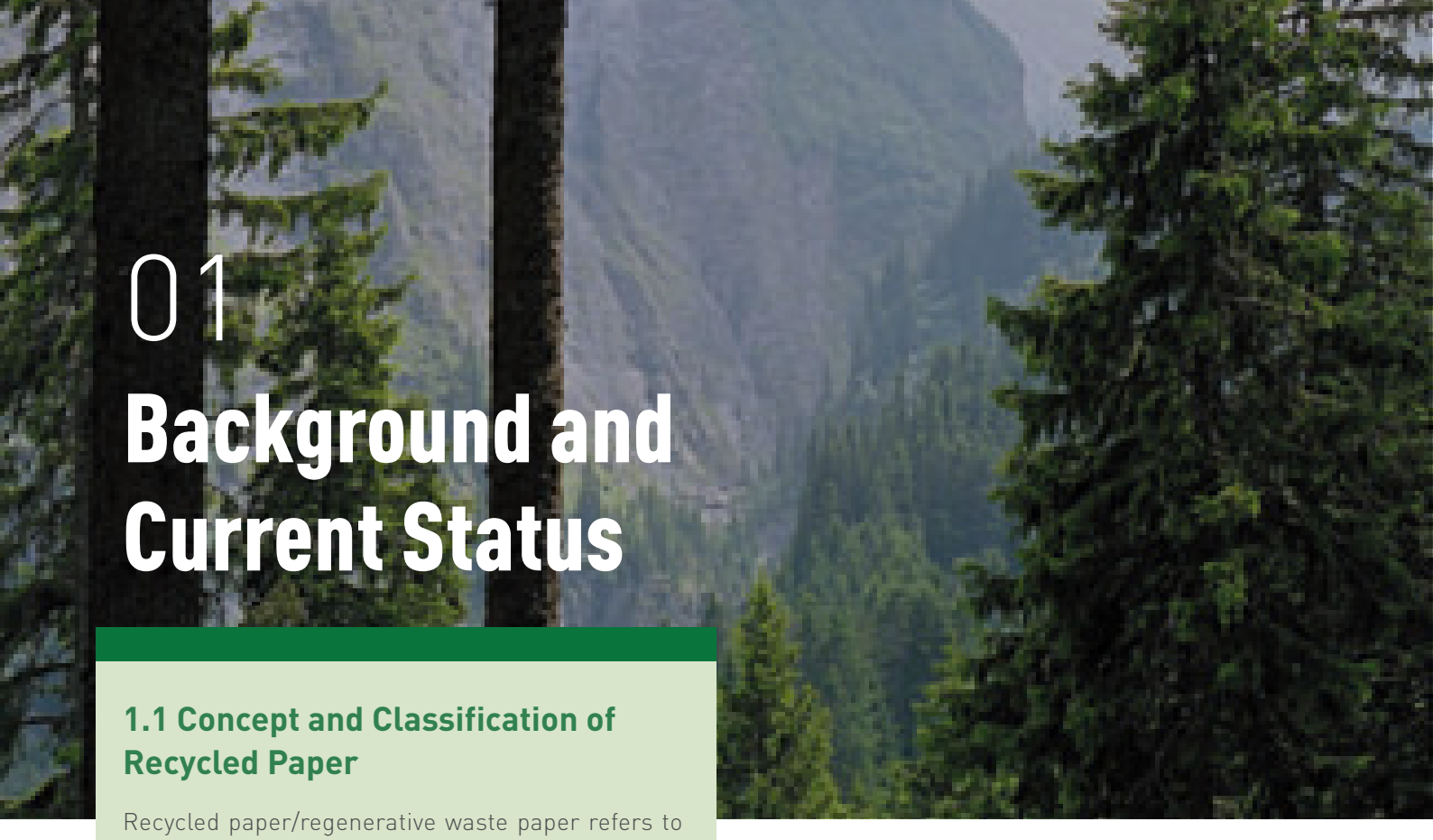
Recommendations for the Sustainable Development of Paper Recycling in China

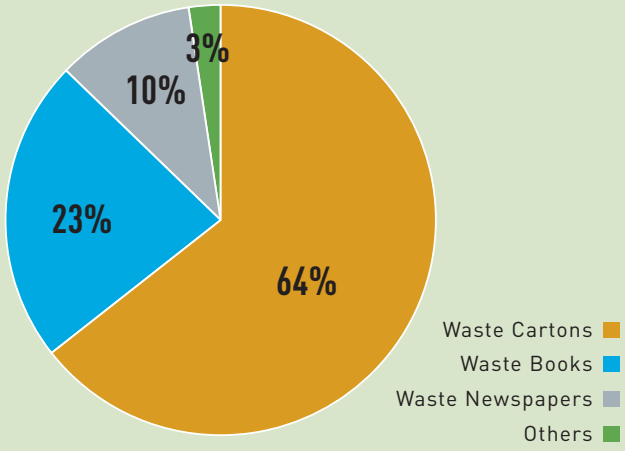


01 Background and Current Status

1.1 Concept and Classification of Recycled Paper

Recycled paper/regenerative waste paper refers to recycled and reusable paper which is generated in the production process and everyday living. It differs from non-reusable paper, which cannot be recycled without refined pre-treatment because it contains prohibited substances, such as paper with paint or oil dirt, label stickers, plastic glossy paper, waxed paper, carbon paper, etc. In China, recycled paper is mainly classified into: waste cartons, waste books, waste newspapers, and others. Among them, waste cartons account for 64%, waste books 23%, waste newspapers 10%, and others around 3%. [1]

