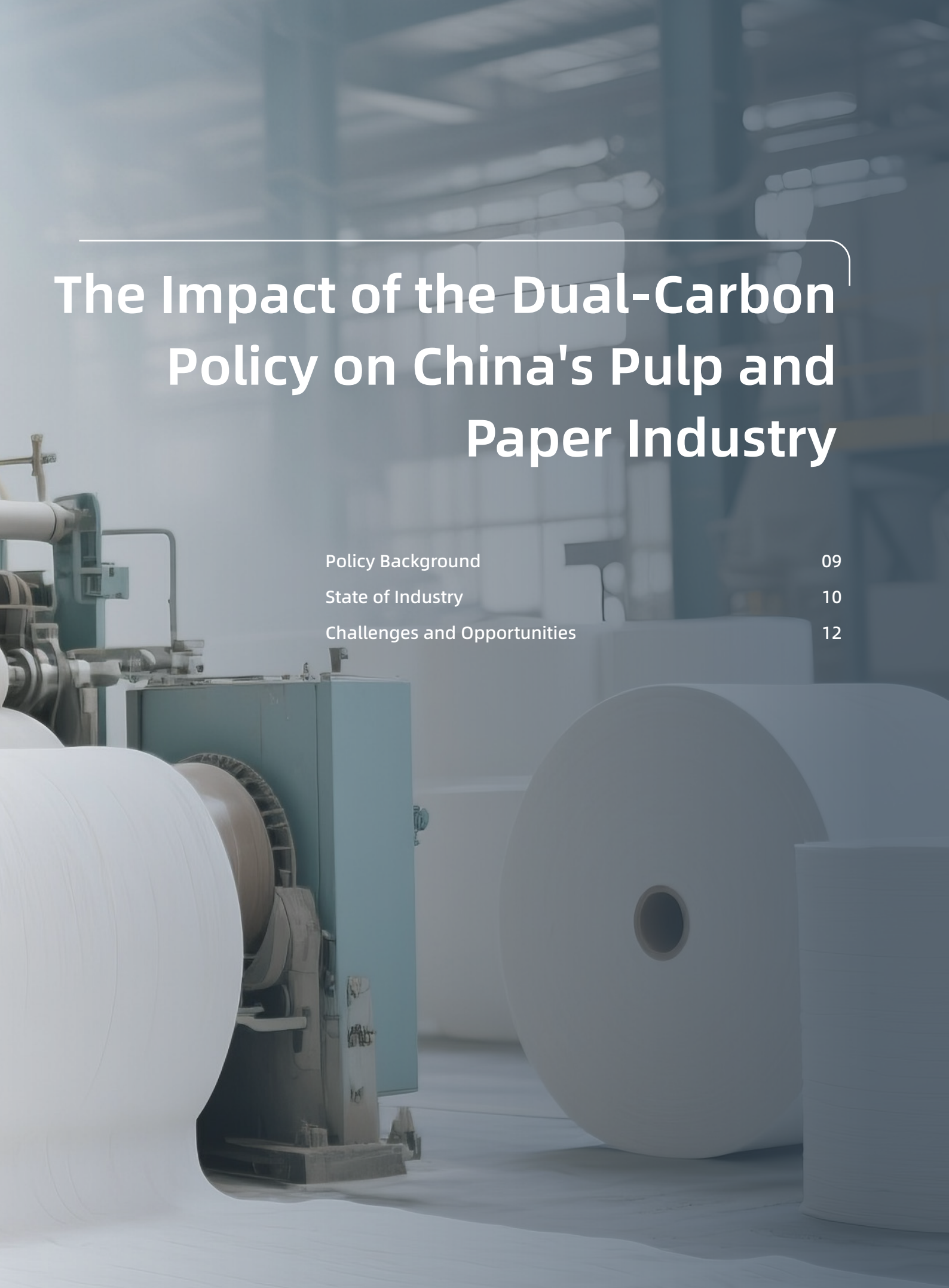
According to the International Energy Agency (IEA)'s latest Tracking Clean Energy Progress 2023[10], the clean energy transition in the pulp and paper industry is far behind what is needed to meet the 2030 carbon targets. To achieve global carbon neutrality goals, the global pulp and paper industry must achieve a more significant reduction in emission intensity.

The operational model of the pulp and paper industry, from forest management, timber harvesting, transportation to the enormous energy consumption and production process emissions in pulping and papermaking, has a significant dual impact on forest carbon sequestration capacity and overall carbon emissions. Therefore, a deep decarbonization transformation of the pulp and paper industry is urgently needed, not only for the industry's own sustainable development but also to protect forests as a critical climate asset and support global climate goals.

Moreover, as a key raw material supplier to numerous industries such as paper, packaging, printing and writing, daily consumer goods, and e-commerce retail, the carbon footprint of the pulp and paper production process is under unprecedented scrutiny. Additionally, the global trade characteristics of the pulp and paper industry make it a significant consideration in international trade and decarbonization policies of various countries. For example, the European Union's Carbon Border Adjustment Mechanism (EU CBAM) extends the scope of carbon tariff products to include chemical and plastic products and plans to cover EU ETS sectors by 2030, putting the pulp and paper industry under dual pressure of trade compliance and green barriers.

If relevant companies fail to effectively address the challenge of green barriers, they risk losing core orders, leading to severe impacts on market share and business competitiveness. Thus, responding to the industry's decarbonization wave and actively embracing decarbonization transformation is no longer an option for relevant companies but an urgent strategic task concerning their survival and development.

The Impact of the Dual-Carbon Policy on China's Pulp and Paper Industry



Policy Background

In 2020, China announced its goal to peak carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060 at the 75th United Nations General Assembly. Since then, China has introduced a series of carbon policies, building upon its existing energy conservation and emission reduction measures, to plan and support the realization of its dual-carbon targets. Currently, China has established a 1+N policy system, with the Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy as the top-level regulation, and implementation plans such as the Action Plan for Carbon Dioxide Peaking Before 2030, which set out clear decarbonization tasks and directions for the pulp and paper industry.

As one of the eight key industries for carbon emissions, the pulp and paper industry has received considerable attention under China's carbon policies. These policies impose systematic and multi-dimensional requirements on the industry, planning its carbon reduction path from multiple aspects such as energy structure, recycling, technological innovation, and collaborative governance. In terms of content, carbon policies related to the pulp and paper industry are becoming more detailed, not only focusing on key carbon reduction tasks but also setting clear targets to quantify the evaluation of the industry's emission reduction effects.

At the same time, with the increasing requirements for carbon verification reports in the pulp and paper industry, the implementation of dual control (total emissions and emission intensity) over carbon emissions, and the expansion of the national carbon market, it can be anticipated that the carbon emission management requirements for the pulp and paper industry will gradually increase. On one hand, as the systems for monitoring carbon emissions, setting targets, and evaluating performance are established, the government will bear the responsibility for reducing and controlling emissions and will tighten carbon emission management within regions. On the other hand, there is a high likelihood that the pulp and paper industry will be included in the national carbon market, where the price mechanism for carbon emission rights will compel the industry to balance between energy conservation and emission reduction and additional costs, thereby promoting upgrades in energy conservation and emission reduction within the pulp and paper industry.

The "1+N" policy framework guides the industry's decarbonization

2021

- "*Action Plan for Carbon Peak Before 2030*" – the State Council

  Requiring high-energy-consuming industries such as paper industry to optimize their energy structure, develop biomass energy, and promote the circular economy.

- "*The 14th Five-Year Plan for Industrial Green Development*" - Ministry of Industry and Information Technology

  Requiring industries such as papermaking to improve resource utilization efficiency and promote clean technology, aiming to achieve a 13.5% reduction in energy consumption per unit of industrial added value by 2025.

2022

- "*Implementation Plan for Carbon Peaking in the Industrial Sector*" – Ministry of Industry and Information Technology et al.

  Requiring industries such as paper industry to optimize their raw material structure, implement energy-saving technological renovations, and complete the low-carbon upgrade of existing projects before 2025.

- "*Guidelines on Advancing High-quality Development in the Light Industry*"

  Requiring industries such as paper industry to develop low-carbon roadmaps, build green manufacturing system and promote the concept of green development throughout the entire lifecycle.

2023

- "*Notice on the Reporting and Verification of Greenhouse Gas Emissions for Key Industries in 2023-2025*" - Ministry of Ecology and Environment

  Requiring key industries such as paper industry to conduct annual greenhouse gas emission reporting and verification.

- "*Catalogue for Promoting Green and Low-carbon Technologies (2023 Edition)*" - National Development and Reform Commission

  Incorporating various green and low-carbon technologies in the papermaking industry to support enterprises in reducing their carbon emission through technological upgrades.

2024

- "*Carbon Emissions Trading Regulations*"

  Improving the carbon market mechanism to encourage participation from high-emission industries such as paper manufacturing.

- "*Action Plan for Strengthening the Standardization and Measurement System for Carbon Peak and Carbon Neutrality (2024-2025)*"

  Coordinating the development of carbon measurement capabilities to support dual control of carbon emissions and the establishment of carbon pricing systems in industries such as papermaking.

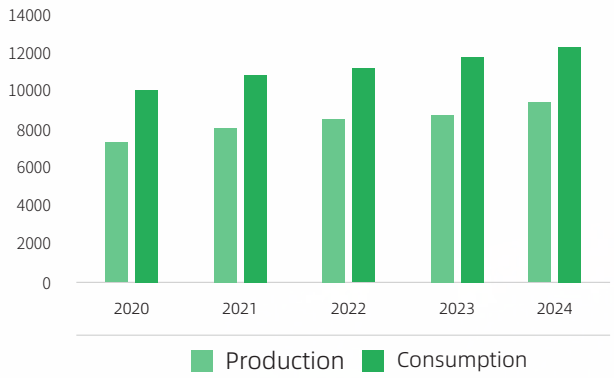
Source: Deloitte China, Government Documents, and Public Sources

State of Industry

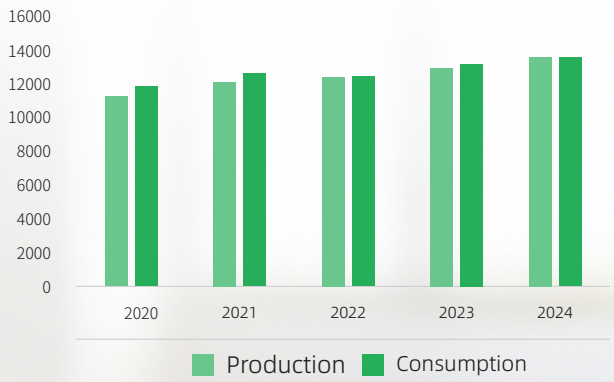
The overall scale continues to grow

The Chinese pulp and paper industry accounts for 29.2% of the global total production capacity, ranking first in the world. Both its production and consumption volumes hold the top position globally, making China a major player in the world's paper production, consumption, and trade. According to the China Paper Association, the national pulp, paper, and paperboard production in 2024 reached 230.79 million tons, with a total consumption of 260.49 million tons. From 2020 to 2024, the annual average growth rate of pulp production was 6.44%, and the annual average growth rate of consumption was 5.05%. The annual average growth rate of paper and paperboard production was 4.90%, and the annual average growth rate of consumption was 3.68%[11].

