NC State University

Global Dynamics of the Pulp and Paper Industry 2017

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Four Main Points

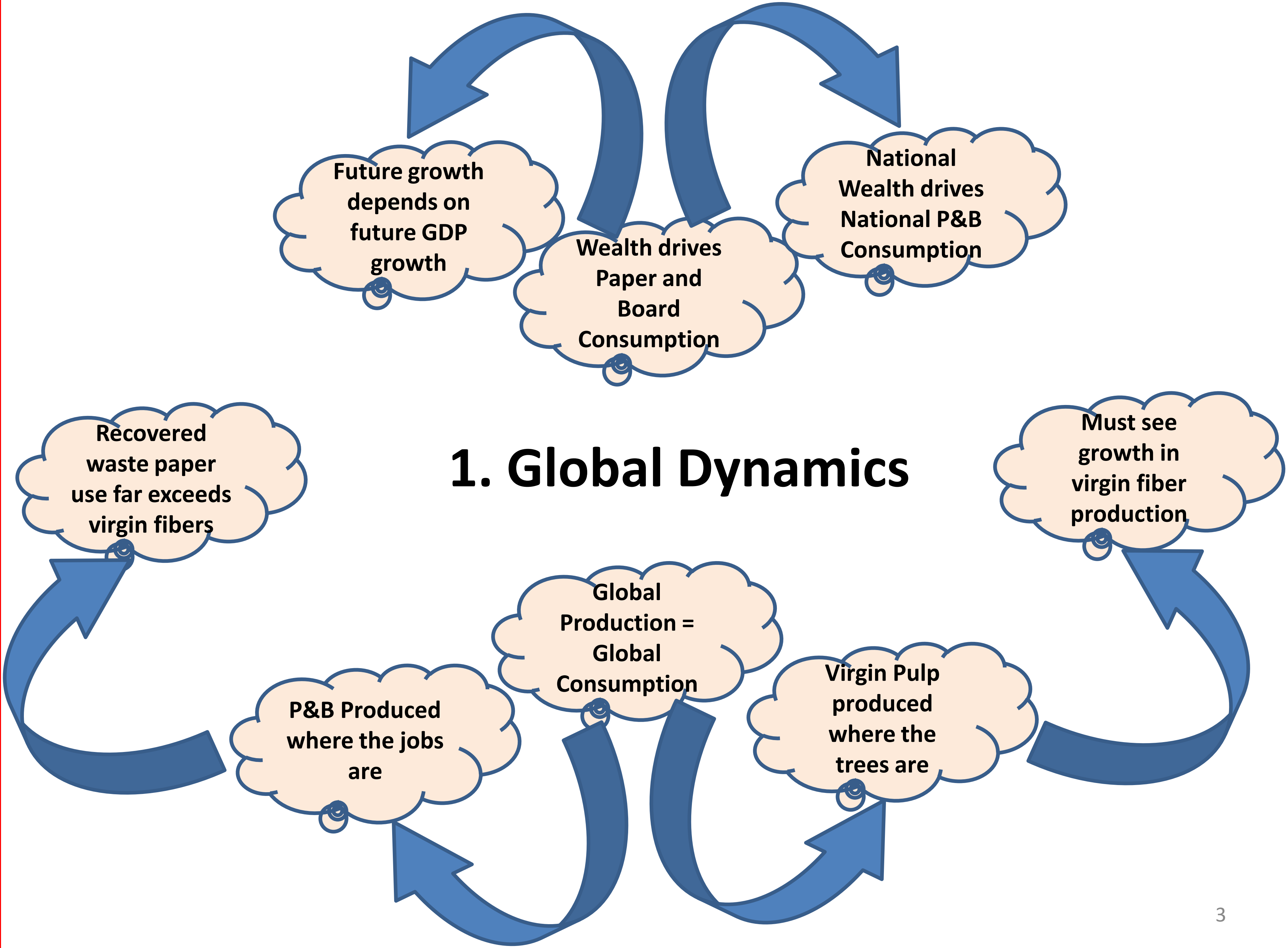
1. **Global Dynamics drive local decisions**
    - *Decisions made by P&B companies in one part of the world impact decisions in all other parts of the world*

2. **Global paper and board consumption increasing …1% per Year**
    - *Continues to grow globally, but declining in most of the Western World*
    - *Tissue and containerboard relatively strong, printing papers very weak*

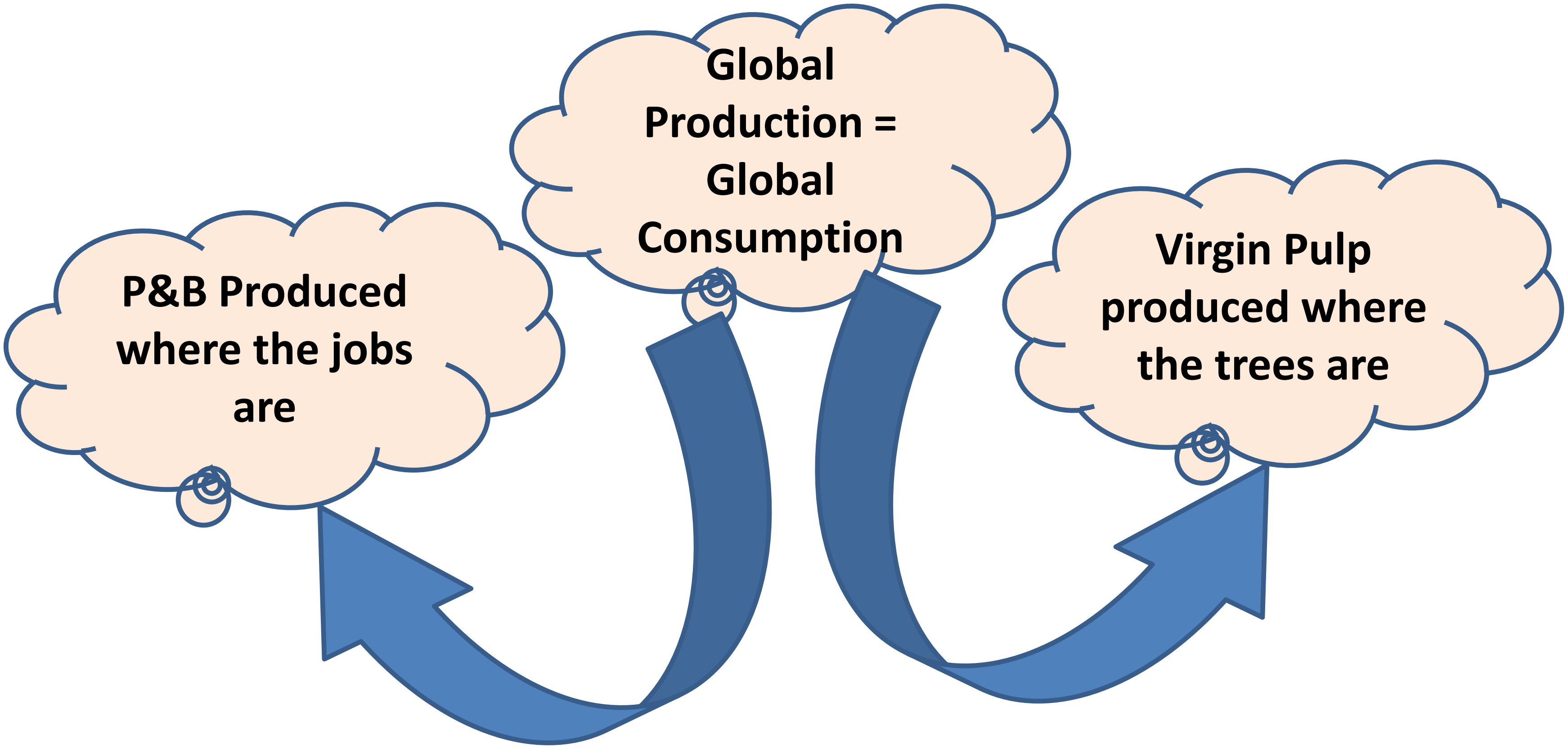
3. **Recycled Fiber availability will become more critical and costly**
    - *Abundant wood – not an issue, but …*
    - *… Long fiber products from virgin fiber not increasing*
    - *Recovered paper supply and quality will be under significant stress*

