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A Report on the Status of Post Consumer Plastic Packaging Recycling in the USA and Canada

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Commissioned by the

Continuous Improvement Fund

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February 6, 2017

Disclaimer:

This Project has been delivered with the assistance of Resource Productivity & Recovery Authority's Continuous Improvement Fund, a fund financed by Ontario municipalities and stewards of blue box waste in Ontario. Notwithstanding this support, the views expressed are the views of the author(s), and Resource Productivity & Recovery Authority and Stewardship Ontario accept no responsibility for these views.

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I) Preface

No packaging material currently found in the Blue Box collection system is more complex to recycle than plastic. The use of different polymers, alone or in layers combined with different conversion techniques, labeling platforms, closures safety seals etc, result in an almost unlimited amount of package variations. Continuous advancement in plastic technology has produced better performing, cheaper, lighter and more attractive packages often resulting in growth in market share at the expense of the more traditional materials, metals, paper and glass. As the amount of plastic packaging has increased, so has the difficulty in recycling it. These difficulties include:

- The crafting of effective consumer education with respect to what should or shouldn't go in the blue box
- Additional sorts and quality control necessary at the MRF
- Additional technologies to remove or mask a moving target of contaminants at Plastic Reclamation Plants

The difficulties being encountered at the reclamation level are arguably the most important to the overall health of the system. Without it the collected material goes nowhere except, perhaps, to other countries.

2016 witnessed the largest amount of post consumer plastic packaging reclamation plant failures in the US and Canada since the formative days of the industry in the early 1990's. In the USA alone, 8 PET Reclamation plants were either shuttered or went bankrupt. Three others have been operating intermittently. This report has been commissioned by CIF to provide Ontario's recycling program operators with timely information about the state of the post consumer plastic packaging industry as well as to identify future issues that may impact its viability, particularly at the reclamation level. It addresses both Canadian and US markets as there is considerable interaction between the two.

Examination of Far Eastern Export markets (mainly China) was not included in the scope of the main body of this report due to their long term inconsistencies. A

general discussion of the impact of imports and exports on the recycling of the designated materials is contained in the addendum .

What follows is a short overview of the post consumer plastic reclamation industry in the US and Canada, and then a recycling profile of the four major commodity plastics, PET, HDPE, PP and film. The data in this report is a distillation, except where direct attribution is given, from a number of sources including resin and package manufacturers, Plastic Recovery Facilities (PRFs) and Reclaimers, and lastly relevant US and Canadian Trade and Stewardship associations. In some cases information was not available and was noted accordingly.

The profiles will be followed by a discussion of potential impacts and implications of future market forces on the system.

Finally this report, like many, provides more question than answers.

II) The Post Consumer Plastic Packaging Reclamation Industry - Overview

Post Consumer Plastic Reclamation plants purchase dirty plastic, usually plastic packaging from MRFs in bales; sort, uniformly size reduce , mechanically wash and remove contaminants necessary to allow the material to be reused in a manufacturing process. Without these plants there would be no post consumer plastic recycling and the business model is not for the timid. Historically, the industry was created by small private entrepreneurs in the early 1980s that recognized an opportunity and built plants using off the shelf components and homegrown technologies. In the early 1990s many of the virgin resin companies got into the business, including DuPont, Union Carbide and Dow to name just a few. While these large companies had capital that the smaller entrepreneurs didn't, they found out relatively quickly that it was not a business they could successfully operate and all closed down within a few years. The business was simply too entrepreneurial to easily fit within the culture of most large corporations.

While more recently we have witnessed the development of sophisticated optical sorting technologies and new investment by major companies that feel they

“need” to be in the recycling business, the business model remains the same, which is:

- Reclaimers buy almost all material on a spot price basis usually determined at time of purchase. Since there is no price elasticity for this material, (When prices go down no less material gets collected, when prices go up no more gets collected), price mostly gets determined by who will pay the most.
- The quality of the material purchased can vary widely based on how the material is collected, the MRF technologies sorting and densifying the material and the entity operating the MRF.
- Packages that could be recycled easily one day can become a major contaminant the next, the result of a new label change or other package appointment. Often the reclaimer does not know these changes have been made and what is causing them until their customers report a problem. To remedy these issues, continual added investments in additional equipment and technologies are needed to maintain quality and result in both higher capital and operating costs.
- The clean flake and pellet produced are, for the most part, sold on a Purchase Order by Purchase Order basis and need to be priced below the alternative material the customer is using, be it Virgin Prime, Off-spec Virgin or Virgin Imports. Of course they also must compete with other reclaimers. When the price for virgin alternatives slip below what it costs to produce PCR flake and pellet, reclaimers are at a severe competitive disadvantage. These were the market conditions seen through a good deal of 2016 for PET.