Pulp Production and Consumption from 2020 to 2024 (10,000 tons)



Paper and Paperboard Production and Consumption from 2020 to 2024 (10,000 tons)



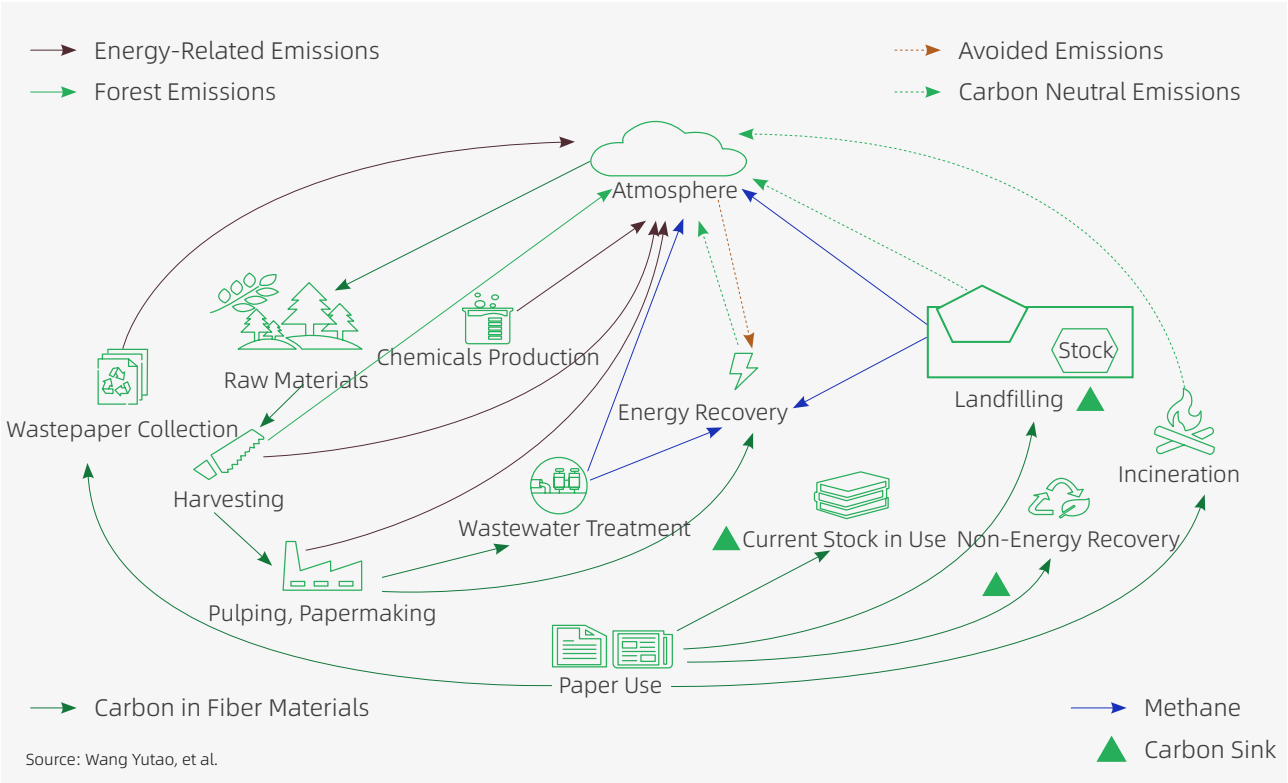
Source: China Paper Association

With the release of new production capacity, growth in downstream demand, and the continuous advancement of the "vertical integration in pulp and paper industry" process, China's wood pulp production and demand have been steadily increasing. In 2024, the total consumption of pulp nationwide reached 124.15 million tons, an increase of 4.34% over the previous year, while the production of pulp was 94.54 million tons, up by 7.15% from the previous year. Additionally, with the growing global awareness of forest resource conservation, China has developed a diversified development path for pulp raw materials. In 2024, the proportions of wood pulp, recycled pulp, and non-wood pulp in the total pulp consumption were 41%, 55% and 4%, respectively. Due to limited domestic forest resources and China's "waste import ban", which restricts recycled paper imports, the country's wood pulp market remains heavily import-dependent to satisfy its substantial demand. According to statistics, China imported 34.41 million tons of pulp in 2024, with the proportion of imported wood pulp approaching 50% of the total pulp consumption.

The carbon emission structure of the value chain has industry-specific characteristics

It is estimated that China's pulp and paper industry—one of the country's eight highest carbon-emitting sectors—generates around 200-300 million tons of CO_2 equivalent annually. The sector is known for its high energy consumption, with an industrial structure marked by large-scale operations, heavy capital investment, long supply chains, and deep interdependencies. Due to the complexity of carbon lifecycle in the pulp and paper industry, the inventory and system boundaries for carbon emissions and carbon sink in the pulp and paper value chain are based on material flow analysis and simulation. The boundary of the accounting system[12] can be defined as follows:

Carbon Emission and Carbon Sink Accounting System Boundary



Source: Wang Yutao, et al.

Based on the system boundary shown above, the lifecycle assessment is executed as pulp being the raw material through the forest-pulp-paper chain. As shown in the figure above, the upstream carbon emissions mainly come from the carbon sink consumption due to logging for raw materials such as wood pulp, carbon emissions from wood processing, energy consumption, and logistics transportation. Carbon emissions also occur during the pulping process, including chemical pulping, alkali recovery, pulping chemicals, and wastewater treatment. The midstream carbon emissions primarily consist of direct emissions from fossil fuel use and indirect emissions from electricity consumption in industrial facilities during the papermaking process. Downstream activities include distribution, sales, use, and disposal of paper products, with major sources of carbon emissions being waste incineration and the anaerobic or aerobic fermentation of wastepaper during landfill degradation, which contribute to greenhouse gas effects. Greenhouse gas emissions in the pulp and paper industry span the entire value chain, from upstream forestry management and raw material collection, through midstream production and energy consumption, to downstream product use and waste management, forming an interconnected network of carbon emissions.

Challenges and Opportunities

The decarbonization process of China's pulp and paper industry is characterized by "strong policy drive, deep technological research, and rapid market iteration". Under the pressure of the dual carbon goals and international trade rules, this systemic transformation across the entire value chain, centered on green and low-carbon development, comes with significant real-world challenges but also holds great potential for industrial upgrading.

Challenge

Technological Renovation Costs

- The pressure of energy structure adjustment: The transformation of the energy structure requires companies to invest substantial funds in technological renovation and modernization.
- The urgent need for technological innovation: Driven by the Dual-Carbon Goals, enterprises need to innovate and transform in aspects such as production processes and energy management.
- Short-term cost increase: The substantial R&D investment in technological innovation and the cost of talent cultivation may lead to a sharp rise in costs for enterprises in the short term.

Sustainable Raw Material Supply

- Risk of raw material structure adjustment: In recent years, the continuous expansion of domestic wood pulp production capacity has led to oversupply, necessitating a transition to sustainable wood pulp that meets green standards.
- Risk of resource shortage: The uncertainty of raw material supply increases operational risks for enterprises. For example, the development and utilization of non-wood fibers require significant time and technological investment.
- Risk of supply chain: Supply constraints on raw materials could undermine companies' supply chain resilience, making it critical to secure reliable sourcing channels.

Intensified Market Competition

- Product homogenization: The industry currently struggles with product homogenization and oversupply issues. To boost competitiveness, companies must accelerate product differentiation efforts, particularly in branding and value-added offerings.
- International competition: Green competition in the international market is becoming increasingly intense, and Chinese papermaking enterprises need to enhance their low-carbon competitiveness in the international market to cope with green barriers from other countries and regions.

Opportunity

Technological Innovation

- Application of energy-saving and emission reduction technologies: Increasing investment in these technologies not only reduces a company's carbon emissions but also enhances production efficiency and product quality.
- Intelligent and automated production: Technological advancements have boosted production efficiency in the pulp and paper industry, significantly increasing capacity utilization rates.
- Investment in green technology R&D: National policies support the development of green technology, allowing pulp and paper companies to benefit and enhance their competitiveness.

Accelerating Industrial Structure Optimization

- Industry consolidation and rising market concentration: Leading players are capitalizing on their technological edge and clean energy investments to establish competitive advantages, both in cost efficiency and sustainability. This is accelerating M&A activity, further consolidating the market and strengthening overall industry competitiveness.
- Value chain expansion and resource optimization: Supported by government policies, paper manufacturers are pursuing mergers and acquisitions to consolidate resources, improve allocation efficiency, and boost overall production performance.
- Phasing out backward production capacity: The dual-carbon goals is driving the pulp and paper industry to eliminate high-energy-consuming and highly polluting backward production capacities, promoting the upgrading of industrial structure towards green and low-carbon directions.

Market Expansion

- Growing demand for green products: Through technological innovation and green transformation, it is possible to meet the market's need for eco-friendly products, thereby expanding market share.
- Driven by the demand of emerging industries: With the development of e-commerce, smart offices, and other emerging industries, the demand for packaging paper, specialty, and other products continues to grow. Paper manufacturers can meet these demands through product portfolio adjustments.