4. **The "Bioeconomy" will make little impact on Pulp and Paper Industry**
    - *The "Nano" developments that are promising represent high price but …*
    - *Low volume products*

1. Global Dynamics

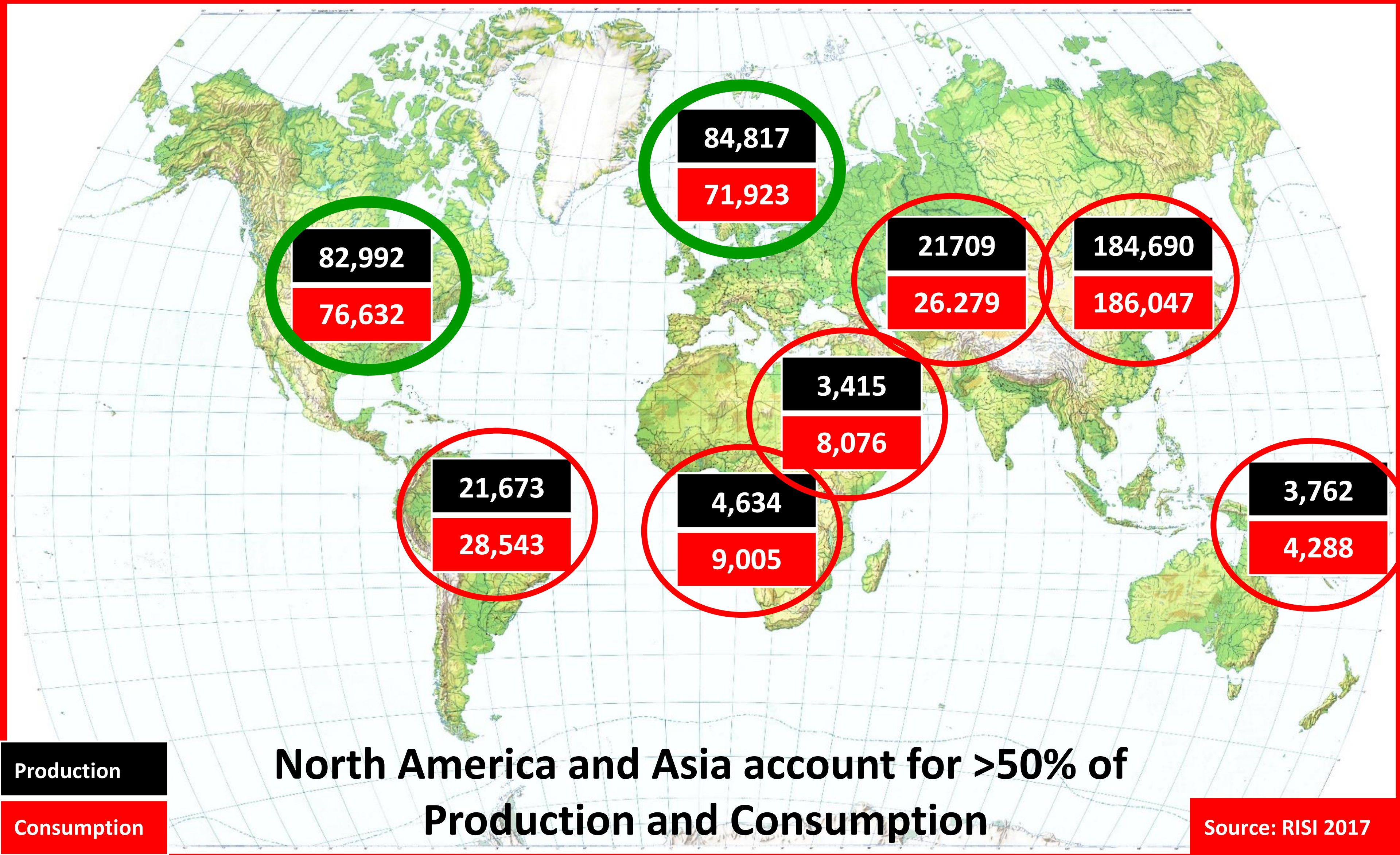


Global Dynamics drive Local Decisions



2015 Global Production / Consumption

27% of Production is Exported



North America and Asia account for >50% of Production and Consumption

Source: RISI 2017

Wood Pulp Balance

	Exports minus Imports				
	P&B	Wood Pulp	Bleached Softwood	Bleached Hardwood	Recovered Paper
World	-1,033	-1,216	-491	-145	-771
North America	5,856	8,633	8,066	-1,199	19,775
Western Europe	13,978	-4,132	701	-4,764	7,508
Eastern Europe	-4,879	-446	-131	-762	806
Africa	-5,088	-424	-449	77	164
Asia	-80	-19,681	-9,747	-6,414	-30,053
Oceania	-566	581	232	-176	1,698
Latin America	-7,303	14,900	1,203	13,354	-1,044
Middle East	-4,647	-648	-367	-260	375

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Latin America	-7,303	14,900	1,203	13,354	-1,044
Middle East	-4,647	-648	-367	-260	375

