MIT-AF&PA PROJECT – CHINA WHITE PAPER

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Last year (2017) China announced that it would no longer accept imports of some categories of recyclable materials including "unsorted waste paper" (or what the industry calls mixed paper) by the end of 2017. China has been the largest importer of U.S. recovered paper. In 2016, China imported 14.5 million short tons of recovered paper from the U.S. This accounts for about 67% of the total U.S. export volume of recovered paper. In March 2018, China imposed tighter contaminant limits for imported recovered paper and is issuing fewer import licenses for all recovered paper grades. The U.S. pulp and paper industry has experienced significant changes in the business environment as a result of China's policies on importing recyclable materials and has raised concerns about its effect on the overall industry.

The purpose of this White Paper is to quantify the volume of recovered fiber potentially affected by the China import policy, identify which U.S. manufacturing sectors could theoretically consume additional recovered fiber that would otherwise be exported to China, and using input from subject matter experts, suggest potential ways to address fiber gaps. We focus primarily on mixed paper as that is perhaps the most impacted grade of recovered paper since the policy has targeted grades of recovered paper with higher contaminant levels, however, we also comment on the impact on grades such as old corrugated containers (OCC).

The data source for U.S. paper manufacturing consumption and exports of recovered fiber comes from the American Forest & Paper Association. The methodology used to estimate the ability for the U.S. paper sectors to consume additional recovered fiber comes from a fiber distribution model developed by researchers at MIT.

The fiber distribution model is designed to model the situation where a part of the system increases its demand for recovered paper for various reasons, such as increased demand for products made of recycled fibers, or a government mandate to use recycled content in products. The fiber distribution model is intended to simulate how the rest of the system may respond to fill those fiber gaps. From this perspective, the model does not explicitly consider the case where there is increased availability of recovered paper domestically. However, we have used the model to examine parameter changes related to export of recovered paper, given the complex interdependent relationship of fiber consumption between different product sectors and

the paper recycling infrastructure in the U.S. The results presented in this document are intended to inform the U.S. paper industry about the potential challenges and directional consumption behaviors as a response to changes in parameters related to export rather than presenting the quantitative consequences. In addition, this document also summarizes key highlights of discussion between AF&PA member companies on China's new trade policy during a January workshop held at MIT.

WHAT IS THE POTENTIAL FOR THE USE OF MIXED PAPER IN THE U.S. PULP AND PAPER INDUSTRY?

We first analyze how recovered paper consumption changes if there is no cost to withdraw mixed paper from the export market, especially paper exported to China. Although this analysis does not directly answer the question about the effect of the increased supply of recovered fibers in the U.S., this analysis examines potential barriers for use of domestic mixed paper after China's new trade ban.

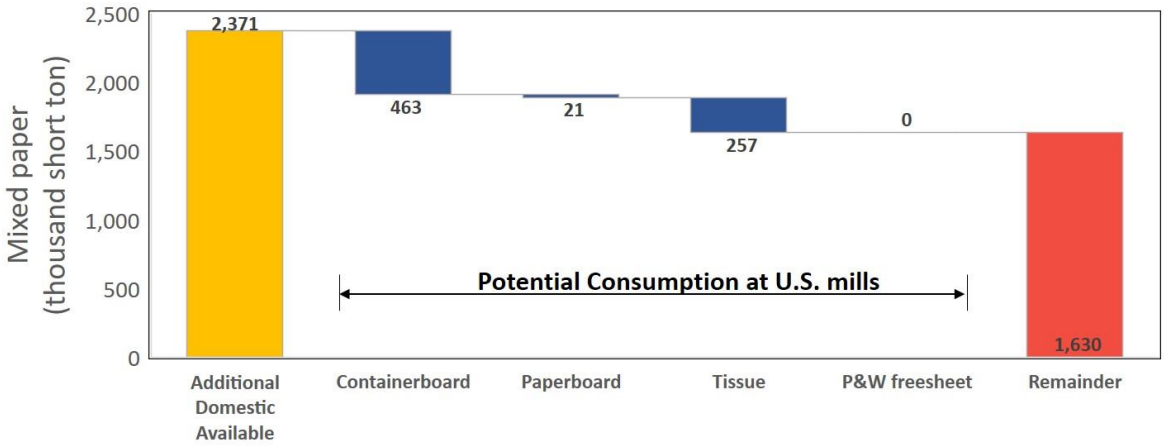

FIGURE 1 ADDITIONAL MIXED PAPER BECOMES AVAILABLE AFTER CHINA'S NEW TRADE BAN AND THE POTENTIAL CONSUMPTION OF MIXED PAPER AT THE MILLS OF DIFFERENT PRODUCT SECTORS.