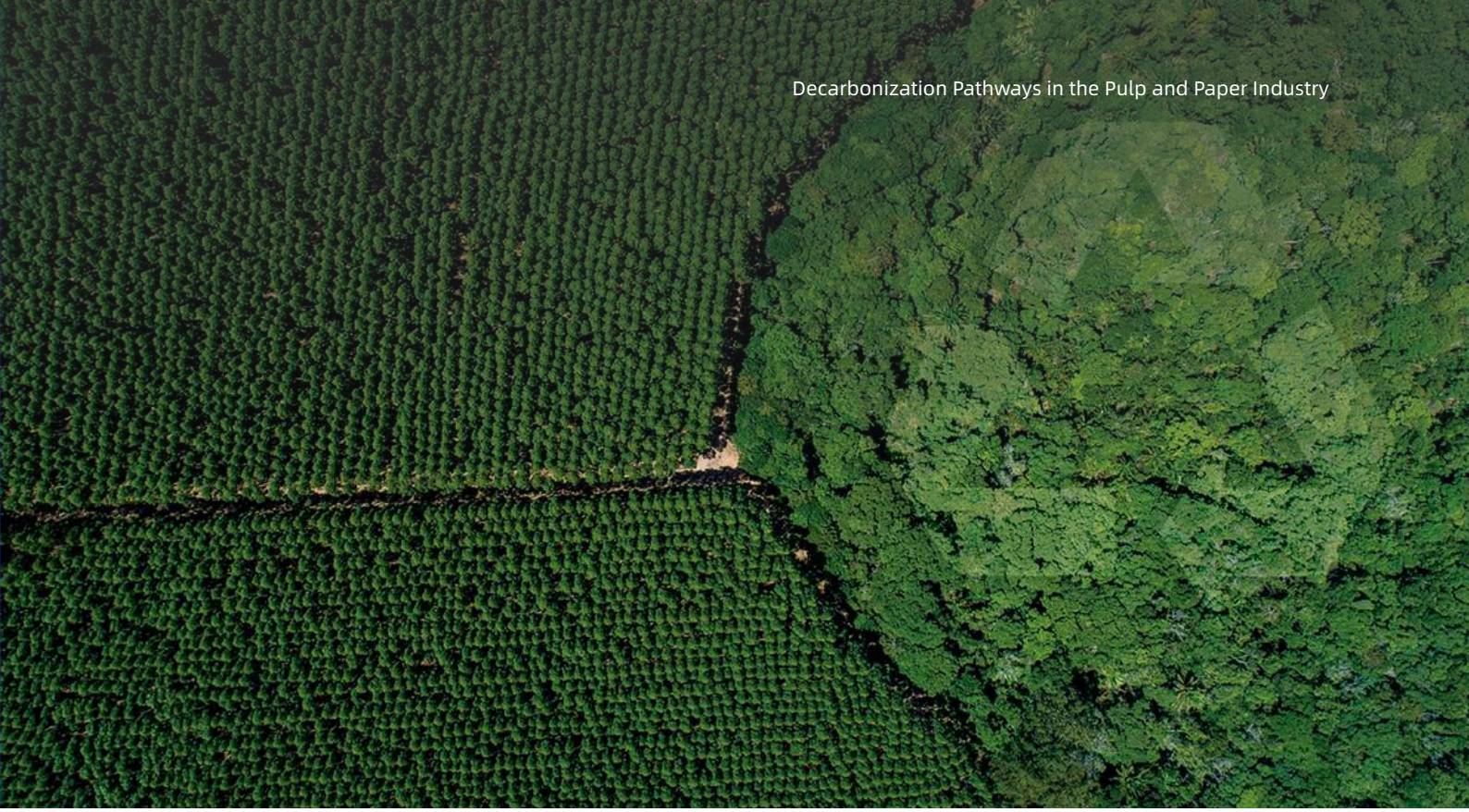
Decarbonization Pathways in the Pulp and Paper Industry

Value Chain Decarbonization Strategy

As global climate action accelerates and China's dual-carbon strategy advances, the pulp and paper industry's net-zero transition is critical. With its dual identity as both a "carbon emitter" and a "carbon sink asset owner", the industry's transformation is not just vital for its own sustainability but also pivotal in restructuring global low-carbon supply chains. Decarbonization is now an urgent imperative for the sector.

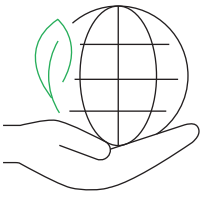
Notably, Scope 3 emissions, those from upstream and downstream value chains, represent 60% of the industry's total carbon footprint. This demands close collaboration across the entire value chain to develop integrated decarbonization strategies and actionable roadmaps. Key levers include sustainable forestry management, green product design, decarbonization in manufacturing, sustainable procurement, value chain collaboration, and circular economy initiatives.

By implementing these measures, the industry can progress toward its net-zero ambitions while reinforcing its role in a climate-resilient future.



Sustainable Forest Management

The core of sustainable forest management lies in achieving the sustainable use of forest resources while protecting and enhancing the ecological functions of forests, thereby bringing multiple benefits to humans and the planet. In the pulp and paper industry, sustainable forest management ensures the renewability and low-carbon attributes of raw materials at the source. By protecting and enhancing forest carbon sinks and through scientific and effective sustainable forest management, it can directly offset industry carbon emissions and reduce product carbon footprints, which is fundamental to the long-term sustainable development of the industry.



Enhancing Forest Carbon Sinks

Forests, as the largest terrestrial carbon sink, absorb and store carbon dioxide through photosynthesis, offsetting carbon emissions from pulp and paper production. The carbon stored in sustainably managed forests, including those planted on previously degraded or human-impacted lands, provides significant climate benefits. These forested areas not only increase carbon removal and expand forest carbon storage but also prevent substantial amounts of carbon dioxide from being released, effectively mitigating climate change. Sustainable forest management, through scientific afforestation and forest conservation measures, significantly enhances the carbon sequestration capacity of forests, providing crucial support for achieving global carbon neutrality goals.

Sustainable Forest Utilization

Sustainable forest management helps minimize forest degradation and carbon emissions from unsustainable logging practices, effectively reducing deforestation-related emissions. By setting protection areas and implementing conservation programs in high conservation value areas (HCVA), it prevents ecosystem damage from irresponsible timber harvesting while preserving forest biodiversity and ecological balance. Additionally, through forest restoration and vegetation recovery initiatives, it promotes the responsible use of forest resources while mitigating carbon emissions caused by forest destruction.

Sustainable Forest Certification

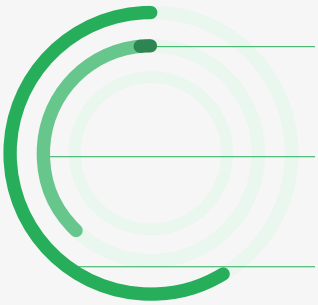
In sustainable forest management practices, companies / organizations typically follow recognized certification standards such as the Forest Stewardship Council (FSC®), the Programme for the Endorsement of Forest Certification (PEFC), and the China Forest Certification Scheme, to ensure the fairness and transparency of sustainable forest management.Translating the company's zero-deforestation commitment into verifiable product traceability credentials demonstrates its core value of safeguarding forest ecosystems.

Suzano - The Outlook in Sustainable Forest Management[14]

As a global pulp giant, Suzano published its "Wood Supply Policy" in July 2020, committing to strictly adhere to the zero-deforestation principle, ensuring that all wood sources are limited to sustainably managed plantations and prohibiting the acquisition of wood from undeveloped areas. Suzano's forest management practices comply with international standards such as the Forest Principles, FSC®, PEFC, and the Brazilian Forest Certification Program (CERFLOR). Through large-scale reforestation activities, it actively practices forest carbon sequestration, enabling its eucalyptus plantations and protected native forests to continuously absorb and store carbon. Additionally, Suzano is committed to restoring natural forests and biodiversity protection, pledging to connect 500,000 hectares of key conservation areas across the Amazon, Atlantic Forest and Cerrado fragments by 2030.

Suzano manages over

2.8 million hectares of forests



85,000 hectares designated as High Conservation Value Areas (HCVA)

1.1 million hectares dedicated to conservation

1.7 million hectares dedicated to production

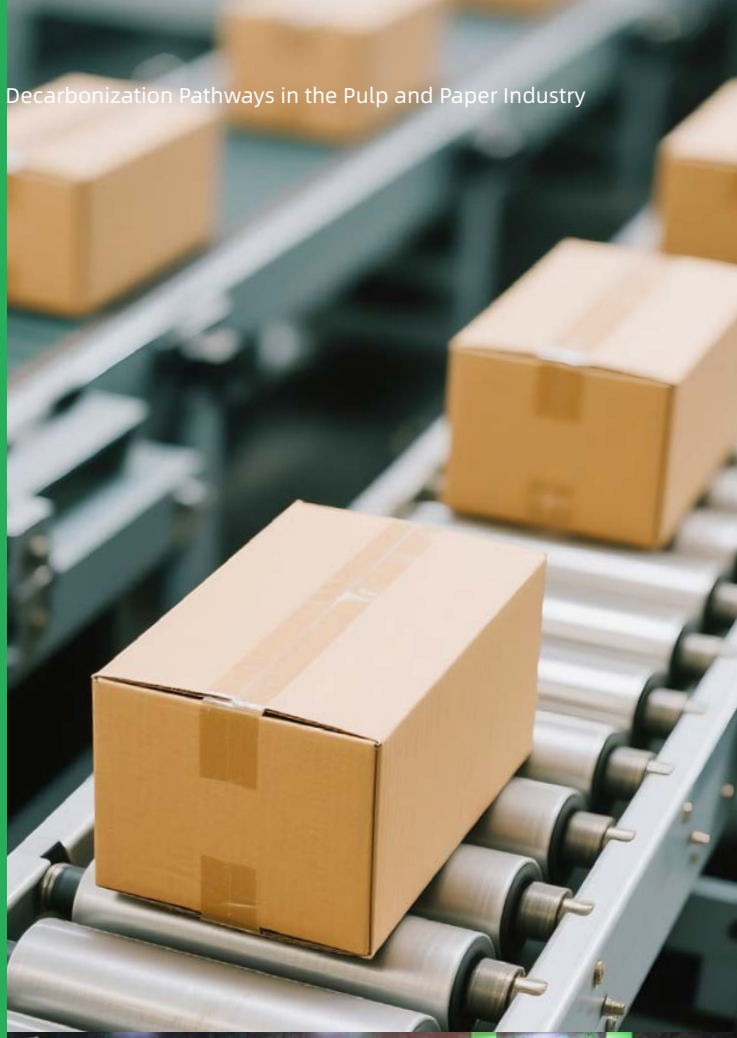
Since 2020, it has removed **29.4** million tons of carbon dioxide from the atmosphere

Green Product Design

Green product design is not only a breakthrough in technological innovation but also a critical step in driving the entire value chain towards sustainable development. This process requires multidimensional innovation and strategic collaboration to achieve a transformation from single emission reduction to value co-creation. Such a transformation not only requires a renewal of concepts but also concrete actions from enterprises. Therefore, pulp and paper companies need to continuously increase their R&D investment, develop and promote more innovative low-carbon products, collaborate across the value chain, and build a strategic cooperative ecosystem to assist related industries in achieving a low-carbon and green transformation, providing new opportunities for reducing carbon footprints globally.