Wood pulp is manufactured where the trees are

Softwood Pulp Balance

	Exports minus Imports				
	P&B	Wood Pulp	Bleached Softwood	Bleached Hardwood	Recovered Paper
World	-1,033	-1,216	-491	-145	-771
North America	5,856	8,633	8,066	-1,199	19,775
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Latin America	-7,303	14,900	1,203	13,354	-1,044
Middle East	-4,647	-648	-367	-260	375

Canada (NBSK) and USA (SBSK) account for long fiber production

Hardwood Pulp Balance

	Exports minus Imports				
	P&B	Wood Pulp	Bleached Softwood	Bleached Hardwood	Recovered Paper
World	-1,033	-1,216	-491	-145	-771
North America	5,856	8,633	8,066	-1,199	19,775
Western Europe	13,978	-4,132	701	-4,764	7,508
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Oceania	-566	581	232	-176	1,698
Latin America	-7,303	14,900	1,203	13,354	-1,044
Middle East	-4,647	-648	-367	-260	375

Brazil, Chile, Argentina and Uruguay (BEK) account for most of world short fiber. Brazil has abundant land for 25 more mills.

Recovered Paper Balance

	Exports minus Imports				
	P&B	Wood Pulp	Bleached Softwood	Bleached Hardwood	Recovered Paper
World	-1,033	-1,216	-491	-145	-771
North America	5,856	8,633	8,066	-1,199	19,775
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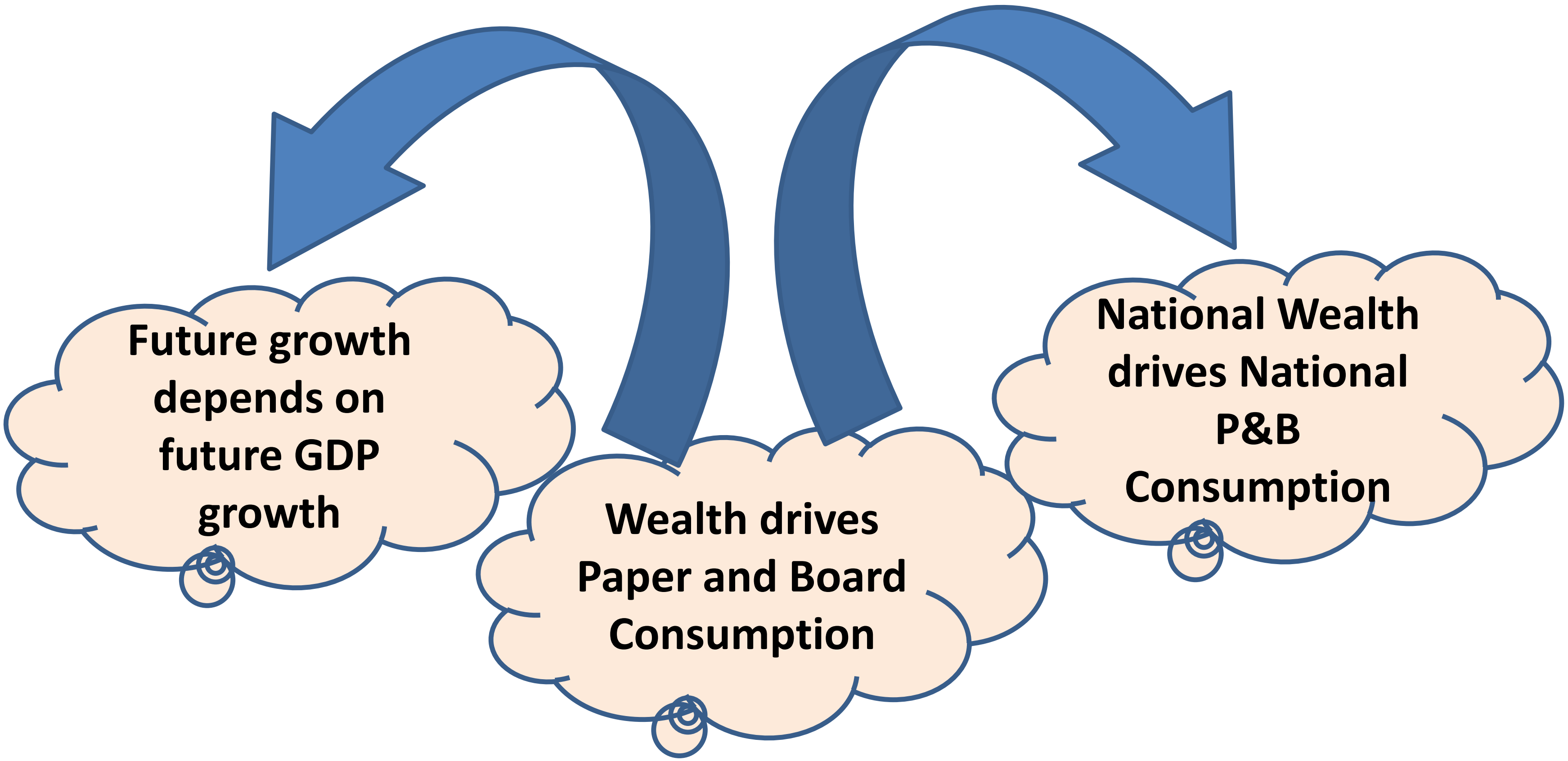
The imbalance in Recovered Paper will cause major problems to be discussed later.