To put it more succinctly, Reclaimers compete over a set amount of material, quality unknown, produce a recycled resin that is expected by end users to perform like its virgin alternative and sell into markets based almost exclusively on being lower than the price of virgin alternatives. In order to obtain “Virgin like” quality, additional investments continue to be necessary to remove new contaminants as they are introduced. This, of course, adds more capital and operating cost to the system.

Finally, the consumer product companies that make the packaging decisions that directly affect this model are often companies that control a supply of raw material or are, or can be, substantial markets for Post Consumer Resin (PCR) flake or pellet. Reclaimers are hesitant to jeopardize these current or future relationships by making public the companies' use of non-recycling friendly packaging which often scuttles "Design for Recycling" initiatives.

This is a model that requires a huge leap of faith.

III) Polyethylene Terephthalate (PET)

Critical Data: PET, the world's most recycled plastic, is commonly used to manufacture beverage bottles of all kinds, but also wide mouth food containers and increasingly thermoformed packaging. While growth in the traditional applications, in particular carbonated soft drinks, has stagnated or worse, food containers and thermoforms are growing at around a 5% per year, for an overall growth rate close to 3%. In 2015 about 146.7 thousand tonnes (kt) of PET was used nationwide in Canada in the manufacture of bottles of which about 28.2 kt was Recycled PET (RPET). Of the 28.9 kt used to make PET thermoforms, about 11.1 kt was RPET.

In 2015 a total of 115.3 kt of PET bottles and jars were sold to either Canadian, US or Chinese reclaimers by Canadian MRFs, plus an additional 3.2 kt post consumer thermoforms. In all, Canadian Reclaimers purchased 132.6 kt of post consumer feedstock that included 36.9 kt from the USA.

It should be noted that while the tonnes available for recycling reflect the actual weight used to make the packaging, the tonnes collected for recycling are the gross weight of the bales that includes the caps, labels, product residue, as well as any plastic or non-plastic contaminants that may be present. This is true for all plastic packaging and often skews attempts of doing a mass balance for a particular plastic resin. Currently there are 5 PET reclamation plants operating in Canada although one may be still trying to debug their technology. Two are

located in Quebec, Plastrec and Klockner; two in Ontario, Urban Polymers and Blue Mountain; and one in Alberta, Merlin Plastics. The total nameplate capacity for the five plants is around 150 kt, so that even if Canadian reclaimers were able to purchase all of the post consumer PET packaging collected in Canada they would still have to import extra to achieve full production capacity. To that end Canadian PET reclaimers bought 37.4 kt from US sources in 2015.

In the United States the picture is much the same, where many of the 10 most active reclaimers, most of which make active attempts to buy Canadian bales, are chronically short of supply. This results in higher bale prices than would otherwise be seen, especially with the current market conditions for RPET flake and pellet being what they are.

Eastern US Curbside Bale Demand (kt)

	Nameplate Capacity	Current Operating Rate
US Reclaimers (10)	480	420
Canada Reclaimers	45	34
Other Exports	275	31
Totals	800	485

US PET Reclaimer Feedstock Supply (kt)

Accessible US bales and DF	410
Canadian Bales and DF	18
Other Imported Bales and DF	32
Other Feedstock	15
Totals	475

Aside from the RPET used in bottles and thermoforms mentioned above, Canadian reclaimers sold 42.6 kt into various fiber applications all of which are located in the USA. At 45.4% this makes fiber the largest market segment of the 93.8 kt of RPET sold by Canadian reclaimers in 2015.