● Main Types and Percentage of Recycled Paper in China



1.2 Resource and Environmental Value of Recyclable Paper

Paper is made from wood, while wood originates from forest. Recycled paper is known as "the Fourth Forest" besides virgin, natural and artificial forests. Waste paper from scrap newspapers, books and periodicals, office paper, kraft paper, paper boxes and corrugated paper are all valuable fibrous raw materials. Recycling of renewable fibrous raw materials can promote the reuse of pulp and improve the pulp utilization rate. This also implies higher paper output from the same amount of wood and a reduced demand for high-intensity forest logging in the pulp and paper industries, which will in turn promote the realization of sustainable forest management. [2]

Using recycled fibrous raw materials to make paper can greatly reduce the consumption of wood, water and electricity and the emission of pollutants in the primary pulping process. Recycling one ton of recycled waste paper can produce 800 kilograms of recycled fiber raw materials, thus saving 17 big trees and a landfill space of 3m3. In addition, papermaking with recycled fibers ischaracterized by low energy consumption, low environmental treatment cost, low unit raw material cost, and can save papermaking energy by over 50% and reduce water pollution by 35%. With growing public awareness of cost control and environmental protection, fibrous materials provided by recycled paper have now become an indispensable source of raw material for the paper industry. [2]

1.3 Current Status of Recycled Paper in China

Due to limited capital and production capacity and lack of domestic recycled fibrous materials, China had no choice but to import foreign waste paper as the raw material for papermaking in the early stages of the reform and opening-up. With the rapid development of China's manufacturing industry, the Chinese paper industry has also achieved high-speed growth. Today, China has become the world's largest producer of paper and paper products. [2] Since 2000, almost all incremental carton paper in China has come from recycled fibers. In 2016, carton paper made from recycled fibers accounted for nearly 75% of China's total carton paper output. The importance of recycled paper in papermaking fibers is self-evident [5]. With the fast development of the paper industry, inadequate separation and recycling of domestic waste paper has led to the underutilization of large amounts of recycled waste paper, which in turn results in far lower quality and pulp yield than those of imported waste paper. Many enterprises are forced to turn to and rely on imported recycled paper. As a result, waste paper exported to China has emerged as a new area of trade in foreign countries, in which foreign waste paper is exported into China as raw material. According to the survey data of the China Paper Association, China's paper and paperboard output reached 108.55 million tons in 2016, while paper and paperboard consumption stood at 104.19 million tons. During the year, China imported 28.50 million tons but exported only 2,300 tons of waste paper. According to the China Resources Recycling Association, waste paper recycling rate was at 49.74% in China in 2016. [1][3]

1.4 New State Provisions on Import of Solid Wastes

In April 2017, the Chinese government deliberated about and adopted the Implementation Plan for Prohibiting the Entry of Foreign Trash and Pushing Forward the Reform of the Administrative System of Solid Waste Imports. On August 16, the Ministry of Environmental Protection of the People's Republic

Viii. Recycled (Scrap) Paper and Paperboards, Including Waste Special Paper.				
No.	Customs Commodity Number	Name of Waste	Abbreviation	Other Requirements or Notes
67	4707900010	Recycled (scrap) wall paper, waxed paper, wax-impregnated paper and carbon paper (including unsorted scrap products)	Waste wall paper, waxed paper, wax-impregnated paper and carbon paper	Include waste carbonless copy paper, thermal paper, asphalt moisture proof paper, self-adhesive paper, oiled paper and used liquid packaging paper (Tetra packs)
68	4707900090	Other recycled paper or paperboard (including unsorted scrap products)	Other waste paper	Do not include waste wall paper, waxed paper, wax-impregnated paper, carbon paper, carbonless copy paper, thermal paper, asphalt moisture proof paper, self-adhesive paper, oiled paper, and used liquid packaging paper (Tetra packs).

of China made a public announcement on the publication of the Catalogue of Imported Waste Management (2017), moving 24 types of solid waste from the Catalogue of Solid Wastes Usable as Raw Material That Are Subject to Import Restriction into the Catalogue of Solid Wastes under Import Ban. These 24 types of solid waste include waste plastics from living sources (8 types), unsorted waste paper (1 type), waste textile raw materials (11 types) and vanadium residue (4 types). Among them, unclassified waste paper is now placed under import ban: [4].