Figure 1 shows how much mixed paper mills may be additionally consumed as a result of China's new trade policy. The result indicates that the containerboard, paperboard, and tissue sectors can additionally consume 463, 21, and 257 thousand short tons of mixed paper, respectively. These three product sectors can only absorb about 30 percent of the mixed paper volume originally exported to China (2.4 million short tons) in 2016 under current processing capability. Even if the value of the additional mixed paper drops significantly below that of other grades or virgin fiber, creating an incentive to utilize more, the results imply that may still not be enough to fully consume mixed paper recovered in the U.S.

This analysis is based on the assumption that other conditions within the model remain the same. In reality, demand for other grades of recovered paper can be changed as the Chinese paper industry responds to its government policy, which can act as additional pressure on the U.S. pulp and paper industry. Nevertheless, the result suggests that a strategy to make more flexible use of mixed paper or find new markets for recovered fiber is clearly needed.

In general, while it is expected that the policy will have less impact on the export of other recovered grades, some impact is expected. Following the initiation of China's policy, there is still a strong demand for the higher-quality grades such as OCC, a significant portion of whose recovered volume was exported to China in the last year. This analysis can be also used to understand the domestic capacity of processing various grades of recovered paper including mixed paper. In 2016, the total amount of domestic recovered paper was 52.6 million short tons. Among these 52.6 million short tons, 30.8 million short tons were domestically consumed in US mills and 21.8 million short tons were exported to China and other countries. If the US mills fully maximize the current capacity, they can increase the consumption of recovered paper up to 36.3 million short tons as shown in Figure 2. This result indicates that, should China stop all Recovered Fiber imports from the U.S., the current paper recovery system would generate 9.1 million short tons of recovered paper that could not be domestically consumed. While this oversupply of recovered paper may not be problematic where there is strong export demand for US recovered paper, this unused domestic volume motivates strategy development to find viable uses of this material, some of which has already begun.

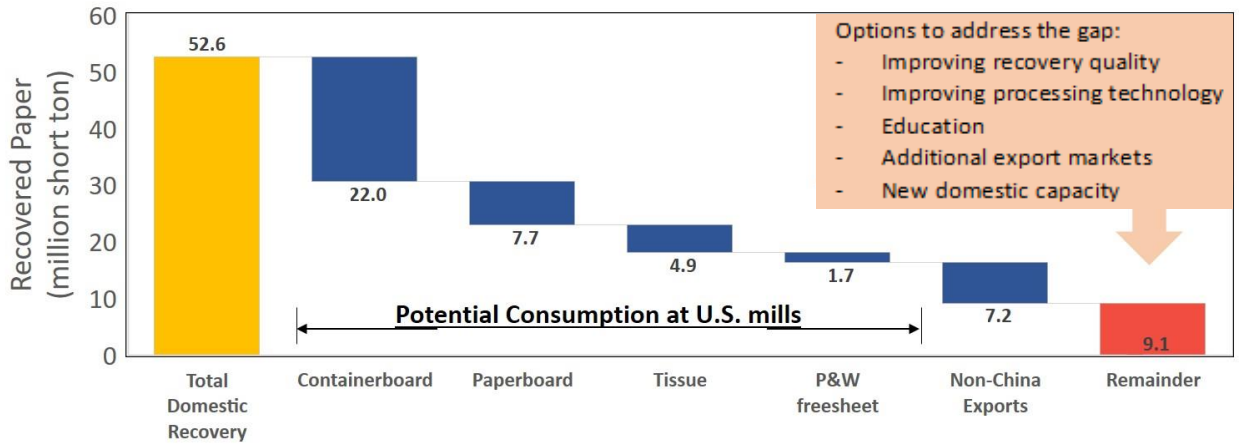

FIGURE 2 TOTAL US DOMESTIC RECOVERED PAPER IN 2016 AND THE POTENTIAL MAXIMUM CONSUMPTION OF RECOVERED PAPER AT THE MILLS OF DIFFERENT PRODUCT SECTORS GIVEN CURRENT CAPACITY AND TECHNOLOGY.