Current Market Conditions:

A glut of virgin resin of all grades from both NAFTA countries and imports, combined with very low energy/raw material cost, has resulted in price levels in real dollars lower than anything the PET packaging industry has experienced since its inception. Since the price of virgin alternatives generally sets the ceiling in pricing RPET flake and pellet, this has resulted in many reclaimers running just to cover costs. In fact some vertically integrated reclaimers are using significant amounts of virgin since they can buy it cheaper than they can make recycled alternatives. This has resulted in a significant rationalization of reclaimer assets in 2016, which started the year with a total of 34 plants operating in the US and Canada. Currently, 23 (including California) are operating at least one full shift, 3 are operating intermittently, ten were shuttered or liquidated and one new plant started up. Despite this rationalization, bale supplies continue to be tight and priced at unsustainably high levels mostly around \$.10 USD picked up sellers dock.

Demand for RPET flake and pellet was weak in 2016, particularly during the 4th quarter, as end use buyers continued to push for price reductions in all applications. There appears to be renewed interest in 2017, particularly from the thermoform segment, but pricing is still being negotiated.

Concerns moving forward: There are two major concerns for the PET recycling industry going forward, and both impact the margins within the industry. The first is bale quality which is impacted by both the operations that make the bales and the companies that make the bottles. A bale priced at \$.10 /lb picked up really costs well over \$.20 / lb when yield loss and transportation are figured in. Also, this price does not factor in extra capital and operating costs for technologies to address packaging that does not adhere to “Design for Recycling Guidelines” as

set forth by the Association of Plastic Recyclers (APR). This lack of adherence results in a continuous opening of Pandora's Box for reclaimers and renders the business model unworkable.

Intertwined in the issue of bale quality is how to handle PET thermoformed packaging. Most PET reclaimers report being able to process thermoforms along with bottles with minor impacts on quality. Most of the initial mechanical engineering issues have been dealt with, but thermoforms have a lower bulk density and tend to produce more fines during the reclamation process. Some reclaimers, notably those producing recyclate for fiber applications, are not impacted as much as those recycling into packaging applications. The latter screen off the fines and sell them as a byproduct, but at a much lower price. So while MRF costs have been contained by expanding the PET bottle category, the net result has been additional cost to the Reclaimer segment, but with more material available.

Similar to the thermoform issue is that of colored PET bottles, jars and thermoforms. Currently this material constitutes around 10% of the bale with light blue and green being about 7% and the other, "non-traditional" colors around 3% and growing. While green and blue recyclate can find value added end markets, (For example green Ice River water bottles) and therefore has a chance of recovering cost, the mixed color fraction does not have that value. Currently clean mixed color flake pricing for end use applications, such as automotive carpet and black thermoformed trays, is far below what it cost to process. As a result, there is no market for bales, and that adversely impacts PRF economics as well as that of PET reclaimers that for the most part sell it off as a byproduct, mostly to Chinese markets.

The second concern is how long the depressed pricing of Virgin resins will last. Despite its recent labor problems, the 900 kt PET resin plant being built in Corpus Christi, TX by M&G and DAK Americas is expected to come on line during the second quarter this year although recent labor issues may delay start-up. This plant will employ the most efficient conversion technology, as well as "On-site" supply of raw materials, allowing them to lower prices in an already glutted

market in order to secure market share. In addition, Mobil Exxon has announced that they have developed, and are moving forward with, a technology that significantly lowers the cost of producing Paraxylene, a key component in the manufacture of PET. When both of these technologies are employed, and if they achieve the efficiencies claimed, they will contribute to continued lower price pressure and potentially renew the debate of whether it makes sense to recycle at all.

IV) High Density Polyethylene (HDPE)

Critical Data: HDPE is the second most commonly used resin for packaging applications. While HDPE blow molded bottles are what is mostly found in the residential waste stream, there is also a significant amount of injection molded HDPE used in bulk packaging, such as pails, racks, trays and tubs. They are distinguished by different melt points, and blending the two categories can be problematic. During the past eight years blow molded HDPE bottles containing household products have experienced negative growth of about 10% in the US, the result of dairy products, motor oil and antifreeze losing market share, and laundry and cleaning products going to concentrates and smaller bottles. There has also been some significant switching to PET by refrigerated juices and in the health and beauty aid segment.