Sustainable Raw Materials Sourcing

Sourcing sustainable raw materials is a cornerstone of green product design for pulp and paper companies. When evaluating materials, companies must assess environmental impacts across the entire lifecycle, from production and transportation to end-use and disposal. Preferred options include certified wood pulp from responsibly managed forests, bamboo and other non-wood fibers of low environmental impact. To ensure credibility, companies should collaborate with suppliers to enhance sustainable supply chain practices, verify ethical sourcing that meets social responsibility benchmarks, and pursue international certifications aligning with global sustainability standards.



Innovation in Green Product Design

Pulp and paper companies need to analyze market demand in depth to identify potential applications for green technologies, then align these opportunities with their own resources and capabilities to develop strategic directions for green product innovation. In product design, companies should focus on sustainable bio-based materials, incorporating biotechnology and chemical modification processes to reduce energy consumption and pollution. As market demand for green products grows and consumers' environmental awareness increases, paper-for-plastic substitution is becoming a key strategy in paper companies' green product development. By continuously innovating with plastic-free coatings and pulp molding technologies, paper products can achieve an optimal balance of environmental friendliness, recyclability, and high performance, building distinctive competitiveness across expanding applications.

RAIN FOREST 雨森卫品 Practice of "Fiber to Fiber"[15]

Yusen Group and Suzano have established comprehensive collaboration in fiber alternative development. Through rigorous production trials and technical refinements, they have successfully demonstrated the viability and advantages of the innovative eucalyptus pulp tissue paper formulation. This breakthrough solution significantly reduces reliance on softwood fibers while maintaining premium product quality standards. With these validated results, the technology has now progressed to full-scale industrial implementation, enabling the widespread adoption of hardwood pulp fiber substitution across all Yusen's compatible production systems.

Concept and Practice of "Paper-for-Plastic"[16]

Guanhao High-tech's independently developed plastic-free coated food paperboard utilizes water-based acrylic polymer coating technology (such as BASF's JONCRYL solution), completely eliminating plastic components. This innovation delivers three key environmental benefits, full recyclability, biodegradability, and high performance.

Recyclability

The coating is compatible with paper fibers, allowing the paper cup to be directly fed into the waste paper recycling system. The fibers can be reused more than 6 times, significantly enhancing resource circulation rates.

Biodegradability

The material is biodegradable in natural environments, avoiding dioxin pollution caused by the incineration of PE-coated films.

Performance Guarantee

By utilizing the REP aqueous barrier coating technology, it ensures that heat resistance, leak-proofing, and other indicators meet food packaging standards, meeting the requirements for hot beverages.

Life Cycle Assessment (LCA)

Currently, carbon accounting by greenhouse gas inventory (GHG Inventory) method has become a common practice. This method records data on carbon emissions within specific organizational boundaries and can effectively reflect emissions across Scope 1, 2, and 3 . LCA provides a more comprehensive and systematic method for environmental impact assessment, which can be used to evaluate the environmental impacts of products or services across all life stages from raw material acquisition to production, use, disposal, or recycling. The pulp and paper industry can utilize the lifecycle assessment approach to ensure that biobased products minimize their environmental impact throughout their entire lifecycle and to develop targeted emission reduction measures.

A Practice of Carbon Neutral Product throughout the Entire Life Cycle[17]

On June 5, 2025, Suzano, in collaboration with its value chain partners, launched the industry's first carbon-neutral notebook in the Chinese market, verified by SGS to receive the ISO 14068-1 verification for carbon neutrality. This innovative achievement highlights Suzano's leadership in sustainable development and climate action, and also provides a value chain reference for the upcoming COP30 in Brazil.

The source materials supplied by Suzano are 100% virgin eucalyptus pulp, which is sustainable forest management certified. This product achieves carbon neutrality across the entire lifecycle, from raw material acquisition, production, and logistics distribution to post-consumer waste disposal, in a "from cradle to grave" approach. Each stage has undergone rigorous carbon footprint assessment and optimization. The unavoidable carbon emissions generated during this process have been offset through Suzano's VERRA-certified carbon credits in Brazil. Paper giants Sun Paper and China's leading stationery brand M&G, as core partners of the project, jointly participated in this comprehensive value chain sustainability initiative. The Center for Environmental Education and Communications of the Ministry of Ecology and Environment has highly recognized this innovative value chain model, considering it to be well-aligned with China's "Dual-Carbon" goals.

Decarbonization in Manufacturing

As a traditional industry characterized by high energy consumption, the pulp and paper industry must pursue integrated decarbonization strategies and pathways to achieve carbon neutrality in its production and manufacturing processes, particularly in the global low carbon transition. These efforts should encompass multiple dimensions, including energy management, production efficiency, process optimization, and digital transformation, to create a cohesive and sustainable approach.

Decarbonization in Energy Management

The pulp and paper industry can reduce its reliance on fossil fuels by increasing the proportion of biomass energy used. Sources of biomass include black liquor, primarily composed of lignin derivatives and cellulose degradation products, from the pulping process, as well as waste residues from production processes. This biomass can be converted into energy through pyrolysis gasification or direct combustion to generate electricity. The recovered heat can be utilized in production processes, thereby reducing dependence on external energy sources.

In addition, processes in the pulp and paper industry such as cooking, bleaching, pressing, and drying, require substantial amounts of heat and electricity. To reduce carbon emissions, the electrification rate of production processes can be gradually increased. At the same time, pulp and paper companies can further reduce their carbon footprint by purchasing green electricity and collaborating with renewable energy companies.

Optimization in Manufacturing Process

The optimization of pulp and paper manufacturing processes can effectively reduce energy consumption and improve efficiency, which is key to reducing carbon emissions. For example, during the pulping stage, technologies such as the displacement digester system (DDS) and rapid displacement heating (RDH) technology are used to improve steam consumption in traditional pulp-making processes and reduce thermal energy loss in conventional cooking technologies. In the papermaking stage, promoting techniques such as hot pressing and hot air penetration drying can enhance pressing efficiency and drying performance, thereby saving steam costs.

In addition, to reduce the use of chemicals and the discharge of wastewater, in the pulp production stage, the application of fiber grading screening technology and neutral ink deinking technology can significantly lower the amount of chemicals required, thereby reducing the pressure on wastewater treatment. In the paper bleaching process, optimizing the bleaching methods, such as using chlorine dioxide bleaching (elemental chlorine-free, ECF) and totally chlorine-free (TCF) , can effectively reduce the emission of chlorides and toxic by-products. In the treatment of paper mill wastewater, the application of ultrasonic white water treatment technology can effectively mitigate chemical pollutants.

Improvement in Production Efficiency

Steam is one of the most important energy sources in paper production. By using steam cascade utilization technology, high-temperature steam can be directed to the drying section of the paper machine, while medium-temperature steam can be used for other processes, such as washing. This approach maximizes the efficiency of steam usage. Additionally, the adoption of multi-effect evaporators and high-efficiency heat exchangers can reduce energy waste and further enhance the efficiency of steam utilization.

The energy consumption of traditional paper-making equipment is relatively high; therefore, promoting the use of efficient and energy-saving equipment is a crucial approach to improving energy efficiency. For example, high-speed turbo vacuum pumps can replace conventional equipment in the vacuum system of paper machines, achieving energy savings of over 30%. Similarly, the application of magnetic levitation technology can further reduce the energy consumption and maintenance costs of equipment.

Adoption of Carbon Capture, Utilization and Storage (CCUS)

The pulp and paper industry involves many high-carbon-emission processes. By employing carbon capture, utilization, and storage (CCUS) technologies, carbon dioxide generated during industrial processes can be captured, compressed, and utilized as resources, thereby achieving the goal of reducing carbon emissions. In major industrial processes such as black liquor combustion in pulping, fossil fuel combustion in paper drying, and combined heat and power boilers in paper mills, large-scale capture can be achieved through membrane separation, amine absorption, and gasification technologies.

The captured carbon dioxide can be further utilized and materialized in several ways. For example, it can be converted into calcium carbonate to reduce carbon levels or used as raw materials for chemical production. Additionally, it can serve as an anti-solvent for producing lignin nanoparticles, enhancing product performance and resource utilization efficiency. For carbon dioxide that is difficult to utilize, it can be compressed, transported, and geologically stored.

Transformation in Digital and Intelligence

Enterprises can establish an intelligent monitoring system for the entire process of pulp and paper production using big data, artificial intelligence, and Internet of Things (IoT) technologies. This system can monitor production parameters such as temperature, pressure, and flow in real-time, optimizing production processes to reduce resource waste and carbon emissions. Additionally, digital twin technology further enhances pulp and paper manufacturing by enabling virtual process simulations. These simulations identify optimal production parameters–minimizing energy use and emissions while maintaining output quality. For instance, manufacturers can test various operating conditions digitally to pinpoint the most efficient, low-carbon configurations before implementing them in actual production.