WHAT ARE POTENTIAL INSTRUMENTS TO ADDRESS MIXED PAPER USE IN THE U.S.?

The results of the fiber distribution model indicate that there may be an unmatched gap between supply and demand of mixed paper. Two technical parameters embedded in the fiber distribution model play key roles in this mismatch. This section describes which part of the U.S. paper industry may lead to this mismatch and how this gap can be further examined.

INCREASE THE CAPACITY TO PROCESS MIXED PAPER, PARTICULARLY IN THE PACKAGING SECTOR (DEMAND SIDE)

One factor that acts as a constraint on using more of the mixed paper available in the U.S. is the mill capacity to process mixed paper. Increasing capacity (there are several ways this can be done) can allow the industry to take advantage of the relatively low cost of using additional mixed paper in products. The effect of increasing processing capability will be particularly significant in the containerboard sector because of the large production volumes as well as mill configuration. While three sectors, containerboard, paperboard, and tissue (specifically primarily the away-from-home segment of the tissue sector), all currently use mixed paper, the potential of individual product sectors to incorporate more mixed paper is significantly different.

The paperboard sector is segmented between different recycled grades of products. There are only a few U.S. paperboard mills that produce products made mixing both virgin and recycled fiber. The rest of the mills produce products made of either 100% recycled fiber or 100% virgin fiber. The industry has communicated that 0%-recycled and 100%-recycled converted products are actually very different in terms of their uses and that they do not compete for the same type of demand. For example, there is a limit to using recycled fiber in the products for food containers due to performance and aesthetic qualities. Increasing the use of mixed paper mostly results in replacing other lower grades such as boxboard cuttings (BOX) or old newsprint (ONP) rather than replacing the use of virgin fiber.

The tissue (primarily away) sector also has limited room to take additional mixed paper. The average recycled content of the tissue-primarily away product is already very high, up to 90% and its total production volume is only about 6% of the production volume of containerboard in 2016. Unless there is a demand shift from tissue-primarily home products to tissue-primarily away products, there is only limited room to increase the recycled content in the tissue-primarily away products.

The containerboard sector used about 1.4 million short tons of mixed paper in 2016. However, a significant portion was consumed by mills only producing 100% of recycled product (recycled mills). Opportunities to increase the use of mixed paper in the containerboard sector include substituting it for virgin fiber or higher yield OCC grades, subject to the critical technical constraints of these mills and specifications of the finished products.

IMPROVE THE PROCESSING CAPABILITY FROM THE RESIDENTIAL SECTOR (SUPPLY SIDE)

Improvements in the current processing capability by recovering waste paper as higher grades than mixed paper can address the use of mixed paper as well as generate additional domestic and Chinese demand for recovered paper. The current recovery system in the U.S. generates significant quantities of mixed paper that can be neither domestically consumed under current U.S. mill capabilities without finding new export markets after China's new trade policy. However, we expect continued demand from China for other high-grades (and virgin fiber). The U.S. paper mills also prefer higher level grades of recovered paper. Therefore, an option to improve the current recovery system must be considered, given the current circumstances. The most relevant collection sector to improve the quality of mixed paper would be the residential sector since the bulk of waste paper recovered from the residential sector is mixed paper. Recovering additional mixed paper will not generally be cost-effective at a Materials Recovery Facility (MRF) due to the declining price of the grade. Although some mills could take advantage of the reduced price of mixed paper and partially absorb the remaining volume of mixed paper calculated above, there are structural aspects of the current recycling system that will continue to generate significant volumes of mixed paper in the long-term. Improvement in the current recovery system requires efforts at the municipal level, consumer education, and upgrading sorting capability at a MRF.

SUMMARY OF CAUSAL-LOOP EXERCISE FROM JANUARY WORKSHOP

The goal of the causal-loop exercise facilitated by Rebecca Niles, Systems Thinking Consultant, during the workshop in January 2018 was to identify relevant factors within the recovered fiber system that could be impacted by China's new trade policy regarding quality recyclable materials. This exercise also outlined potential opportunities and obstacles under the current recovered fiber context that may lead to increased availability of recovered paper in the U.S.