In 2015 there was about 82.2 kt available for recycling in Canada's residential waste stream. Of this, about 41 kt were collected for recycling. This material was purchased by three Canadian reclaimers as well as some US reclaimers. With the closing of Entropex the remaining two reclaimers, Merlin in BC and Energiplast in Quebec has an estimated 30 kt of bale processing capacity. Recently EFS Plastics in Ontario has also been buying some truckloads. MRFs located in the eastern part of the country will have to depend heavily on US reclaimers for their HDPE markets until such time as the former Entropex assets are resuscitated.

US HDPE reclaimers do have excess processing capacity that they often use to clean olefin material other than HDPE bottles (such as HDPE crates, buckets and barrels and PP), otherwise it is simply underutilized. The 2015 Recycling Report

published by APR indicates that there are at least 28 HDPE bottle reclaimers with a wash capacity of more than 666 kt per year gross weight in. Of that total 200 kt was reported as excess capacity which was more than enough to absorb all of the HDPE bottles collected in Canada.

Canadian end markets for the processed Recycled High Density Polyethylene (RHDPE) are not robust. The Canadian bottles bought by US reclaimers are sold to or used by US markets after processing, so very little if any RHDPE finds its way back to Canada. I could not determine whether there would be adequate end markets if all of the HDPE collected in Canada was reclaimed in Canada. The amount of bankruptcies in this industry segment in Canada over time would lead one to doubt it.

Current Market Conditions: Bale prices for both natural and pigmented have for the most part been sliding gradually throughout 2016 before stabilizing near the end of the year at \$.25 and \$.12 /lb USD respectively. This downward drift is a result of the first of a new wave of ethylene /polyethylene capacity coming on line. The premium paid for natural bales (such as milk containers and one gallon water bottles) reflects not only the greater utility over mixed color but also the demand for this material by bottle manufactures to comply with the California content law.

Critical Issues: Shale energy availability is driving unprecedented investment throughout the ethylene chain in the US. The projected volume increase of ethylene production and its derivatives through 2019 is truly staggering, with industry estimates ranging up to and exceeding 4,000 kt. These investments will be using the latest, most efficient technologies, as well as some being located in the shale fields further reducing overall costs. The question on HDPE reclaimers' minds is not will virgin prices continue to slide, but how far down will they go.

V) Polypropylene (PP)

As opposed to the new investment seen in PET and PE plants, the 227 kt of new polypropylene capacity expected to come on line in 2017 will be from debottlenecking projects. This, despite as much as 2,200 kt of new propylene

capacity being added by 2019. This does not include a polypropylene plant proposed by the Canadian gas company Pembina in Alberta of 800 KT. Despite the new capacity, most analysts do not see prices destabilizing like PE and PET. However, it must be noted that the PP market in general is known for wild price fluctuations, where movement of \$.10 / lb in either direction is not unheard of over the course of a month.

There is very little hard data on the use and recycling of PP packaging in Canada. PP is used primarily in applications that require good thermal properties such as bottles that are hot filled, dual ovenable trays and tubs used for take-out food such as soup. For the most part, it does not have enough volume to warrant a dedicated sort at the MRF, rather most PP packaging is incorporated in either “mixed rigid” or a “Tubs and lids” bale. These bales can contain anywhere from 20% - 65% PP. The latest report on post consumer plastic recycling published by CPIA indicates that 7.2 kt of PP and “Other” bottles were recovered for recycling in Canada during 2014 as well as 66.7 kt of non-bottle mixed rigid material.

During 2016 there were 5 Canadian reclaimers in Ontario and Quebec that processed mixed rigid bales at one time or another for an estimated “soft” capacity of 46 kt gross weight in.

Exporters to the USA and China were also active, often outbidding Canadian reclaimers for the material.

Current Market Conditions: PET and Mixed Rigid Reclaimers report much lower market demand for RPP flake and pellets, with buyers either using virgin alternatives or enforcing tighter specs. This reflects a steady downward drift in virgin pricing since September.

With the closure of Entropex, the only Canadian mixed rigids reclaimer of any magnitude is EFS Plastics, and yet EFS is currently sourcing material from the USA to fill their plant. This is the result of aggressive pricing being offered to Canadian suppliers by exporters, particularly for poor quality bales. The strength of the US dollar is also a major factor. The price of mixed rigid bales, from which the bulk of the PP collected for recycling is derived, ranges from \$30 CD/ tonne - \$80 CD /

tonne picked up. Most buyers require at least a 50% PP content in the bale and can/will assess deductions. Recently there has been some backing away from the market by long term buyers of clean PP flake and pellet mostly due to price. This is particularly true of the PP byproduct generated by PET reclaimers.