In addition, for sorted waste paper, the Ministry of Environmental Protection in conjunction with the General Administration of Quality Supervision, Inspection and Quarantine has issued the Environmental Protection and Control Standard for the Import of Solid Wastes Usable as Raw Material, setting a 0.5% impunity content for imported waste paper. This provision went into force on March 1, 2018. This implies that even for sorted waste paper, if they have a content of over 0.5% in other impurities (including wood wastes, scrap metals, waste glasses, waste plastics, waste rubbers, waste fabrics, waste absorbents, aluminum plastic paper composite packaging, thermal paper, asphalt moisture proof paper, self-adhesive paper, wall paper, waxed paper, wax-impregnated paper, oiled paper, silicon oil paper, carbon paper and other wastes) they will also be barred from entering China. [6] The more stringent waste paper import management policy will pose more severe challenges to the supply of waste paper resources.

In the context of the entry management of imported foreign trash and despite the fact that the recovery

rate of domestic waste paper and the specific shortage of recycled fibrous raw materials likely to result from the entry management of imported foreign trash still need to be further verified due to the complicated statistical process, we nevertheless must establish a standard and environment-friendly system for the recycling and reuse of domestic waste paper as soon as possible. We need to set up a standard for sustainable waste paper supply and consumption so as to improve the efficiency and quality of domestic waste paper recycling. This is both an opportunity and a challenge for the recycling and circular use of local renewable fibrous materials in China. [1][2][3]

1.5 Problems Facing Domestic Recycled Paper under the New Provisions and Their Causes

To a certain extent, lack of preference for domestic recycled paper is because recycled paper imported from foreign countries does have their advantages in both fibrous raw material and cost. Another reason lies in the sound dry and wet separation of the imported waste paper, which means a lower probability of contamination and mildewing and a good quality guarantee for imported recycled paper. However, given the more stringent environmental requirements in force at present, it has now become an urgent issue to be addressed as how to break the current barrier for domestic recycled paper, minimize the negative impact on their quality through better sorting processes and make domestic recycled paper a qualified source of raw material for papermaking enterprises. [2][6]

More specifically, lack of domestic waste classification standards, unsound recycling system, non-refined classification of wastes and weak consumer awareness of recycling all contribute to complex, time-consuming and heavy-wasting processes of recycled paper sorting, while prolonged sorting is prone to cause mildewing and other types of secondary pollution, thus reducing the quality of the recycled paper. Meanwhile, in order to make more gains, some recyclers add more impurities and moisture into the recycling process, which both reduces the quality of the recycled paper and results in unnecessary losses. [2][3]

With reference to the four stages of the recycled paper supply chain – the recycling link from the generating source to the sorting and processing center, the papermaking link from pulp making to raw paper formation, the packaging link from raw paper to packaging, and the circulation link from packaging to consumers – and in relation to the above analysis, we can find that low-efficiency waste paper recycling in China mainly occurs in the circulation link. The recycling link itself also involves waste paper generating and recycling ends, as well as a sorting and processing link which plays the role of sorting and transferring between them. This document attempts to deconstruct and analyze the recycling link so as to make some practical recommendations for improving the current situation of domestic waste paper recycling in China.

Links of the Recycled Paper Supply Chain

02 The Recycling Link

2.1 The Generating End

2.1.1 Residents

Recycled paper generated in residential areas mainly includes yellow straw boards and waste books and newspapers. Despite repeated emphasis on the benefits of garbage sorting and the publicity of garbage sorting methods, it is still difficult to achieve sound garbage sorting at the residential end, thus resulting in the poor quality of paper recycled from residential areas. [3]

After all, at the current stage there is no way for us to demand all households to master the right garbage sorting method and form the habit of garbage sorting. Moreover, trash bins downstairs in residential areas are all for public use. As long as one person/household fails to make the right garbage sorting, all the garbage sorting are affected by households in the whole building will come to nothing. In addition, even if all the residents have done garbage sorting, garbage in the trash bins is still likely to be mixed and transported away. This renders garbage sorting useless.

Moreover, under an incomplete garbage classification system, most residents can only distinguish recyclable items from non-recyclable ones by "common sense", let alone whether such classification is correct or not. Even among the recyclable items, residents can only manage to put together the garbage that is commonly believed to be reusable rather than distinguished paper from other recyclable items. In addition to increasing the sorting pressure, such classification also causes paper pollution by other wastes, thus affecting the quality of the paper recycled. As far as paper is concerned, residents tend to classify all paper products as recyclable garbage, which leads to the mix of recycled paper with other contaminated, non-recyclable paper, such as e-invoices, labels and so on.

To sum up, paper recycled from residential areas suffers fairly serious pollution and is of low quality and often requires extremely complicated subsequent sorting processes.