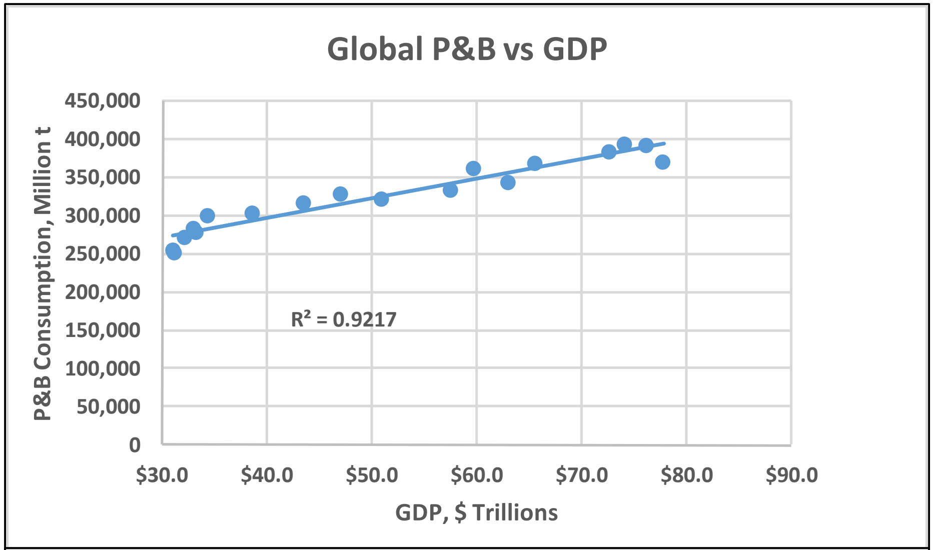
Wealth drives consumption



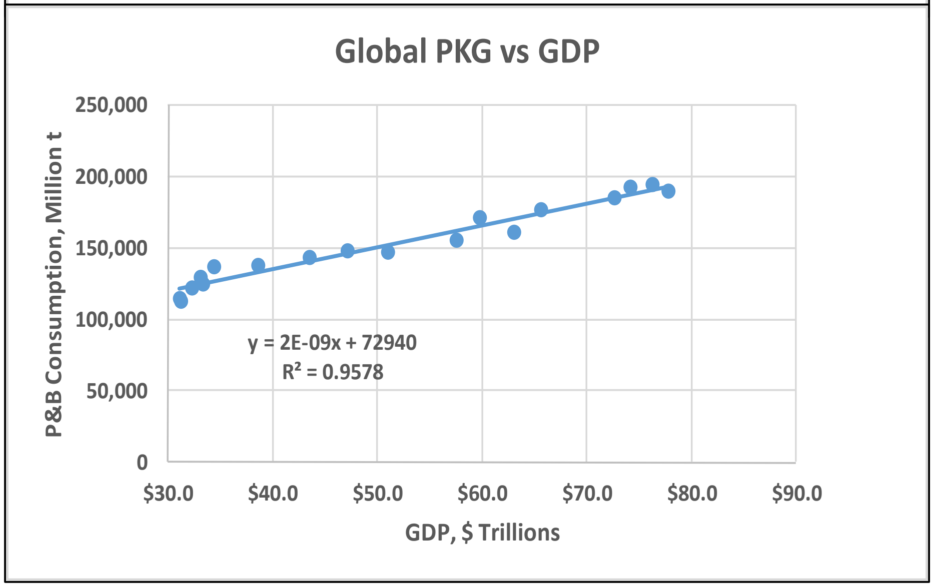
Consumption

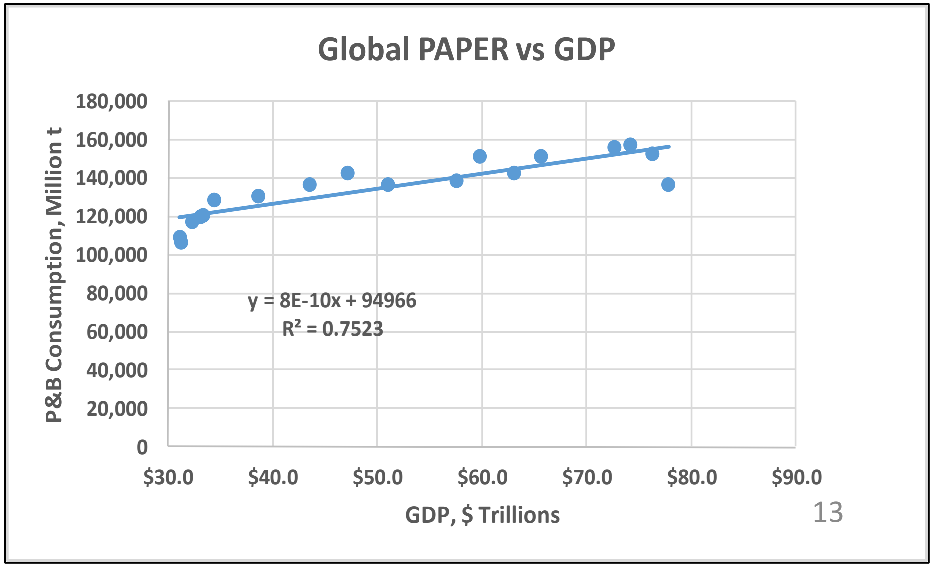
- **Paper and Board Consumption are driven by wealth**
  - ***Manufacturing activity drives containerboard***
  - ***Business activity drives printing papers***
  - ***Consumer activity drives containerboard and others other***
- **Local consumption is driven by local wealth**
  - ***Global consumption can be predicted by Global GDP growth***
  - ***National consumption is not so predictable***
- **Paper and Board are recovered at increasing rates**
  - ***Paper is recovered locally and shipped globally***