Issues: The few reclaimers of mixed rigids that exist in the US and Canada claim that the financial underpinning of their operations is the value of the PP. That may be so, but the other components of the bale need to cover at least their respective handling, sorting and processing costs to allow the PP a chance to make the operation profitable. The most problematic issue for this industry segment is the lack of adherence to any recognized specification. Reclaimers often find themselves buying what is being offered, not necessarily what they can profitably handle. What is being offered is frequently the plastic that is left after the PET and HDPE bottles, and in many cases, the tubs and lids are removed. As long as there are willing export buyers for this material this situation is unlikely to change. With the bale quality for this material as erratic as it is, this business model is again, questionable.

VI) Plastic Film

Critical Data: Plastic film, defined as plastic sheet with a wall thickness less than 12 mils, is the fastest growing packaging platform, with total use in 2016 in the USA approaching 6,800 kt or around 21 kg /person/year. In the Stewardship programs in Ontario and Quebec it is the largest plastic packaging category. While the overall growth rate in the USA is around 2%, categories such as shopping and dry cleaning bags, video and audio tape, xray and photographic film, are experiencing zero or negative growth, they are more than compensated by the rapid growth of stand up pouches for food. A wide array of resins is used in these applications. Linear Low Density Polyethylene (LLDPE) is the dominant resin with almost 50% of the market, followed by HDPE, LDPE and PP. PET is a small but significant part of the market, with growth coming from high performance stand up pouches for food that Brand Owners will, irrespective of the resin, want to

include in the Blue Box program. There is also some speculation that there will be significant growth in degradable film as prices come down, a result of lower virgin resin cost discussed in the HDPE section. Other specialty resins and exotic constructions are also being marketed to applications not previously thought to be appropriate for flexible packaging. All of this will be problematic for the fledgling Film Reclaimer industry to keep up with.

In its 2014 [Post Consumer Plastic Bag and Film Recycling Report](#), which includes Canada, the American Chemistry Council cites that around 528 kt of film was collected for recycling. Of that only 4.4 kt film came from MRFs and curbside programs, the overwhelming majority of the remainder being coming from commercial sources, shrink wrap etc. This is more a reflection of a lack of interested buyers and/or reclamation capacity rather than material availability.

Currently there appears to be only three plants in the US and Canada with reclamation capacity for dirty film and one is in California. The EFS plant in Ontario has about the capacity to handle the 6.775 tonnes reported as recovered in Ontario in 2015, assuming the material can meet EFS' specifications. Chinese export buyers have become much less aggressive since the "Green Fence" regulations have been enacted and enforced, with many no longer buying at all. Some segments of the plastic lumber industry have the ability to use dirty film if not overly contaminated but choose not to. They can purchase alternative feedstock cost effectively that doesn't carry with it the unknowns and inconsistencies of curbside film.

Concerns and Issues: Since most of the resins used in plastic film are olefins the impact of much cheaper resin will be felt in this packaging segment as well. Against this backdrop, any new investments at MRFs in post consumer film recovery face not only the mechanical engineering issues of handling and extracting the material without it impacting MRF efficiency but must also anticipate having to deal with an array of incompatible resins and package constructions that will increasingly be seen in the residential stream. This is in addition to the standard contaminants seen in MRF material.

VII) Summary

Spurred on by cheap prices for natural gas and crude oil, there will be a dramatic increase in the production of virgin resins during the next three years, leading to lower, and maybe much lower prices. PE (HDPE, LDPE and LLDPE) will be the most impacted followed by PET and PP. As a result, the post consumer plastics recycling industry will continue to undergo a rationalization that began in 2016 for all of the four resins discussed.

When most of the key reclaimers were asked the question as to whether the business model for post consumer plastic recycling is sustainable, only one reclaimer said yes. Two answered yes but qualified their answer by saying only for those operations that are vertically integrated. Four said their greatest concern was the low price of virgin resin, while 11 stated that it was bale quality and one said utility cost. All of the merchant reclaimers expressed concern over end market demand and all expressed frustration at not being able to get adherence to Design for Recycling guidelines.