中顺洁柔 Low-carbon Technology Iteration + Energy Structure Transition[18]

C&S Paper's primary decarbonization strategy focuses on equipment upgrades, process optimization, and energy substitution. At its Hubei and Yunfu production bases, the company has reduced equipment power consumption by implementing solutions such as magnetic levitation vacuum pumps and improved paper machine hoods. These facilities have also enhanced their thermal energy recovery systems to maximize efficiency. The Sichuan base has adopted DDS (dimethyl disulfide) and ECF (elemental chlorine-free) pulping technologies, which significantly lower steam consumption compared to traditional sulfite methods. Through coordinated waste gas incineration and alkali recovery furnace treatment, the facility achieves near-zero exhaust emissions. For cleaner energy use, the Yunfu and Hubei bases have installed distributed photovoltaic systems. These solar power installations generate over 50 million kilowatt-hours annually, covering approximately 15% of the plants' electricity needs.

Paper Production Facility Upgrade[19]

Wuzhou Special Paper Group has invested 5.42 million yuan in upgrading one of its existing specialty paper production facilities. By introducing advanced technologies and equipment such as the rewinder's arc-shaped roll, pressure screens and screen drums, as well as the intelligent ultra-high pressure online cleaning system for watermark rolls, the company has eliminated the need to shut down and disassemble for cleaning during traditional production processes. This not only enhances product quality but also improves the overall efficiency of the production. After the upgrade, the annual output of the production line is expected to increase from 35,000 tons to 45,000 tons, achieving a significant improvement in both production capacity and efficiency with a relatively small investment.

华旺科技 HUAWON Water-Saving Innovative Technology[20]

Huawang New Materials has achieved significant efficiency gains and water conservation through multiple innovative initiatives. The company implemented intelligent high-pressure mobile cleaning technology to optimize operations. By replacing traditional energy-intensive water ring pumps with adjustable-speed turbine vacuum pumps, it realized energy savings exceeding 30%. A comprehensive water recycling system was established, including the reuse of mechanical seal water and the implementation of a cascaded water utilization model to maximize white water circulation. These integrated solutions collectively save tens of thousands of tons of water annually while substantially reducing the production carbon footprint through three key mechanisms: lowered energy demand for water treatment, reduced pump power consumption (particularly through the elimination of inefficient water ring pumps), and decreased indirect emissions from water extraction and processing. This holistic approach to sustainable manufacturing played a pivotal role in the company's designation as a "National Green Factory," recognizing its leadership in environmentally responsible production.

Sustainable Procurement

Sustainable procurement refers to the integration of environmental friendliness, social responsibility, and ethical practices into supplier selection and cooperation as part of a long-term strategy in global supply chain management. At its core, it involves establishing sustainable partnerships with suppliers to promote efficient resource use, reduce environmental footprints, and enhance social well-being. A well-executed sustainable procurement strategy delivers comprehensive climate benefits across the value chain. By systematically addressing embedded upstream emissions, companies can drive meaningful supplier engagement through long-term partnerships. This collaborative approach creates powerful synergies in emission reduction while strengthening organizational climate resilience. Ultimately, such strategic procurement practices cultivate durable low-carbon competitive advantages in the marketplace.

Sustainable Raw Materials Sourcing

Companies can enhance the sustainability of their pulp and paper industry supply chains by prioritizing the procurement of wood from sustainably managed forests. For example, giving priority to wood certified by the FSC® and PEFC, these certifications ensure that the wood sources meet stringent sustainability standards. At the same time, companies strictly adhere to a zero-deforestation policy, ensuring that all wood is sourced from sustainably managed plantations, thereby protecting forest ecosystems and reducing carbon emissions.

Supply Chain Traceability

To address challenges from international trade regulations like the EUDR and EU CBAM, supply chain traceability has become essential to decarbonization strategies in the pulp and paper industry. Pulp and paper companies can implement digital platforms to accurately track the complete carbon footprint across their value chain, from sustainable timber harvesting and pulp production to energy inputs, logistics transportation, and finished product manufacturing. By linking sustainable forestry certification systems with low-carbon raw material procurement and supplier carbon disclosure requirements, the industry can collaborate with upstream and downstream partners. This enables creation of a transparent, verifiable low-carbon closed-loop supply chain that achieves both precise carbon accounting and decarbonization throughout the entire value chain.

Sustainable Logistics

Enterprises can reduce carbon emissions during the procurement phase of raw materials or products by optimizing logistics networks, transportation modes, and promoting green logistics. For instance, by optimizing logistics networks to reduce transportation distances and energy consumption, utilizing the IoT and big data to optimize logistics routes, and decreasing empty running rates, significant reductions in carbon emissions during the logistics process can be achieved. Moreover, enterprises can focus on port-proximity layouts and large-scale transportation, such as using large vessels instead of land transport, to lower the energy consumption and emissions per unit of cargo transported. Enterprises can also further reduce carbon emissions in logistics processes by using green transportation methods powered by renewable energy.

Hengan Group's Sustainable Procurement Strategy[21]

In 2024, approximately 97% of the wood pulp purchased by Hengan Group can be traced back to forest lands, and the proportion of FSC®-certified wood pulp purchased is nearly one-fifth. Additionally, PEFC-certified wood pulp accounts for about 97% of the group's total wood pulp procurement. In production management, Hengan strictly categorizes the management of wood pulp raw materials and actively promotes market trends and production ratios of FSC®-certified products globally. The group is committed to obtaining FSC®-CoC certification to ensure that all raw materials used in the production of its products come from sustainably managed forests. This commitment contributes to the protection of forest resources and promotes sustainable forest development. In 2024, Hengan Group comprehensively upgraded its transportation management system (TMS 3.0), achieving digital full-chain closed-loop management in logistics to reduce carbon emissions from transportation. Simultaneously, the group promoted the use of online bill signing functions among distribution customers nationwide. In 2024, this effort cumulatively reduced the printing of over 130,000 paper receipts, equivalent to a reduction of 1 ton of CO_2 emissions. Additionally, Hengan Group has implemented a Regional Distribution Center (RDC) direct-delivery program, which has significantly streamlined the supply chain by eliminating intermediate warehousing stages. In 2024 alone, this initiative reduced total logistics mileage by 2.567 million kilometers, equivalent to cutting 1,533.88 tons of CO_2 emissions.

Value Chain Collaboration

Pulp and paper industry enterprises should establish long-term strategic partnerships with partners, downstream users, and upstream suppliers to collaborate in reducing carbon emissions throughout the value chain.

Enterprises can screen suppliers based on environmental and social standards, giving priority to those who excel in environmental management and social responsibility. Technological innovation and cooperation are key to achieving carbon reduction in the value chain. The application of industry standards and certifications is also an important means of reducing carbon emissions. Enterprises can apply national standards in supply chain management and encourage suppliers to obtain relevant environmental and social certifications, thereby enhancing the overall sustainability of the supply chain. By sharing advanced decarbonization strategies, emission reduction technologies, and carbon accounting management experiences, enterprises can help suppliers establish practical carbon reduction targets and carbon accounting systems, continuously optimize emission reduction measures, and collectively achieve carbon neutrality of the industry. Pulp and paper companies and their downstream customers can achieve green and low-carbon development through value chain collaboration to reduce carbon emissions. By enhancing cooperation in supply chain management, promoting green office practices, and fostering technological innovation, they can further lower the carbon footprint of their products. Through these measures, pulp and paper companies contribute to the sustainable development of the industry.

"TianGong LCA" ––Lifecycle Data Platform[22]

"TianGong LCA" is an international scientific program led by Professor Xu Ming from the School of Environment at Tsinghua University, in collaboration with 30 universities and research institutions worldwide. This initiative, based on artificial intelligence technology, aims to establish an intelligent, standardized, and transparent life cycle assessment system, revolutionizing traditional tools and methods. As a co-initiator, professor Wang Yutao from Fudan University has provided crucial support for data in the pulp and paper industry. This support enables related enterprises to accurately calculate carbon footprints, identify reduction potentials, guide low-carbon process improvements, and promote green value chain development, as well as eco-design of products.

"Green Journey Initiative" - Sustainable Action for the Pulp, Paper, and Packaging Industry[23]

At the 15th China Paper & Pulp Industry Development Conference held by China Paper and Pulp Industry Chamber of Commerce (CPICC), leading global pulp and paper industry enterprises jointly initiated the establishment of a national, industry-focused Sustainability Development Committee (SDC) under CPICC. Together with the Chinese pulp and paper industry, they launched the "Green Journey Initiative", a sustainability action initiative for the pulp, paper, and packaging industry. This initiative aims to promote the establishment of a sustainable paper industry supply chain system and collectively take responsibility for mitigating climate change.

Supply Chain Collaboration for Carbon Reduction Measures[24]

Sun Paper actively promotes supply chain decarbonization and green development in accordance with the national standard for green supply chain management in manufacturing enterprises. The company focuses on establishing long-term cooperation with suppliers that demonstrate strong ESG performance, implementing green procurement standards, and driving green and low-carbon transformation throughout the supply chain. Additionally, to explore sustainable integration between paper use and office equipment, Sun Paper has partnered with Ricoh China to host the "Exploring New Power of Carbon - Blueprinting Together in Beihai" ESG event. The two companies have also signed the "Joint Initiative for the Development of Green OA Office Ecosystem." This initiative brings together upstream and downstream partners and industry stakeholders to advance the development of green office solutions. Through a green office cycle system comprising zero-carbon paper and carbon-neutral printing devices, Sun Paper and its partners aim to build a comprehensive green office ecosystem.

Circular Economy

The circular economy model in the pulp and paper industry overturns the traditional linear "take-make-waste" model, aiming to minimize resource consumption and waste generation throughout the product lifecycle. This approach maximizes resource value and significantly reduces the carbon footprint. Resource recovery of waste materials represents the central objective of waste management in pulp and paper manufacturing processes. Companies should adopt advanced technologies to convert non-recyclable organic waste into high-quality solid recovered fuel or biogas, replacing fossil fuels and significantly reducing direct carbon emissions in production processes. Additionally, companies can enhance the coverage density and accessibility of wastepaper recycling sites through cooperation with local governments and community organizations. Equipping recycling facilities with IoT technology for real-time data collection enables digital empowerment for efficient operations.