Global P&B Consumption related to Wealth

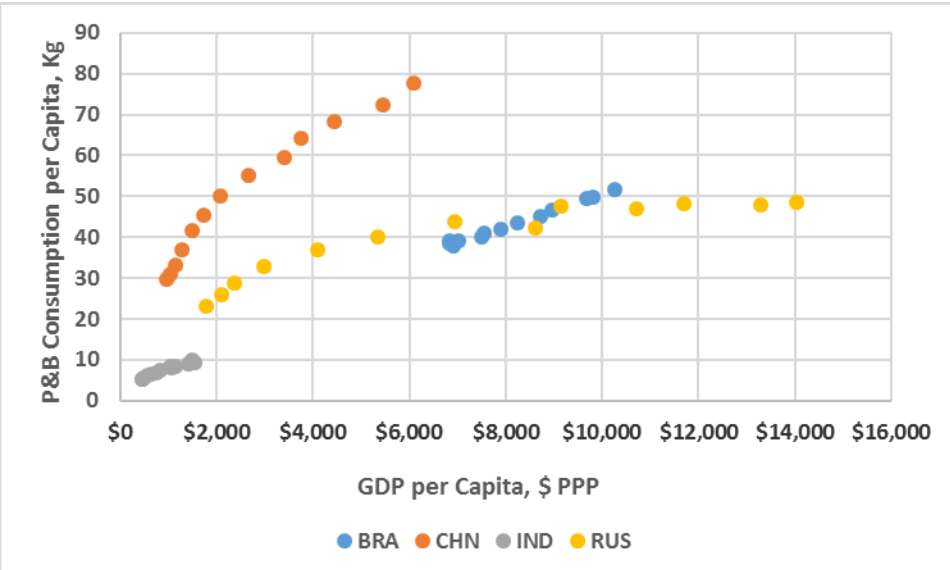


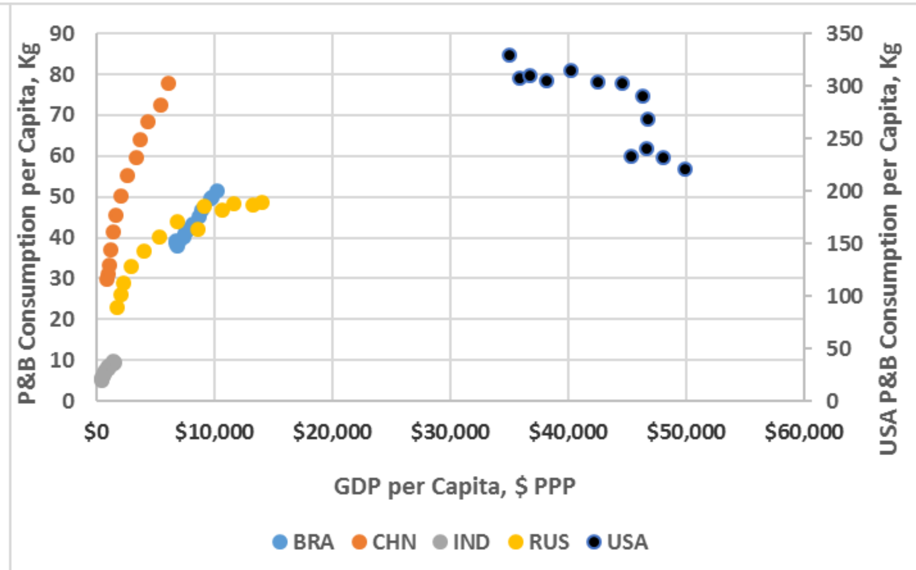
- **Gross Domestic Product the best indicator**
- **Better correlation with packaging than paper**