2.1.2 Supermarkets and Office Buildings

Recycled paper from supermarkets mainly consists of yellow straw boards, while paper recycled from office buildings mainly comprises recycled office paper and express packaging materials. Compared with the recycled paper generated by residents, paper recycled from supermarkets and office buildings contains less impurities and less pollution and is of medium quality. Due to their huge volumes, such paper is mainly collected by recyclers at the doorsteps, thus requiring a certain logistic capability. However, because of the existence of shredded documents, fully shredded paper is more difficult to recover and transport. [2][3]

2.1.3 Factories

Bulk raw materials and equipment packaging materials are the main sources of paper that can be recycled from factories. Such paper is of relatively high quality and in huge volumes and stable supply. As a result, factories are often a source of competition for all recycling companies. However, because of the large and concentrated sources of paper for recycling at factories, recycling such paper presents an enormous test for recycling enterprises' logistic capacity and also has certain requirements for their capital flows. In addition, oil immersion, incineration and packaging breakage may occur in factory operations, which will affect the quality of the paper recycled from factories. As raw materials and equipment packaging materials mostly consist of straw boards and plastics, paper recycled from factories naturally has a high quality than paper originating from residential areas. However, most factories do not properly classify these packaging materials, thus resulting in a mixture of recycled paper with plastic materials. To a certain extent, this reduces the quality of the recycled paper and increases production capacity consumption for recyclers or in the sorting process. [3]

2.2 The Recycling End

The recycling end of regenerative waste paper includes individual recyclers, small- and medium-sized recycling enterprises, large-sized recycling enterprises, and sorting and processing centers that play the role of sorting and transmission. Different types of recyclers mainly connect with different waste paper generating ends, and their market shares also vary significantly from region to region as a result of different local policies and consumer habits. At the current stage, it is only possible to analyze these different types of recyclers one by one, while horizontal comparison will be made after data are improved.

2.2.1 Individual Recyclers

Individual recyclers are the first link for the effective sorting and recycling of most regenerative waste paper produced by residents. Their methods of recycling mainly include street visits and collection by appointment. As a result, their recycling volume and efficiency are both limited. Due to inadequate supporting facilities, individual recyclers can only perform relatively coarse treatment of their recycled items. Moreover, they are also enthusiastic about recycling high-value items. Due to the constraint of logistic costs, individual recyclers are usually densely distributed in the vicinities of sorting and processing centers and other downstream distribution centers, but they are rarely found in other areas. This has made it impossible for many residential areas to connect with this "first link of recycling", making effective recycling in residential quarters difficult to come by. [3][7][8]

Among individual recyclers, there are instances of "turf zoning". Often, there is only one individual recycler or recycling enterprise operating in one residential area. Besides seriously lowering efficiency, this can also lead to "monopoly". Such "monopolistic" effect makes it difficult for recycling-

conscious residents to connect with recyclers to a certain extent, it also leads to a confrontation with small- and medium-sized recycling enterprises which want to enter residential areas, thus forming a kind of resistance to a standardized recycling system. Meanwhile, "monopoly" gives individual recyclers a big independent "pricing power", thus causing significant fluctuations in the price of recycled items and often leading to short weight and price suppression. This can easily arouse aversion from residents and damp their enthusiasm about recycling. By contrast, some community residents and community administrators consider individual recyclers as a potential threat to community security, therefore forbid their entry into local residential areas. This antagonistic situation has even more impeded the effective sorting and recycling of garbage.

2.2.2 Small- and Medium-Sized Recycling Enterprises

Small- and medium-sized recycling enterprises have higher recycling capacities. With their relatively stable and reliable price offers, they are more easily accepted by community and supermarket groups. However, small- and medium-sized recycling enterprises mostly adopt the methods of "Internet+" and doorstep collection by appointment to connect with some supermarket groups which have large volumes of items for recycling. However, these recycling enterprises have met with repeated setbacks when trying to enter residential areas. The main reason is that the amount of recycled paper generated by residents is rather small and such paper is fairly scattered. The recycling of such paper carries high labor, logistic and site rental costs, while the low profit of the recycled paper is not enough to pay these costs. Some small- and medium-sized recycling enterprises have opted to hire free individual recyclers to do the recycling work for them. However, the low quality of some individual recyclers has left a negative impression on local residents and also affects the relationship between residents, community administrators and small- and medium recycling enterprises. [7][8][9]

Another way is to set up recycling kiosks in residential areas to count on local residents to consciously bring in their items for recycling. This approach also puts into test the cooperative relationship between community administrators and small- and medium-sized recycling enterprises. In addition, due to residents' different personal qualities, there are situations where residents take their unrecyclable garbage to the automatic recycling outlets and cheat for returns. While the returns may not be a big matter per se, the practice will make all the recycling work by other residents in the area covered by the outlet come to nothing. Besides, it also greatly increases the subsequent sorting process of the recycling outlet, which makes it completely meaningless for the automatic recycling outlet to exist. [9]

Both garbage collection by appointment and active recycling by locals depend on the consciousness of residents and supermarkets, which are the generating end of recycled paper. How to guide the active participation and arouse the enthusiasm of the generating end is also an issue to be urgently addressed. In addition, there is a process of concentration, stacking and accumulation in both recycling models above. In this process, apart from site rental costs, there may also other material wastage caused by damping, mildewing and pollution, all of which affect the quality of the recycled paper.