Close cooperation between upstream and downstream enterprises is also key to promoting the development of a circular economy. Enterprises need to break down barriers, engage in close strategic cooperation, and optimize the recycling and reuse pathways of products "from cradle to grave". Companies can layout or deepen an strategy of "forest-pulp-paper-recycling-reuse," forming a closed-loop economy. In terms of collaborative innovation along the value chain, companies can work with partners in the value chain and research institutes, jointly invest in the R&D of next-generation circular technologies, explore innovative business models, promote the construction of shared platforms, and jointly develop and promote unified industry standards to enhance the efficiency of the circular economy.

仙鹤股份 Xianhe Corp. A New Model of Circular Economy[25]

Xianhe focuses on the research, development, production, and sales of high-performance paper-based functional materials. The company is also dedicated to integrated forest-pulp-paper value chain and new models of circular economy. In recent years, the two major projects of Xianhe in Guangxi and Hubei for high-performance paper-based new materials, embody the company's commitment to "zero waste, low energy consumption, and responsibility" in circular economy. These projects represent green practices that include closed-loop governance models for afforestation, pulp and paper manufacturing, and the resource recovery of waste.

岳阳林纸 YUEYANG FOREST & PAPER Resource Utilization of Waste[26]

Yueyang Forest & Paper adheres to the concept of circular economy and green manufacturing, focusing on ecological optimization and green development. The company upholds the principles of reducing, reusing, and recycling waste materials. By resourcefully and cyclically utilizing waste, the company achieves both reduction and harmless treatment. For biomass waste such as tree bark and wood chips generated during production, the company uses these materials in co-firing with coal in thermal power boilers to reduce coal consumption. For high-moisture biomass solid waste, such as pulp sludge and water-soaked wood chips, the company collaborates with partners to convert these materials into raw materials for producing packaging, achieving high-value-added comprehensive utilization.

Insights from Global Decarbonization Best Practices

Case Studies through the Value Chain

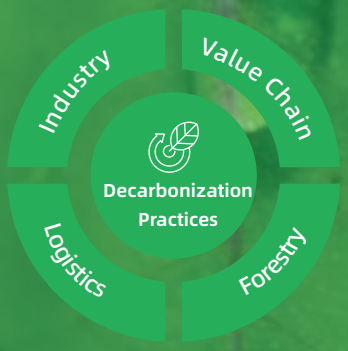
Value chain	Label	Advanced Technology	Case	Core Advantages
From Forestry to Woods	Forest Management	Tree Species Selection	Suzano	To enhance the productivity and adaptability of trees to their environment, appropriate tree species are selected through AI tool based on essential environmental conditions such as temperature, humidity, soil, and biodiversity. This approach improves wood quality and sustainability.
		Biological Control	Suzano	This approach involves the preventive release of natural pest predators and biological control agents to maintain balanced pest populations through ecological means.
		Smart Forestry	UPM	Adopt digital monitoring systems, analytical modeling tools, and data science methodologies, such as utilizing digital passports that incorporate forestry and ecological data to enable the development of science-based forest management plans that can be continuously evaluated and improved over time.
From Pulp to Paper	Pulping process	Displacement Digester System	Yibin Paper Industry Co., Ltd.	To address the drawbacks of traditional chemical pulping methods, such as high steam consumption, difficulties in recovering waste heat, and insufficient utilization of system heat, new approaches and technologies are being developed.
		Super-Efficient Shallow Air Flotation Technology	Dingfeng Paper Co., Ltd.	Compared with traditional cooking technologies, RDH technology can save 60% to 75% of the steam used in cooking and increase pulp strength by 10% to 20%.
	Papermaking process	High-Speed Turbomolecular Vacuum Pump	Ingersoll Rand	In the vacuum system of a paper machine, compared to ordinary liquid ring pumps, this technology can save more than 30% energy and over 85% fresh water, while virtually eliminating issues of corrosion and scaling.
		Superficial Gas Flotation Technology	Baodi Paper Co., Ltd.	Effectively address the issue of pollutant emissions in the traditional primary material treatment process of white-water recovery, while significantly improving efficiency and reducing energy consumption.
Energy Structure and Industrial Facilities	Energy Transition	Utilization of Photovoltaic Energy	Sun Paper Co., Ltd.	Utilize solar power generation to reduce the proportion of grid and fossil fuel usage.
		Biomass Energy	UPM	Replace petro-based fuels with biomass granule fuels and biorefinery products.
	Facility Emission Reduction	Combined Heat and Power	LUCART S.p.A	Optimize the combustion efficiency and energy utilization rate of steam power plants through low NOx combustion technology and by upgrading the end-of-pipe treatment level of equipment.
		Commercial-Scale Carbon Capture Systems	Svante Technology	The capability of using low-grade waste heat for carbon capture can significantly reduce energy consumption and carbon capture costs, and is conducive to seamless integration with pulp mills.
Waste Management	Wastewater treatment	Moving-Bed Biofilm Reactor	Hongyuan Paper Co., Ltd.	Pollutants are adsorbed onto the membrane surface through size exclusion and electrostatic interactions, forming a biofilm layer that is then subjected to biodegradation.
	Waste gas treatment	Flue Gas Treatment Technology for Incinerators	C&S Paper Co., Ltd.	The treatment of pollutants mainly includes fly ash, sulfur dioxide, and nitrogen oxides.
	Waste Solid Disposal	Pulping Residue Combustion	Sun Paper Co., Ltd.	Mixing lime with coal before combining them to absorb chlorides from the waste can reduce the generation of atmospheric pollutants.
Sustainable Logistics	Storage and Transportation	Sustainable Logistics	Hengan Group	Electric and hydrogen fuel heavy trucks are used for short-distance transportation, while electric and liquefied natural gas (LNG) powered vessels are applied to inland and coastal shipping, reducing carbon emissions in the maritime sector.
Circular Economy	Green packaging	Bio-Based & Biodegradable Material Technology	Metsa Group	Metsa develops degradable paper packaging materials that balance performance and green characteristics using pulp as the base material, through processes such as pulp molding, nano-coating, and eco-friendly printing.

Source: Deloitte China, Public Sources

Global Successful Decarbonization Cases

Suzano's Decarbonization Practice[27]

Suzano plans to reduce the intensity of Scope 1 and Scope 2 greenhouse gas emissions per ton of production by 15% by 2030. To achieve this decarbonization target, Suzano has developed a carbon reduction plan across four pathways–industrial, logistics, value chain, and forestry–based on a detailed assessment of emissions throughout the entire value chain (Scope 1, 2, and 3) and the risks and opportunities associated with the transition to a low-carbon economy.



Value Chain Decarbonization Practices

Suzano has taken comprehensive measures in the value chain aimed at reducing Scope 3 indirect emissions and promoting low-carbon practices throughout the production chain.

- Renewable Inputs: By substituting traditional petroleum-based materials with renewable raw material solutions, the carbon footprint across the value chain is reduced.
- Value Chain Decarbonization: Strengthening collaboration with suppliers and customers to jointly develop sustainable solutions; participating in the CDP Supply Chain Program to enhance suppliers' emission management capabilities.

Industrial Decarbonization Practices

Aimed at reducing the use of fossil fuels in industrial processes through technological innovation and mature solutions, thereby lowering direct emissions (Scope 1) and emissions from electricity use (Scope 2).

- Research and Development of Biomass Gasification: Biomass gasification is a thermochemical process that converts biomass into syngas through pyrolysis, with the potential to reduce emissions and support the sustainable transition of industries.
- Enhancement of Energy Efficiency Transition: Replace natural gas-powered turbine generators with steam power models, and improve chemical recovery.

Case:

Ribas do Rio Pardo Plant in Brazil: Powered by biomass gasification, the lime kiln's emissions are reduced by 97% compared to plants that consume fossil fuels.

Sustainable Forestry Decarbonization Practices

Emissions from this approach include both direct emissions (Scope 1), such as the use of fossil fuels in forestry operations and timber transportation, and the use of fertilizers, as well as indirect emissions (Scope 3), related to the production of fertilizers, purchasing timber from the market, and transportation.

- Biological Products: Biological products used in agriculture can enhance soil fertility, control pests and diseases, and promote healthy crop growth. All factories are equipped with biological products laboratories to reduce the use of chemical pesticides and the energy consumption of pesticide application through efficient biological control.
- Biofuel Application: Research focuses on the use of renewable alternative fuels such as biodiesel and biogas, primarily to replace fossil fuels used in timber transportation and farm management.

Logistics Decarbonization Practices

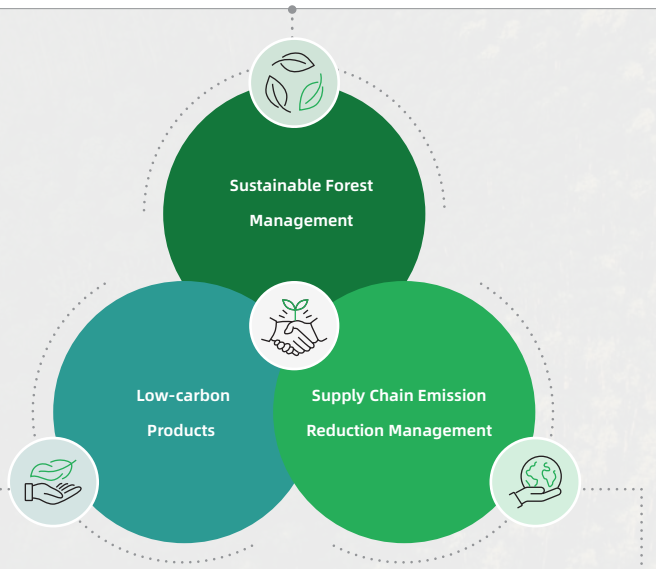
In the logistics sector, Suzano focuses on reducing indirect emissions generated by maritime and land transportation of its products.

- Electrification Transition: By replacing fossil fuel vehicles and equipment with electric, hybrid, or autonomous devices to reduce greenhouse gas emissions. Additionally, actively collaborating with the maritime industry to explore the potential of green bio-methanol as a fuel for vessels.
- Route and Load Optimization: By increasing load capacity per shipment, reducing empty truck runs, consolidating delivery cycles, and optimizing transport operations, Suzano aims to reduce the environmental impact of logistics.

UPM Group's Decarbonization Practices[28]

UPM plans to achieve a carbon reduction target of reducing CO_2 emissions by 65% compared to 2015 level by 2030, and to reach carbon neutrality within the organization by 2040. To this end, UPM is creating a low-carbon and environmentally friendly value chain through various measures such as sustainable forest management, supply chain emission reduction management, and innovative products.