P&B Consumption v GDP per Capita

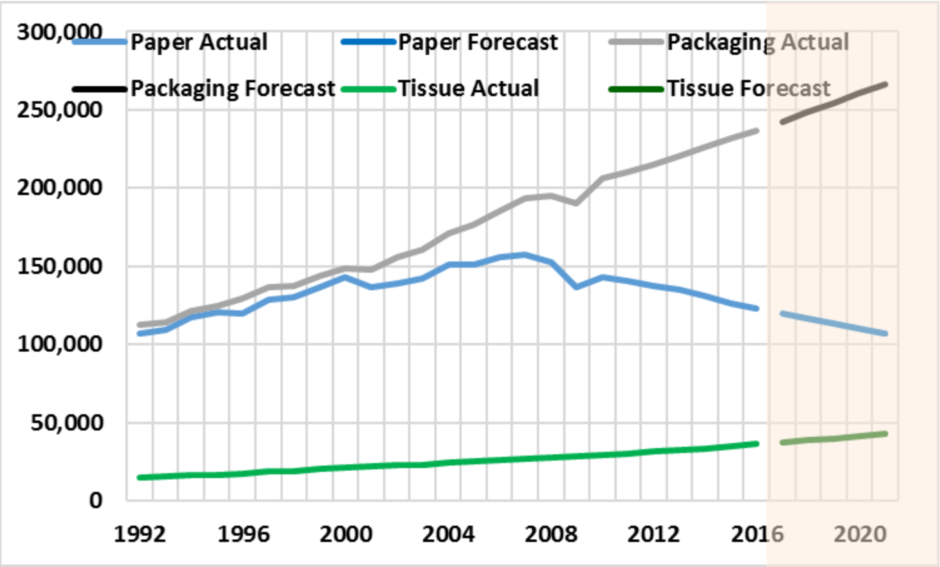


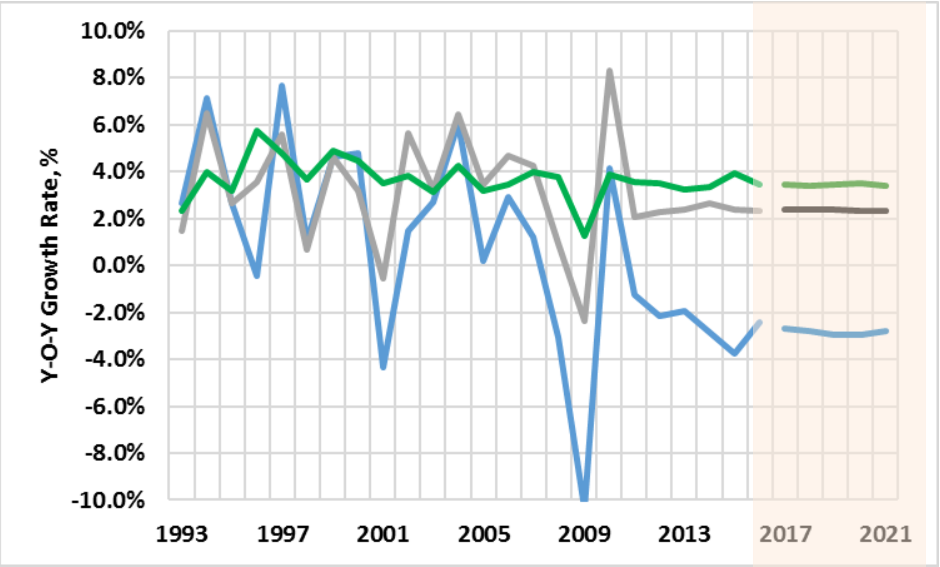


P&B consumption predictable for Developing nations

Not so much for Developed: Decline related to Printing Papers and Newsprint

Extremes in Global Product Demand Forecast

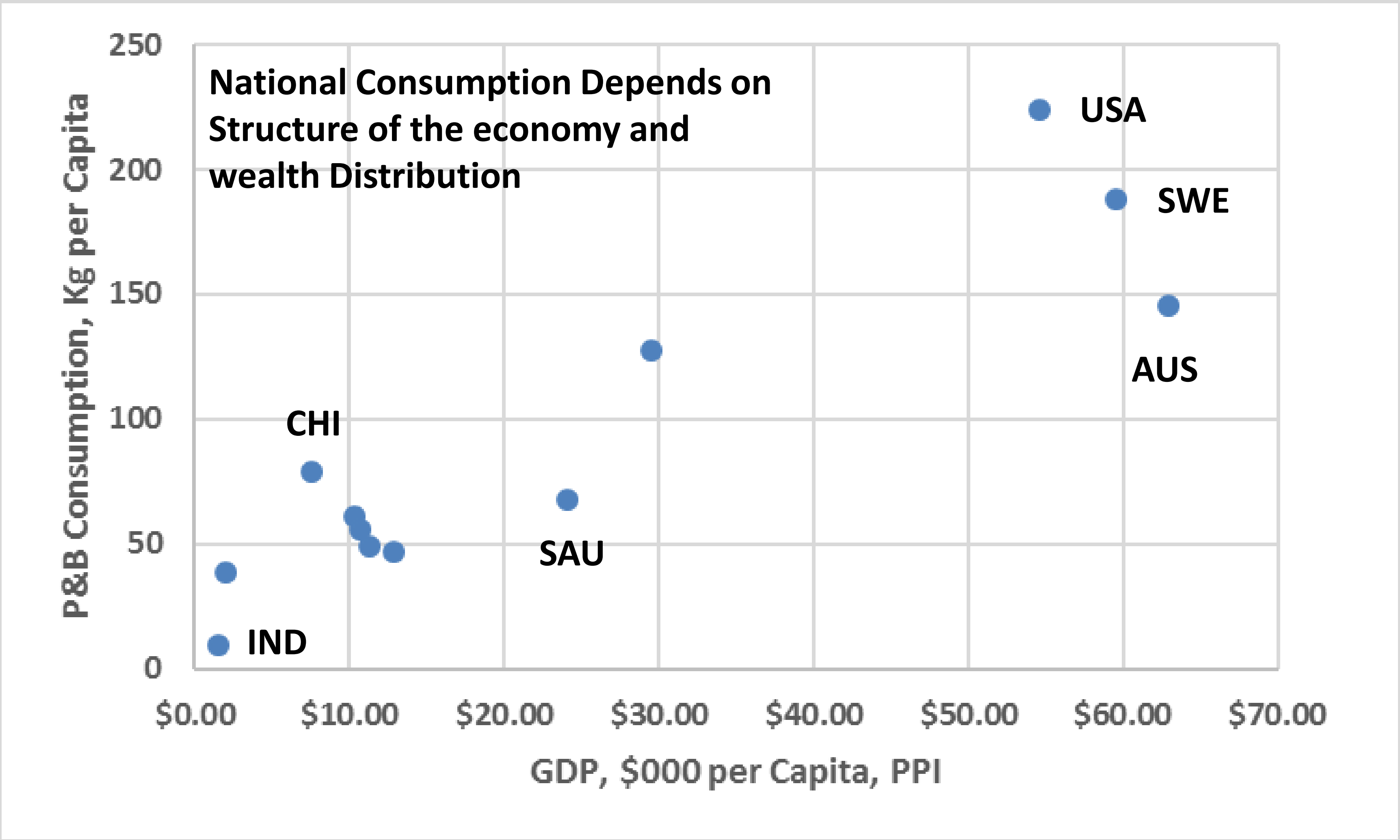




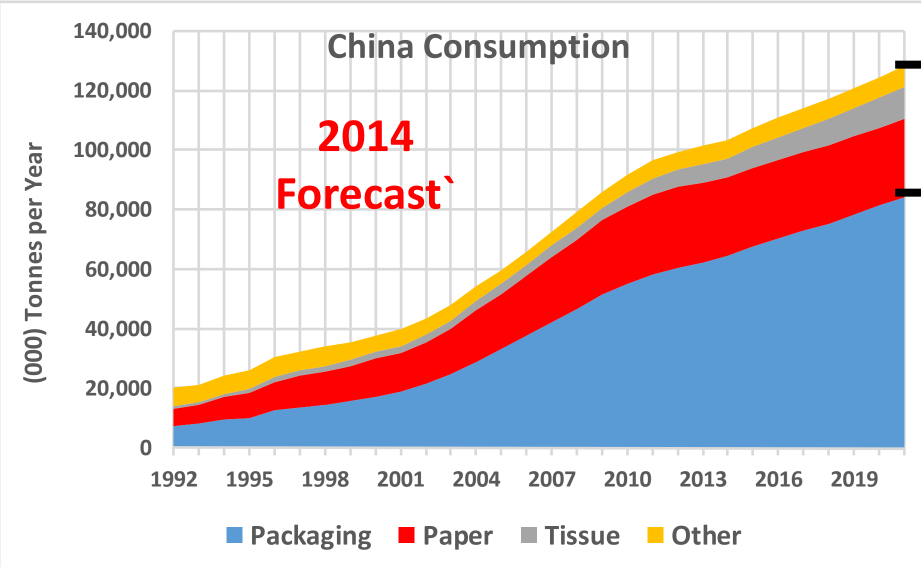
- Packaging more than 50% of P&B consumed, growing ~2% per year
- Tissue growth ~3.5% per year
- Both products highly dependent on the growth of wealth
- Printing Papers decline leveled off at -2.5% per year, but faster in Developed economies