2.3 Sorting and Processing Centers

Waste paper sorting and processing centers refer to sites where waste paper is put into large-scale sorting, selection, impurity removal, cutting, drying and packing in accordance with the source, use, classification criteria and quality requirements of waste paper. If it meets the quality requirements after processing, the recycled paper can directly enter the regeneration and utilization link as the raw material for production. However, most waste paper sorting and processing centers in China currently only have the packaging function. Moreover, many sorting and processing centers only have makeshift factory buildings, occupy agricultural land, and have no land ownership certificate, environmental assessment approval by the environmental department or filing with the department for industry and commerce. In order to save cost, these sorting and processing centers often use unstandardized processing, loading and unloading equipment, and unsound fire safety facilities, which lead to serious security risks. Moreover, their lack of adequate labor safety measures for workers often results in a high accident rate. In addition, non-standardized sorting and processing centers themselves may become a source of environmental pollution because of their open workshops and lack of dust, noise and sewage treatment facilities. Even regular sorting and processing centers also have the same problem of dirty, disorderly and poor operations, because their warehouses are on commercial land, which can be expropriated at any time due to lack of communication between the centers and the government. The existence of high uncertainty makes sorting and processing centers dare not to invest too much in their warehouse construction. [7][8][10]

In order to strengthen the standardized management of sorting and processing centers, local governments often adopt a combination of tax incentives and punishments. However, such measures are aimed at registered and regular sorting and processing centers and thus cannot effectively act on non-regular sorting and processing centers which are in urgent need of standardization. Meanwhile, they also put various restrictions on regular sorting and processing centers. [7]

As a link close to papermaking enterprises, recycled paper must be sorted properly by sorting and processing centers before it can be effectively sold. However, due to the high cost of sorting equipment, sorting work is still basically done by manual labor, thus leading to low efficiency, relatively high human cost, longer storage time, and increased risk of pollution, mildewing and fire hazards. In order to increase profits, non-standardized sorting and processing centers may add impurities and water into their processing operations, which will cause serious damage to the quality of their recycled paper. Further, mouldy and contaminated low-quality recycled paper does not help to reverse regenerative paper enterprises' current preference for imported waste paper. Meanwhile, it also causes the waste of renewable fibers and lowers the actual recycling rate.

03
What Can We Do?

3.1 The Generating End

The Ministry of Housing and Urban-Rural Development has made the following general classification of garbage: kitchen waste, recyclable garbage, hazardous garbage and other garbage. Besides, we need to know what recyclable paper is and what non-recyclable paper is. While different regions may adopt different policies, the general rules are basically the same, which are summarized as follows:

► Recyclable Paper

Category	Principle of Treatment
Newspapers, magazines, books, packaging paper, cartons, envelopes, packaging cartons, egg boxes, shopping bags, toilet paper rolls.	The most basic principle is dry and wet separation, followed by the separation of paper in the dried garbage from plastics, plastic sealings and other substances. First remove the plastic wrap cover, outer envelope, notebook plastic coil, adhesive tape and staple, then flatten the recycled paper, and classify the recycled paper and sort it out. For cartons, packing boxes and tapes should be placed separately, because adhesive tapes are a major difficult spot in the recycling of cartons.
Composite paper packaging for drinks, dairy products, drinking water cleaning agents, etc.	Remove the suction tubes, empty the content, flatten them as much as possible and store separately. Do not mix them with other recycled paper.

► Non-Recyclable Paper

Category	Principle of Treatment
Paper with paint or oil soiling, plastic glossed waste paper, carbon paper, waxed paper, paper-interlayered laminated wood, label stickers, thermal paper (e-invoice, fax or electrocardiogram paper), oil-proof paper, sand paper, transfer paper, used sanitary paper, paper diaper, etc.	Put them into trash bins marked with "Other Garbage" (Due to their coating materials, e-invoices and other thermal paper will form spots upon heating, which affect the quality of the paper recycled form them. In the current recycling systems of various countries in the world, it is generally recommended to classify e-invoices and other thermal paper as other garbage for subsequent treatment.

• We recommend that residents and office buildings prepare different garbage bags/barrels, separate kitchen/organic waste, waste paper, plastics and packing boxes, and classify and sort paper items according to the above table.

• Property management companies and community administrators should publicize the right classification method to local residents, mobilize volunteers and security patrols to persuade those residents who litter and encourage mutual supervision among local residents.