PAST SYSTEM DYNAMICS IN RECYCLING PAPER SYSTEM

- The continued trends around online shopping, and the use of electronic document formats, and perceived benefits of recycled materials has been increasing consumer demand for recycled products and driving up the cost of recycled fiber. Downward market pressure holds the market value of products fairly consistent.
- Increased demand has encouraged the collection of commercial sources by the industry.
- Municipalities have also joined in and set recovery targets as they see value in the recovered materials as well as the reduction of disposal and its related costs.
- In an effort to meet the growing interest in increasing recovery and perceived demand for recycled products, quality standards for recovered material were reduced. Mandatory and single stream recycling along with poor consumer education and mixed waste processing has reduced the quality

of recovered fiber, which has previously been absorbed by the international market because China would take recovered paper U.S. mills were not utilizing.

NEW PRESSURE INTRODUCED INTO THE SYSTEM

- China has raised the quality standard for imported waste paper and has taken a policy position that they will no longer purchase low-quality U.S. recovered paper. This has resulted in the excess domestic availability of low-grade recovered paper, which in turn drives down the value derived from this material.

POSSIBLE RESPONSE SCENARIOS IN CHINA UNDER NEW TRADE POLICY

Summarized from workshop notes/discussion

- China increases demand for other grades (e.g. OCC)
  ⇨ Implication for U.S.: decreases in the overall standards of recovered paper in the U.S. market.
- China will consider alternative solutions to achieving their desired standard – like increasing use of virgin pulp –
  ⇨ Implication for U.S.: providing some time for the U.S. to improve quality level.
- China will further expand their domestic collection capacity to recover waste paper
  ⇨ Implication for U.S.: creating permanent competition with U.S. supply
- China will start importing from other countries that could supply the grades they need
  ⇨ Implication for U.S.: creating permanent competition with U.S. supply.
- The manufacturers in China will find it impossible to meet their production goals with reduced amounts of imported recovered paper due to newly stated quality standards, and that Chinese government may ultimately revise their position (it is unlikely they would shut down papermaking capacity due to a lack of fiber).

The scenarios described above could lead to a decreasing value of recovered fiber (specifically low-purity grade such as mixed paper). The implication of the falling value of recovered fiber can potentially:

- Cause China to change its policy and settle for lowered standards again.
- Have negative effects on MRF profitability
- Increase domestic demand for low-quality recovered paper and attract a third-party buyer for the low-quality recycled products.

POTENTIAL SOLUTIONS TO MITIGATE THE EFFECT OF CHINA'S NEW TRADE POLICY

During the workshop, the following potential solutions were proposed. These solutions are listed in the order of receiving the most votes from the workshop participants.

1. American grade standards: Movement to single stream and China's previously reduced standards has historically incentivized a lower quality standard. Improving standards by working with municipalities to increase their standards and shift municipal targets should be considered. This would likely include consumer education and could lead to:
   - Increased quality of U.S. recovered paper
   - Increased Chinese demand for U.S. recovered paper

- Increased cost of recycled fiber
- Increased collection of waste paper
- Decreased MRF profitability
- Decreased third party supply/collection in China/ demand for virgin fiber

2. Investment in MRF technology
    - Improved standard of U.S. recovered fiber
    - Increased Chinese demand for U.S. recovered fiber
    - Increased cost of recycled fiber
    - Increased collection of waste paper
    - Increased MRF profitability
    - Decreased third party supply/collection in China/ demand for virgin fiber
3. Finding new export markets to replace volume previously exported to China.
4. Corporate education: Efforts to educate business and government stakeholders to ultimately change corporate policies to encourage reuse, recovery, and design for recyclability as well as use of recycled products.
    - Improved purity of U.S. recovered fiber
    - Increased Chinese demand for U.S. recovered fiber
    - Increased collection of waste paper
    - Decreased MRF profitability
    - Decreased third party supply/collection in China/ demand for virgin fiber