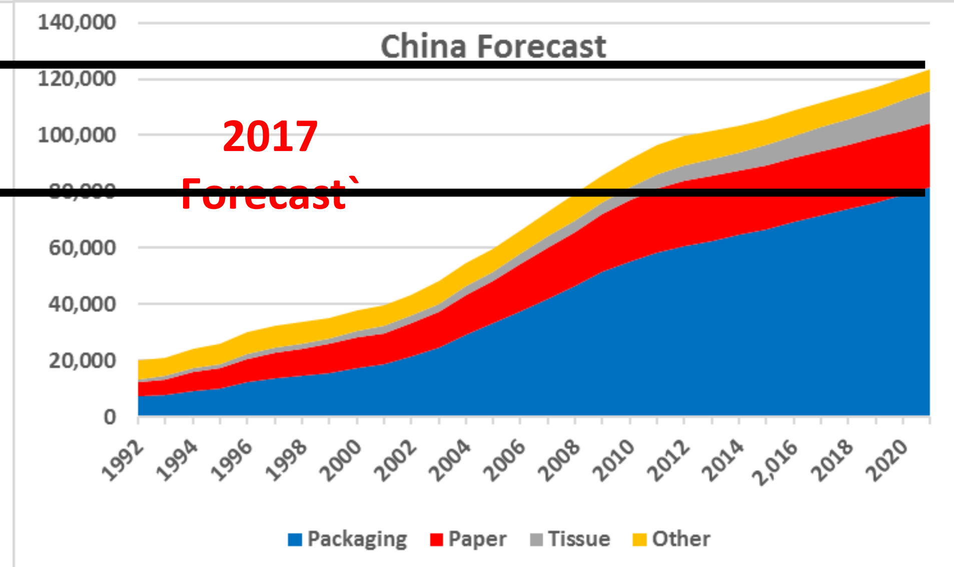
Source: RISI 2017

Selected Countries GDP vs P&B Consumption



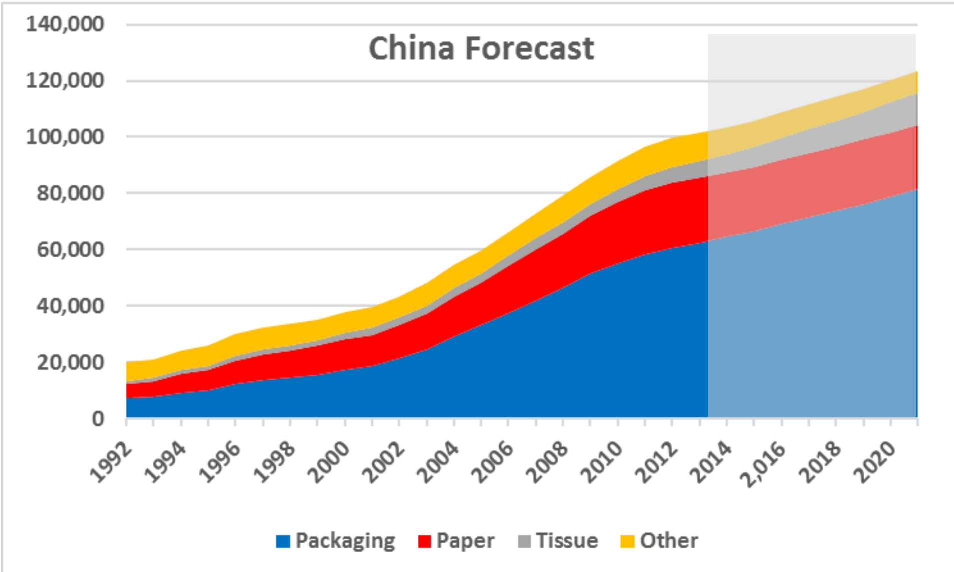
China View

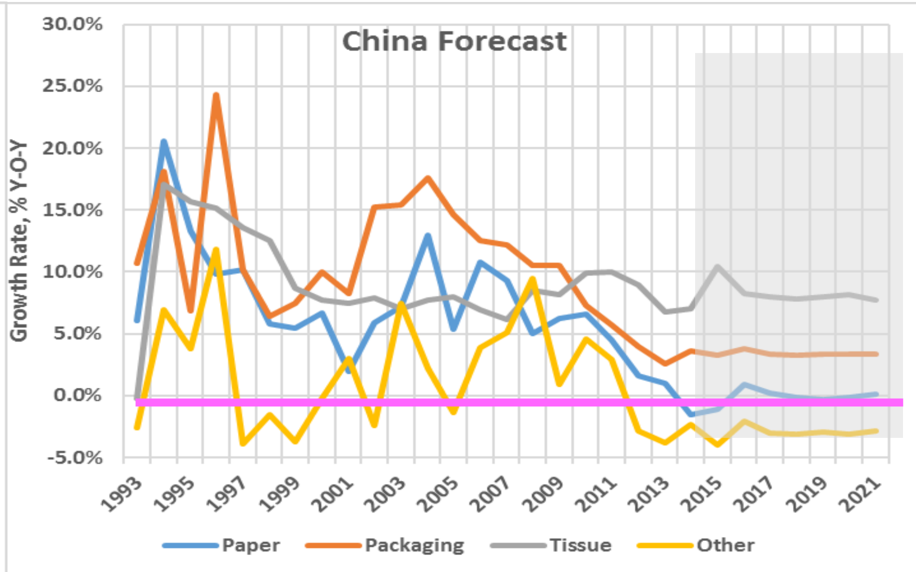




- A "Forecast" is an educated guess
- My guess in 2014 and my guess in 2017 are both based on RISI numbers for 2 years earlier (that's the best you can get from RISI)
- All economists were more bullish in 2014 about the World and the Chinese economy in 2017 than today