• With reference to the garbage sorting experience promoted in Taiwan [11], the right quantity of free garbage bags or similar small rewards should be provided to residents who do the right sorting work. The better the classification is, the more the recyclable garbage and the other wastes will be, and residents will also get more rewards.

• We recommend that office buildings seal and (compress) pack their shredded paper.

• We recommend that factories separate paper from plastics and store them separately when unpacking their equipment and raw materials.

• We recommend that factories should not put their unpacked equipment, raw materials or disassembled packaging materials in the production area. This will not only prevent pollution to the equipment and raw materials, but also reduce the contamination of the recycled paper and improve the quality of the recycled paper. Meanwhile, it will also reduce the potential danger of fire.

• The government should strengthen policy guidance, standardize garbage classification, and search from various sources for the best way of garbage sorting and recycling which suits China's situation.

• Garbage truck classification should go hand in hand with garbage classification. Multiple garbage trucks may be used to clear different types of garbage, or different types of garbage be cleared at different time. For example, kitchen waste can be cleared on Monday, while recyclable garbage cleared on Tuesday, with paper separated from plastics, and other garbage cleared on Wednesday. This will not only serve as a complement to the efforts made by the public, but also play a guiding role.

3.2 The Recycling End

• Garbage classification and recycling indicators may be included into the rating of property management companies, thus motivating them to participate in the recycling and reuse of resources and actively cooperate with local residents and recycling enterprises.

• Small- and medium-sized recycling enterprises can work with property management companies and community administrators to recruit, hire and train scarpered individual recyclers. Community cleaning workers may also take part. This will both

raise the income of individual recyclers and cleaning workers and help them to integrate into the social welfare system, but also facilitate the standardization of management and reduce disturbance to local residents. Through the unified market-based pricing of small- and medium-sized enterprises, it is possible to avoid price gouging by individual recyclers. The stable recycling price will also make it easier for recycling enterprises to cement long-term cooperation with downstream regenerative paper-making enterprises. Recycling enterprise can share the transportation cost with individual recyclers, while experienced recyclers can save recycling enterprises' labor and time costs in the sorting process. The cooperation between property management companies and recycling enterprises will help recycling outlets to enter local residential areas and provide a convenient way for recycling-conscious residents to make recycling. Property management companies and community administrators can act as supervisors and guides in the process of recycling and standardize the behavior of recyclers, which will help to both solve the problem of the falling quality of recycled paper caused by adulteration and give residents a sense of safety. With the help of reliable recycling prices, it will be possible to make residents more enthusiastic about participating in the sorting of garbage and the recycling of renewable resources. Meanwhile, it is necessary to guide residents to make the right garbage classification and prevent them from "offering poor wastes as good wastes" at recycling outlets. This will reduce the downstream sorting pressure, lower the various costs of sorting, and cut down unstable factors arising from the tedious downstream process, thus achieving efficient recycling. The relationship of multi-party cooperation is conducive to the optimization of resources and can help small- and medium-sized recycling enterprises to expand, attract further policy attention and eventually form a benign cycle.

- If it is not possible to fully absorb individual cyclers in the short term, we encourage small- and medium-sized recycling enterprises to connect with individual recyclers by reasonably setting up more business outlets [8]. This can save the logistic cost of individual recyclers and make the distribution of recyclers more reasonable. Through their control over the source and quality of recycled paper, small- and medium-sized recycling enterprises can indirectly supervise the price suppression and adulteration conduct of individual recyclers.

- We recommend that small- and medium-sized recycling enterprises look for sheltered warehouses as much as possible, or strengthen connectivity with downstream recycling enterprises, sorting and processing centers and even regenerative paper-making enterprises, thereby reducing the falling quality of the recycled paper caused by mildewing due to climatic and environmental factors and preventing it from affecting the recycling rate and corporate profit.

- All recycling enterprises should also promptly carry out follow-up sorting work, negotiate a reasonable supply frequency with regenerative paper-making enterprises and reduce storage time, thus cutting down the cost of storage and the risk of pollution, mildewing and fire. Small- and medium-sized recycling enterprises may carry out basic paper and plastic separation work as far as possible according to their manpower and material resources, and maximally improve the quality of their recycled paper. Meanwhile, they may also add a recycling chain to plastics and further increase their profit margin. Large-sized recycling enterprises should fully analyze and understand their own complete supply chain and rationally allocate their sources, logistics, warehousing, distribution outlets and objects, as well as sales volumes of recycled paper, thus reducing the wastage of resources and time and the risks caused by storage, long-distance transportation and repeated

transfers, so as to save cost. Large-sized recycling enterprises should also strengthen their control over the transport process to reduce losses and fire risks.