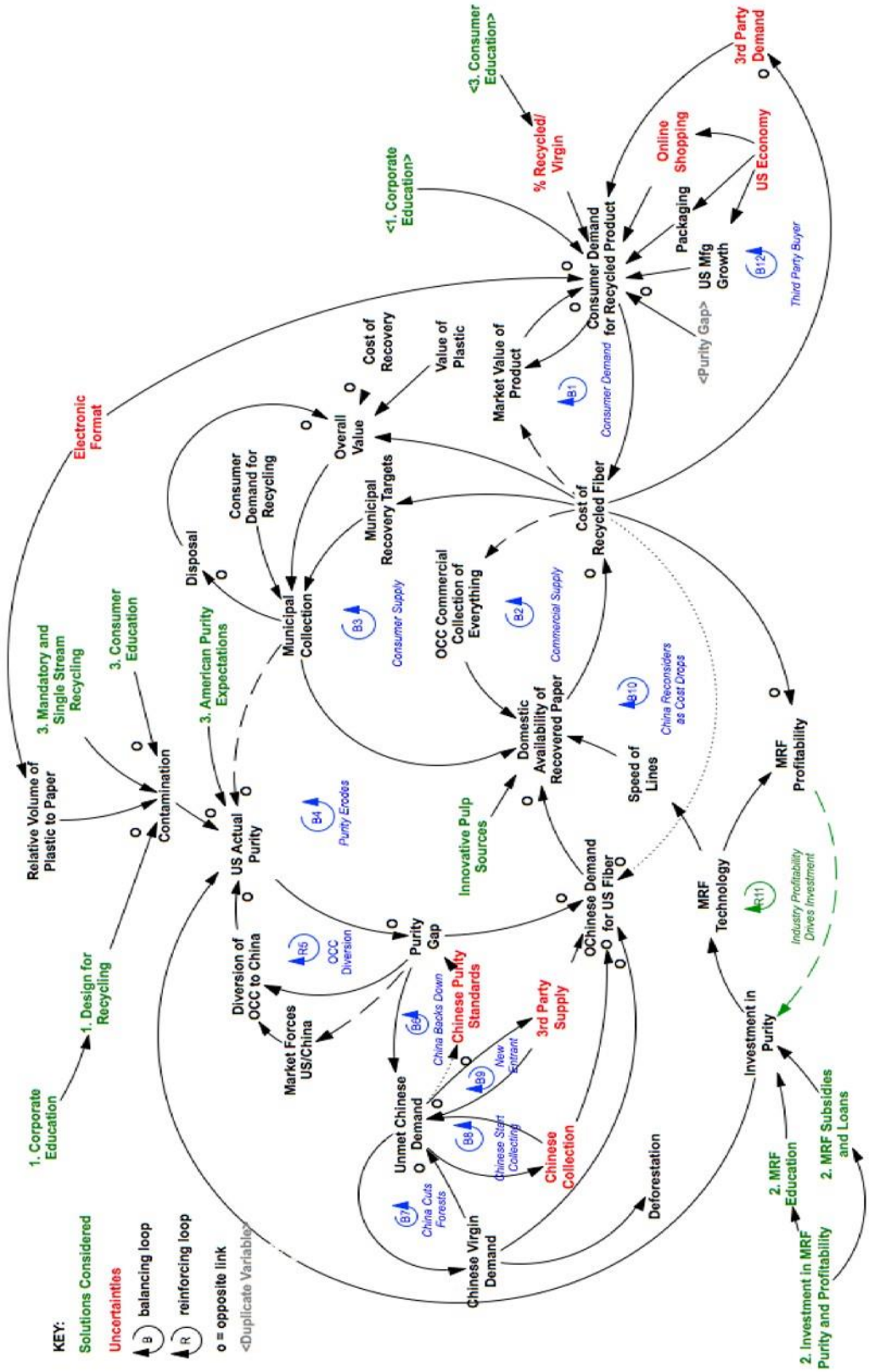

FIGURE 3 FULL CAUSAL LOOP DIAGRAM – CHINESE EFFECT BUILT DURING THE JANUARY WORKSHOP (DEVELOPED BY REBECCA D. NILES, SYSTEMS THINKING CONSULTANT)

CONCLUSION

Here we summarize the key conclusions from this analysis:

- There is finite capability in the U.S. pulp and paper industry to absorb the low-quality recovered paper (e.g. mixed paper) in the U.S. that were being exported to China.
    - Containerboard, paperboard and tissue-primarily away sectors could be potential opportunities in some regions for increased domestic availability of mixed paper, however, the current capacity of processing mixed paper is not enough to handle all the mixed paper that has become available.
- Improving the quality of mixed paper recovery and residential recovery at their source would increase the opportunities for use of this material
- Improving MRF technical capability to increase processing abilities should be considered. This improvement in the recovery system for higher-quality recovery fiber can also create additional domestic demand as well as keep strong Chinese demand for U.S. recovered fiber.