UPM has extensive experience in sustainable forest management and has established a comprehensive forest management system, achieving full-process management from forest to paper. Currently, all UPM forests have been certified by the FSC® or PEFC. All pulp and paper mills globally have also obtained FSC® or PEFC Chain of Custody certification. To achieve its decarbonization commitment and ensure the sustainable growth of forests, UPM plants 55 million trees annually worldwide and implements various forestry management practices, such as mixed-species planting, diversified tree ages, varied forest structures, and the retention of deadwood, to enhance forest ecological capacity and realize the potential of forest carbon sinks.



UPM's paper has excellent lifecycle carbon emission performance. In 2023, 31% of all fibers used in UPM's paper production were recycled fibers, and 88% of the fibers used in paper production came from FSC® or PEFC certified sources, with the remainder sourced from controlled wood. Many of UPM's paper products meet industry standards for paper recycling, making them easy to recycle. Additionally, UPM has developed various low-carbon innovative products leveraging the characteristics of the pulp and paper industry, such as biomass plastic products made from 100% renewable raw materials, which can replace petro-plastics and significantly reduce the carbon footprint of their finished products.

UPM's "-30 by 30 programme" focuses on integrating carbon factors into value chain management, aiming to reduce value chain emissions by 30% from the 2018 level by 2030. UPM has developed a product carbon footprint calculation guide on its carbon reduction management platform for the value chain, obtaining overall carbon emission data from upstream and downstream partners. Value chain partners of UPM can access decarbonization guidelines related to materials and logistics through this platform, enabling them to formulate decarbonization plans suitable for their operations. UPM collaborates with its value chain to enhance energy access, operational efficiency, and technological improvements, and considers carbon emissions as one of the criteria when selecting suppliers and developing products, to promote both product development and supply chain decarbonization.

Latest Decarbonization Policies in Developed Countries

Country /Region	Policy	Effective Date	Overview
EU	EU Industrial Emissions Directive (IED)	August 4, 2024	To identify the best available technologies in various industrial sectors, focusing on energy consumption, environmental impacts (air, water, soil), and resource utilization efficiency.
	Packaging & Packaging Waste Regulation (PPWR)	February 11, 2025	To enhance the recyclability of packaging to ensure that all packaging on the EU market is recyclable by 2030, increase the use of recycled materials, and achieve climate neutrality in the industry by 2050.
	EU Deforestation Regulation (EUDR)	December 30, 2025	The requirement is that the product should not harm forests and that companies must conduct due diligence on their supply chains, or else they will face substantial fines and trade bans.
	Carbon Border Adjustment Mechanism (EU CBAM)	May 10, 2023	The requirements on certain products with high carbon emissions, stipulating that importers must declare the embedded carbon emissions of the product when it is imported into the EU. Subsequently, taxes will be levied based on the embedded carbon emissions and the average price in the EU Emissions Trading System.
Canada	Greenhouse Gas Pollution Pricing Act (GGPPA)	January 1, 2019	To establish a national carbon tax system to levy taxes on industrial greenhouse gas emissions, with the revenue from the carbon tax being used for green investments. This is expected to help Canada achieve its emission reduction targets of 20% to 48% by 2030.
	Energy Innovation Program (EIP)	April 19, 2021	Anchored in Canada's 2021 Federal Budget, this CCUS-focused program committed C$319 million over seven years. To date, it has initiated over 20 carbon capture projects and developed 10 globally accredited carbon management enterprises, materially enhancing the nation's low-carbon industrial capacity.
Australia	Technology Investment Roadmap (TIR)	May 21, 2020	The low-carbon technology development initiative categorizes key technologies into three priority tiers. Top-priority technologies, including clean hydrogen production, low-cost solar and power storage solutions, are being fast-tracked with defined commercialization targets and implementation timelines.
	Industrial Transformation Stream (ITS)	November 13, 2023	Financial support for low-carbon technologies and renewable energy is provided by the Australian Renewable Energy Agency, which funds research, demonstration, and deployment actions to decarbonize industrial processes.
Japan	GX2040 Vision	January 18, 2025	The "Basic Energy Plan" was released, aiming to optimize energy utilization efficiency through setting energy-saving standards, developing energy-saving technologies, and promoting renewable and nuclear energy. Additionally, over 150 billion yen in social investment is expected to be attracted through the 20-billion-yen GX Transformation Fund, with plans to establish a carbon trading system by 2026.

Source: Deloitte China, Government Documents, and Public Sources

Industry Outlook

The Green Development Trend of China's Pulp and Paper Industry

Since the 21st century, energy conservation and emission reduction have received high attention from the Chinese government. In terms of legislation, the government has incorporated the promotion of clean production into relevant laws and plans. Since the Eleventh Five-Year Plan, China has vigorously promoted the concept of energy conservation and emission reduction, achieving very significant results.

The pulp and paper industry, as one of the high carbon-emission industries in China, is also an important raw material industry closely tied to the national economy and social development. It provides essential raw materials for sectors such as industry, agriculture, science and technology, and national defense, making it a crucial link in the socio-economic chain. The modern papermaking industry has largely formed a green industrial system with comprehensive energy conservation, emission reduction, resource recycling, and the ability to achieve carbon cycling in nature, embodying the principles of a circular economy.

Moreover, China's pulp supply chain is showing trends towards diversified raw material structures, international certification, and regional collaboration, accelerating its transformation into a green supply chain that is low-carbon, traceable, and cross-border collaborative. In the meantime, the modern paper manufacturing industry has evolved into a technology-driven sector distinguished by its advanced technical sophistication, highly automated processes, precision engineering standards, and exacting material specifications. The industry is now actively progressing through three key transformational phases: information technology integration, comprehensive digitalization, and intelligent automation.

China's "Belt and Road" Initiative to Build an Global Pulp Ecosystem

China's papermaking industry has entered a relatively mature stage, with the apparent consumption of paper and paperboard ranking first globally. However, the per capita apparent consumption of paper and paperboard is still less than half that of developed countries. As living standards improve and e-commerce continues to develop, the apparent consumption of paper and paperboard is expected to increase.

In recent years, the pulp and paper industry in China has faced challenges such as phased overcapacity and intense competition, necessitating adjustments to product structures and the exploration of new markets to absorb excess capacity. By the end of October 2021, China had signed 206 cooperation documents for the joint construction of the Belt and Road Initiative (BRI) with 140 countries and 32 international organizations, establishing more than 90 bilateral cooperation mechanisms.

Economic development and the papermaking industry in some BRI-participating countries are relatively underdeveloped, with insufficient production capacity in the pulp and paper sector and low per capita apparent consumption of paper and paperboard. The pulp and paper industry in these countries has significant room for growth, and there is considerable potential for increasing the apparent consumption of paper and paperboard. These countries need to actively adjust their product structures and reasonably expand production capacity based on actual conditions to align with the trends of the times.

Currently, the BRI offers new opportunities and broad market space for China's pulp and paper industry, not only facilitating the absorption of excess capacity but also stimulating the development potential of the pulp and paper industry and increasing the consumption of paper products in BRI-participating countries.

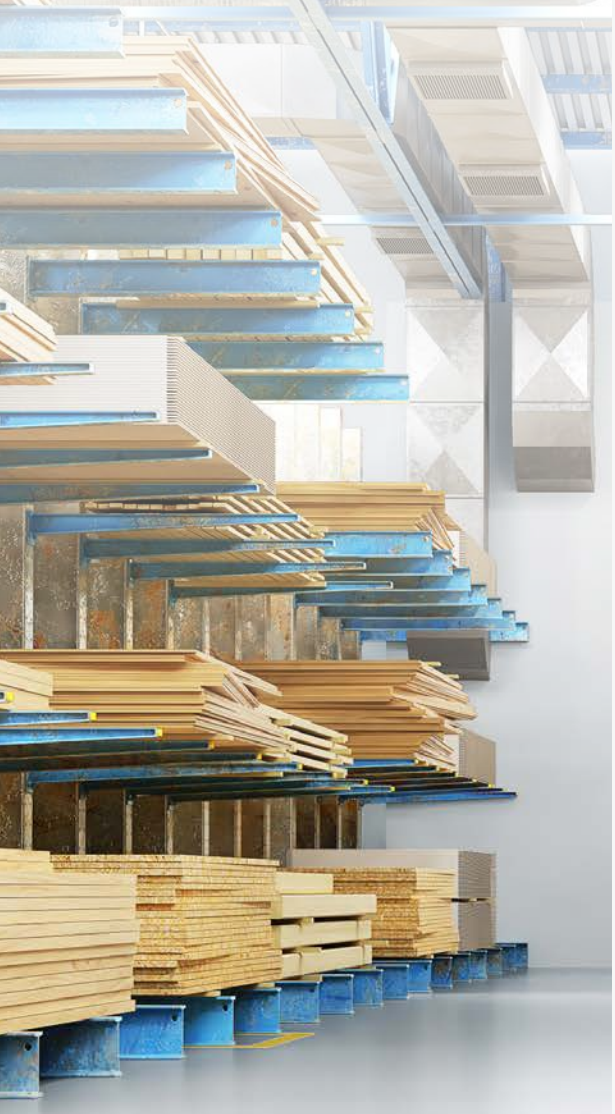
China's Pulp and Paper Industry Accelerates Overseas Expansion with "Being Green and Going Global" Strategy

In the face of domestic forest resource constraints, the steady progress towards the "dual carbon" goals, and the global trend towards decarbonization, China's pulp and paper industry is accelerating its overseas expansion of industrial chains under the guidance of green development. This shift ushers in a new chapter of globalization, moving from "product exporting" to "industry rooting." In the wave of global value chain restructuring, the "Going Global" strategy of China's paper industry is not just about relocating production capacity but also a significant leap in globalizing green innovation capabilities.

Enterprises are actively deepening communication and cooperation with partners in countries rich in forest resources, such as Southeast Asia, South America, and Northern Europe. They are employing various models, including jointly investing in integrated forestry-pulp-paper bases, mergers and acquisitions, co-building circular economy industrial parks, and constructing cross-border supply chain networks. These efforts aim to address raw material bottlenecks and avoid trade barriers while promoting the integration and sharing of advanced technologies and experiences in energy conservation, carbon reduction, and efficient resource utilization. Collectively, these initiatives enhance the sustainable development competitiveness of the industry.