• rom paper factories to sorting and processing centers, front-end recycling enterprises, individual recyclers and eventually residents, tiered pricing may be adopted in the transaction process of each link based on the purity, i.e. garbage classification, of the recycled paper being traded. The cleaner the recycled paper is, the less oil dirt, damp, mildewing and impurities it has, and even the more monolithic the variety is, the higher its price will be. Price will be used as a leverage to motivate participants in each link to take their initiative to carry out sorting, classification and standardized storage work.

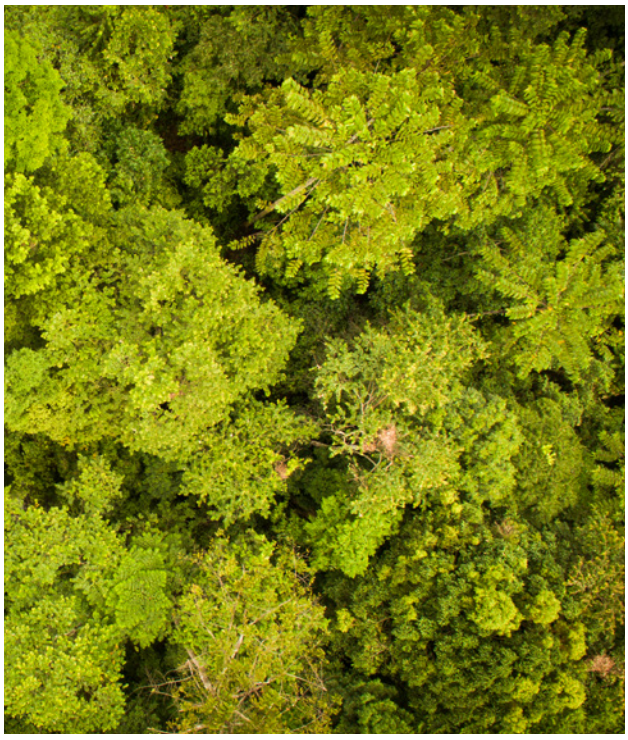
• We recommend that local governments introduce feasible policies to help, train and well manage individual recyclers, and offer certain policy support to small- and medium-sized enterprises to help them to connect and cooperate with all links of the recycling chain.

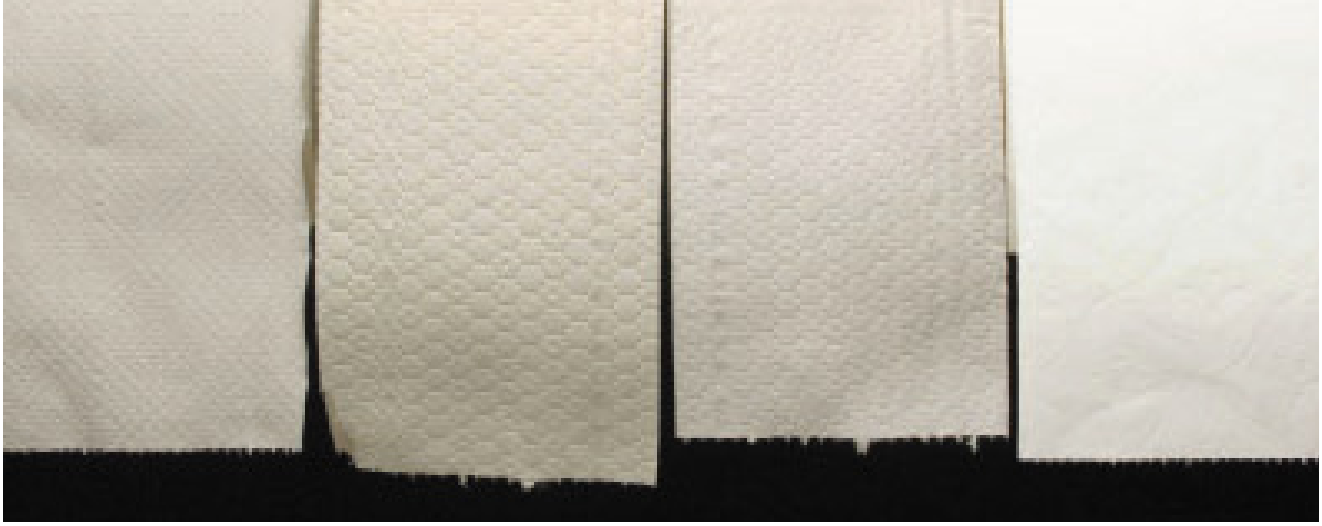
3.3 The Sorting and Processing Link

• Sorting and processing centers may cooperate with large-sized recycling enterprises, regenerative paper-making enterprises and industry associations, and strengthen their communication with local governments [7], promptly express their pursuits, obtain truly needed help and assist in the implementation of local policies. For example, for warehousing land, sorting and processing centers can promptly get relevant information, express their opinions and suggestions through communication with local governments, change from being a completely passive recipient of information into a participant to a certain extent, further increase their sense of security through accurate information sources, make reasonable investment in warehousing land and strengthen their warehousing construction. This will enable sorting and processing centers to improve their employees' working environment, while reducing losses resulting from harsh warehousing environments and raising their profit margin and fiber recycling efficiency.