Once the Entropex plant comes back on line it appears that there will be enough reclamation capacity in Ontario to process the volume of PET, HDPE, Mixed Rigids (PP) and Film, collected in Ontario for recycling. It also appears that there are adequate end markets in Ontario once the material is cleaned by a reclaimer. This of course assumes that sellers of bales, flake and pellet can meet buyers' specifications and pricing. Export buyers, particularly from the US, will continue to play a major role in the plastic recycling market dynamics. Buyers from the Far East, including China, will be more buyers of opportunity for particular plastic materials when the margins and conditions allow, rather than as permanent markets. Currently, extremely low shipping cost has prompted some renewed export interest, particularly out of Pacific ports.

Finally, "Eco-friendly" Virgin Resins will continue to be developed and promoted by both resin companies and brand owners that are not necessarily engaged on the recycling issue. These fall into two categories, plant based and degradable. Plant based, renewable resins will have a hard time competing as prices come

down on fossil fuel based commodity resins. Consumer product companies will support the concept as long as the price is competitive. This category also tends not to have much impact on recycling as usually the plant based resin is molecularly identical to its fossil fuel derived alternative.

Degradable/compostable resins, however, are an entirely different matter and pose two issues; those that do not perform as advertized and those that do. Claims of compostability and recyclability have been made by various stakeholders with little hard data to substantiate them. Many items that end up in the compost stream do not degrade as advertized and end up needing to be screened out by commercial composters.

The far more worrisome technologies are the ones that claim degradability under landfill conditions and actually work. Reclaimers that sell/use recycle in applications such as strapping, pipe or plastic lumber want nothing to do with additives that may jeopardize the integrity (and safety) of their products. All of this warrants a broader policy discussion as to whether there is any place in the solid waste hierarchy for these technologies.

VIII) Conclusions

The business model for the reclaimers of post consumer plastics is broken, and has been for some time. With long term virgin price forecast being lower, the multiple frailties of the industry are exposed, namely:

- Feedstock (bales) sourcing is conducted on a spot basis, with price determined almost by auction and not by some meaningful index, resulting in bales being overvalued most of the time due in no small part to lack of availability
- Bale quality has been getting steadily worse, a result of poor quality control at the MRF and packages not adhering to Design for Recycling guidelines. This has produced lower yields and higher processing costs.
- The value of the cleaned material is determined by the lowest price of virgin alternatives available to a particular application.

Simply put, as virgin prices drop, there is not enough value in the material to cover the cost of bales (MRF cost) as well as the transportation, processing and packaging costs. So as lower energy costs and new efficient technologies allow for cheaper virgin, the capital and operating costs to recycle post consumer continue to spiral upward. Arguably this is where PET, mixed rigid and film reclaimers find themselves currently. How long crude oil prices stay depressed is a matter of great conjecture, as industry analysts' debate supply and demand as well as geopolitical implications. Most involved in post consumer plastic recycling industry feel that crude oil prices need to exceed \$60 USD per barrel for the industry to be economically viable. Most energy forecasters are not bullish on that happening in 2017.

Is there a fix? From a supply standpoint either more needs to be collected for recycling or demand needs to be reduced through plant closings. As more than a few reclaimers have said, "The strong will survive". That may be valid for PET and HDPE bottle reclaimers that have long standing infrastructure, but for film and mixed rigids, any plant closures would have far reaching impacts, as witnessed by the Entropex closing.

Better bale quality sounds easier than it is. As long as there are more buyers chasing too little volume, enforcing bale specifications is problematic. So, too, with Design for Recycling guidelines, where the lack of any ramifications for offenders and worse, false recyclability claims, renders the exercise frustrating at best. Still, these are areas that could be addressed, particularly through a stewardship program.

Lastly, the issue of virgin pricing is what it is. Irrespective of whether the forecasts are correct, there will be times when post consumer recyclate cannot compete with Virgin resin and those periods could be catastrophic for an industry as fragile as post consumer plastic recycling. A content program, either mandatory or incentivized, would go a long way toward imparting / creating some additional value in the recycled material that is not currently recognized. This goes to the heart of the matter; if public policy is going to create a supply of material it should also address the issue of markets to consume it.