Act Now for a Sustainable Future

In the context of the increasingly severe global climate crisis, the pulp and paper industry, as a crucial link between forestry, manufacturing, and consumer markets, bears the mission of sustainable development and faces the urgent challenge of deep decarbonization. Achieving carbon neutrality is not a task that can be accomplished by a single company, a single link in the chain, or a local region. Only through close collaboration across the entire value chain and concerted efforts from the international community can drive the green transformation of the industry.



Value Chain Collaboration: A Green Closed Loop from Upstream to Downstream

The decarbonization process in the pulp and paper industry begins with the sustainable management of forest resources. Upstream forestry must practice responsible planting and harvesting, enhance carbon sequestration efficiency through technological innovation, and protect biodiversity. Midstream manufacturing enterprises should accelerate the substitution of clean energy, optimize processes, and apply circular technologies to reduce carbon emissions during production. Downstream distribution and consumption should promote green packaging design and improve waste paper recycling systems to minimize resource wastage. Only by breaking down industrial barriers and establishing a comprehensive collaboration mechanism that spans from "tree cultivation to low-carbon production to green consumption to circular regeneration" can decarbonization efforts be transformed into quantifiable real outcomes.

International Cooperation: A Community of Shared Responsibility across Borders

Climate change knows no boundaries, and the global nature of the pulp industry underscores the critical importance of international cooperation. Developed countries should increase their support for green technology transfer and financial assistance to developing countries to jointly promote carbon neutrality in the industry. International organizations need to facilitate the establishment of unified carbon accounting standards and certification systems to prevent carbon leakage and unfair competition. Multinational corporations should leverage their role as a bridge by embedding low-carbon requirements into supply chain management, driving global partners toward a shared transformation. By building cross-border technology sharing platforms and forming regional decarbonization alliances, the industry can harness collective strength that transcends geographical borders.

Innovation-driven: Building a Sustainable Future Together Inside and Outside the Industry

Achieving decarbonization targets requires breakthrough technological innovations and cross-sectoral thinking. Research institutions, industries, and academia should collaborate to tackle key technologies such as bioenergy and carbon capture. Financial institutions can guide capital towards low-carbon projects through green lending and carbon trading mechanisms. Policymakers need to provide a long-term and stable policy framework for emission reduction. By working together, governments, enterprises, research institutions, and social organizations can inject sustained momentum into the industry's transition to carbon neutrality.

Conclusion

Facing climate challenges, both globally and in our country, the pulp and paper industry stands at a critical juncture on the path to decarbonization. We call on industry to promote knowledge sharing, resource connectivity, and shared responsibility with an open mindset. By building a more resilient industrial ecosystem, we can not only achieve our carbon neutrality goals but also redefine the future of resource-intensive industries—making every sheet of paper carry a green commitment and every forest nourish the community of shared destiny for mankind. Action starts now, carbon neutrality is in our hands.

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Glossary

Terms	Definition
Carbon neutrality	Countries, companies, organizations, products, events, or individuals calculate the total amount of greenhouse gas emissions directly or indirectly generated over a certain period and offset their own carbon dioxide emissions through afforestation, energy conservation, emission reduction, and other forms to achieve "zero CO_2 emissions".
Decarbonization	Reducing the use and emission of carbon in socioeconomic systems and transitioning towards low-carbon or even carbon-free socioeconomic models.
Nationally Determined Contributions	Nationally Determined Contributions are the actions and measures proposed by countries under the Paris Agreement framework, based on their own circumstances and capabilities, to address climate change. These contributions include aspects such as greenhouse gas emissions reduction and adaptation to climate change.
EU Carbon Border Adjustment Mechanism	A policy implemented by the EU aims to impose additional charges on high-carbon products imported into the EU, aligning their carbon costs with those of products under the EU's internal carbon emission trading system, to prevent carbon leakage and ensure the competitiveness of EU companies.
EU Emissions Trading System	It is the greenhouse gas emission allowance trading market established by the EU. The EU allocates a certain number of carbon emission allowances to enterprises. If an enterprise's emissions exceed its allocation, it must purchase additional allowances; if emissions are below the allocation, the surplus can be sold. This system incentivizes enterprises to reduce emissions through total quantity control and market mechanisms.
Waste Import Ban	Decree of the Ministry of Ecology and Environment of the People's Republic of China (No. 21), Decision on Abolishing the Regulations and Normative Documents Concerning the Import of Solid Wastes.
Scope 1 emissions	Direct greenhouse gas emissions from resources owned or controlled by the company, such as combustion emissions from the company's own power plant and emissions from vehicle fuel consumption.
Scope 2 emissions	Refers to indirect greenhouse gas emissions from the use of purchased electricity, heat, etc., related to the company's own energy consumption activities.
Scope 3 emissions	Refers to emissions related to the company's value chain upstream and downstream, outside of the company's direct and indirect activities, including raw material procurement, product transportation, employee commuting, etc.
Sustainable forest management	Driven by innovation for sustainable development, achieving a balance between forest operational benefits and environmental protection in the production process.
Integration of Forestry, Pulp, and Paper	Integrating the forestry, pulp, and paper sectors to form an industry pattern where paper production supports afforestation and afforestation promotes paper production, thus promoting sustainable operation and development of pulping and papermaking enterprises.
Life cycle assessment	A method for aggregating and evaluating all inputs and outputs of a product (or service) system throughout its lifecycle to assess the actual and potential environmental impacts.
Greenhouse gas inventory	A tool for systematically accounting for the total amount of greenhouse gases emitted directly or indirectly by entities such as governments and businesses in their social production activities.
Carbon capture, utilization, and storage	The process of separating carbon dioxide from industrial processes, energy use, or the atmosphere, and either utilizing it directly or injecting it into geological formations to achieve emission reductions.
Circular economy	The general term for activities of reduction, reuse, and resource utilization in the processes of production, distribution, and consumption.

Terms	Definition
Carbon footprint	The sum of greenhouse gas emissions and removals generated by countries, companies, organizations, products, activities, or individuals in the system.
Wood pulp	Pulp made from wood fibers.
Non-wood pulp	Pulp made from fibrous materials other than wood.
Recycled pulp	Pulp made from recycled wastepaper and cardboard through processes such as sorting, pulping, and screening.
Pulping	The process of separating plant fiber raw materials into pulp through mechanical, chemical or chemical-mechanical methods.
Black liquor	Black liquor is the residual liquid separated from the pulp after the raw materials undergo alkaline cooking.
Alkali recovery	Alkali recovery is the treatment and comprehensive utilization of waste liquor from the alkaline pulping process.
Boiling	The process of thoroughly mixing the cooking liquid with the plant fiber raw materials in the cooking equipment, and then conducting a chemical reaction under certain temperature and pressure conditions to remove the lignin from the raw materials and obtain the pulp.
Bleaching	The process of removing the colored components from the pulp through chemical or biological means.
Pressing	The process of achieving dehydration and density enhancement by mechanically squeezing the wet paper sheet with the help of the press rollers.
Drying	The process of drying wet paper by having it pass over the surface of a cylinder that is internally exposed to hot steam.
Washing	The process of separating the cooked pulp from the waste liquid through water or a solvent.
Chlorine dioxide bleaching technology	The technology that replaces chlorine with chlorine dioxide for bleaching, which significantly reduces the content of chlorinated organic compounds in the bleaching wastewater.
Totally chlorine-free	The technology where the reagent used for bleaching contains absolutely no chlorine.
Steam cascade utilization technology	The technology that analyses the energy level differences of steam under different pressures and temperatures and makes rational use of steam of different energy levels to fully utilize its efficiency.
Heat pressing technology	The pressing technology that reduces the resistance during dehydration by applying pressure to the wet paper sheets while they are heated, thereby improving the dryness of the paper during output and enhancing the dehydration efficiency.
Hot air penetration drying technology	By using a series of guide rollers, the high-temperature hot air can directly impact the paper sheet in a relatively enclosed area, employing a drying technology that combines heat convection and heat conduction.
Fiber grading screening technology	The technology for separating the long and short fibers in waste pulp for processing.
Neutral deinking technology	A deinking technology for wastepaper papermaking that only uses surfactants without adding alkaline substances such as sodium hydroxide.

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About Deloitte

Deloitte China provides integrated professional services, with our long-term commitment to be a leading contributor to China's reform, opening-up and economic development. We are a globally connected firm with deep roots locally, owned by our partners in China. With over 20,000 professionals across 31 Chinese cities, we provide our clients with a one-stop shop offering world-leading audit, tax and consulting services.

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About Suzano

Suzano is the world's leading pulp supplier, a major paper and packaging producer in the Americas, and one of Brazil's biggest employers. Driven by a deep commitment to sustainability and innovation, Suzano produces responsibly-grown raw materials that are exported to more than 100 countries around the world, meeting the global demand for bio-based solutions. These are used to make everyday items that reach more than two billion people, including toilet paper and tissue, packaging, printing and writing paper, personal hygiene products, and textiles. Founded in Brazil over 100 years ago, today Suzano operates across Latin America, North America, Europe and Asia. The company's shares are listed on the B3 in São Paulo (SUZB3) and the New York Stock Exchange (SUZ).

Entering China in 1980s, Suzano started its business by supplying pulp in response to the development of the domestic paper industry. Thanks to the accelerated growth of the industry in the past decade, China is now Suzano's largest pulp export destination.

Suzano began its presence with a representative office in Shanghai in 2007 and changed it to a fully-owned subsidiary in 2020. Its main business is pulp sales in Asia, with a professional logistics team, an experienced technical team and a customer-centric commercial team.

To enhance its long-term commitment to China, Suzano further expanded its team in Shanghai in 2022 to better serve the country's strategic call for the transition towards a low-carbon society and local customers' corresponding needs. The extended team focuses on ensuring that the company increasingly deliver solutions to support China in meeting its ambitious environmental and social goals, from developing innovative products out of renewable sources, to bringing, co-developing and promoting innovability, or the pursuit of sustainable solutions through innovation. Learn more at www.suzanoasia.com.cn.