• We recommend that upstream and downstream recycling enterprises and regenerative paper-making enterprises choose regular sorting and processing centers for cooperation, thus indirectly promoting the transformation of irregular sorting and processing centers. Thanks to their complete and standardized equipment and facilities and relatively professional personnel, regular sorting and processing centers can undertake better sorting work than irregular sorting and processing centers. Therefore, the quality of the recycled paper coming from regular sorting and processing centers will also be relatively higher.

• Where conditions permit, large-sized recycling enterprises may do their own packing so as to reduce middlemen's influence on their profit, while ensuring the quality of their recycled paper at the





same time. Based on their own needs, small- and medium-sized recycling enterprises can seek long-term cooperation with appropriate regular sorting and processing centers and then optimize their industrial chain. Sorting and processing centers can also obtain a stable source of supply through such cooperation and leverage this advantage to establish contact with downstream regenerative paper-making enterprises. Through stable supply and sales relationships and personnel allocation, small- and medium-sized recycling enterprises can reduce the wastage of their recycled paper in the warehousing process and make large-scale development possible.

- We recommend that sorting and processing centers subdivide waste paper categories and grades as far as possible, and adopt tiered pricing for procurements and sales, use the price differential as a source of stimulation, separate and make classified collection of waste paper and wastes at the source, divert the sorting pressure and realize the full-process supervision of waste paper quality. Sorting and processing centers may mark waste paper according to the requirements of the corresponding classification grades, and add product labels to specify waste paper category, grade, quality inspection record, ex-factory date, producer and other information. Downstream enterprises should be encouraged to use IoT, green labelling and other technologies to trace the whole process of their product processing and utilization.

- As resources transmitters, sorting and processing centers should fully sort out the waste paper they collect and provide processing and reuse enterprises with domestic recycled paper that meets the quality requirements, and seize the opportunity of reduced imports of recycled paper. In addition, sorting and processing centers may also create more profit sources by properly recycling and utilizing separated plastics, metals, glass and other resources.

- We recommend that the government formulate and implement waste paper recycling industry specifications and regulatory measures through industry associations as soon as possible, strengthen its control over irregular sorting and processing centers, seek reasonable ways and appropriate opportunities to help them to transform. The government should also provide necessary and reasonable assistance and subsidies to regular sorting and processing centers.

- In Germany, mechanized sorting equipment provides a guarantee for efficient resources recycling. [12][13] Facing the situation of unsound garbage classification and rich but difficult-to-separate recycling resources in China, many recycling enterprises and sorting and processing centers have seen the advantages of such equipment. But, its high price has put off small- and medium-sized recycling enterprises and sorting and processing centers whose cash flows are small. [10] We recommend that local governments help small- and medium-sized recycling enterprises and standardized sorting and processing centers to import or cooperate with other enterprises to develop similar sorting equipment, so as to reduce their manpower and time consumption

and improve their sorting efficiency and the quality of their recycled paper. The research and development and import of sorting equipment will also help recycling enterprises and sorting and processing centers to connect with the generating ends of recycled paper with mixed garbage in residential areas, thus expanding the scope of the raw materials (garbage) that they can receive and promoting the expansion of corporate size.

3.4 Other Supplementary Recommendations

- Given that waste paper is the main source of packaging materials and affects the normal production of most enterprises, it is hoped that the concerned government departments should pay close attention to the supply, demand and price trend of waste paper, and especially smooth out the circulation of waste paper and crack down on acts of hoarding and price gouging when market demand is strong.

- At the current stage, renewable resources utilization in China has gradually matured. However renewable resources recycling is still in its infancy in the country. [2] There is an urgent need to improve the laws and systems for recycling work and strengthen the support and technology R&D so as to improve the efficiency of recycling and eliminate secondary pollution to renewable resources and the environment in the recycling process. [1][14] On the one hand, it is necessary to make recycling more feasible. On the other hand, it is imperative to strengthen the assistance and supervision of the whole recycling chain and prevent the profit-driven low-value recycling of resources, the spillover of toxic and harmful substances and the pollution of the environment caused by the dust, noise and volatile organic substances produced in the processing procedure, so as to safeguard the health and safety of recycling personnel, local residents and end consumers.

- Well-classified recycled paper can provide an optional raw material for resources recycling and papermaking enterprises. Meanwhile, we also recommend that resources recycling and papermaking enterprises learn and develop more environment-friendly and mild methods to treat recycling paper so as to reduce damage to paper fibers and environmental pollution. In this regard, we can draw on the treatment technologies in Taiwan [14]. Local governments may also provide some assurance to enterprises engaged in this kind of research and development, thus promoting the utilization and sustainable development of indigenous renewable resources in our country.

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