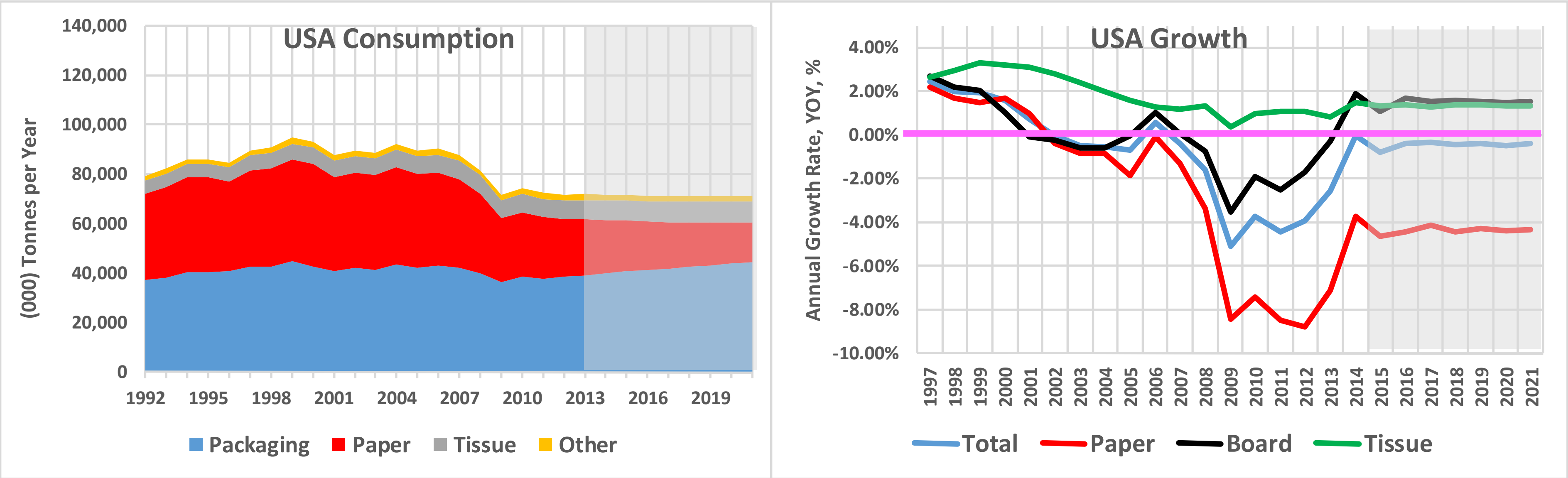
China View





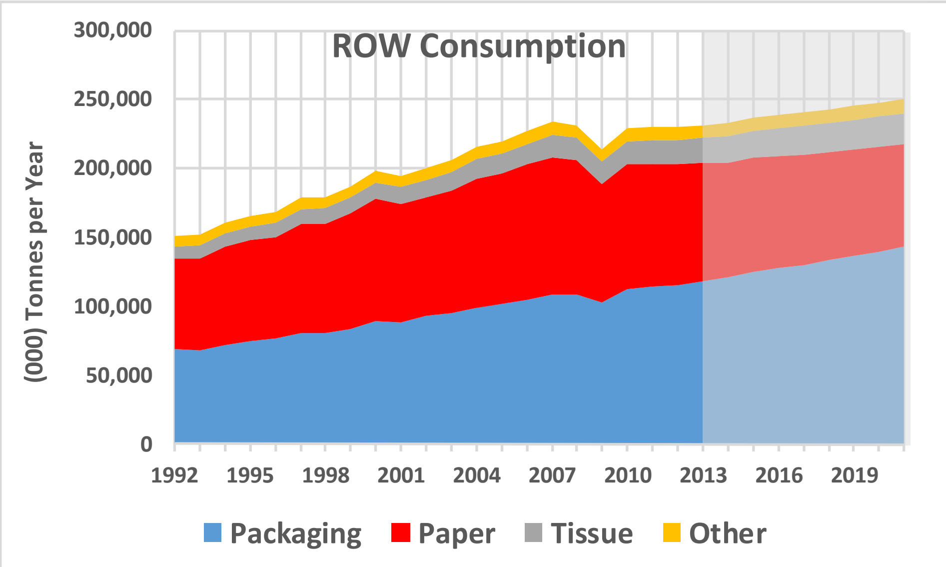
- Continued overall growth of paper and board consumption, leveling off to still good numbers
- Packaging board continues to grow ~4% per year
- No growth in paper
- Tissue continues to grow, but volumes are small

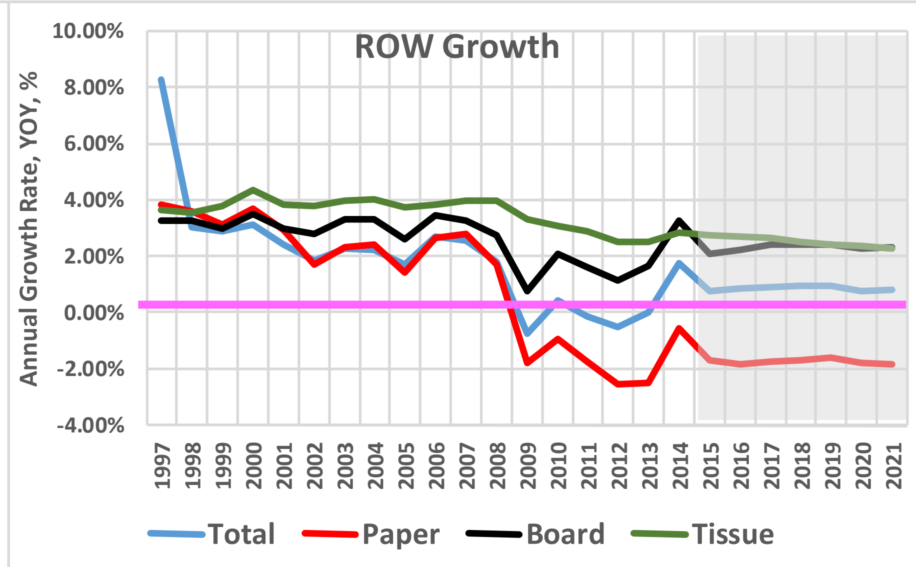
USA View



- Paper and board consumption continues to decline, perhaps at slower rate
- Packaging board continues to grow ~2% per year
- Continued shrinkage in paper consumption
- Tissue continues to grow, but volumes are small

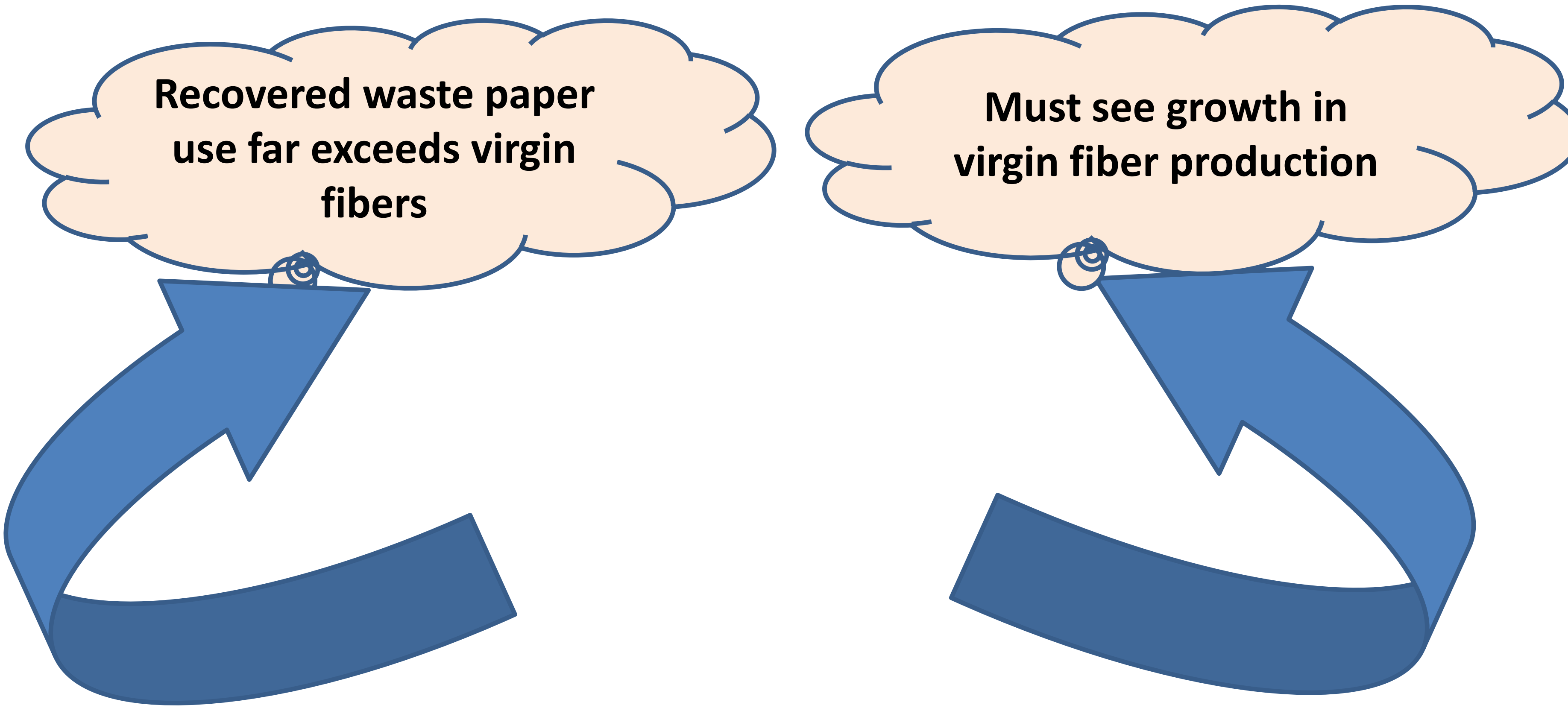
Rest of the World View





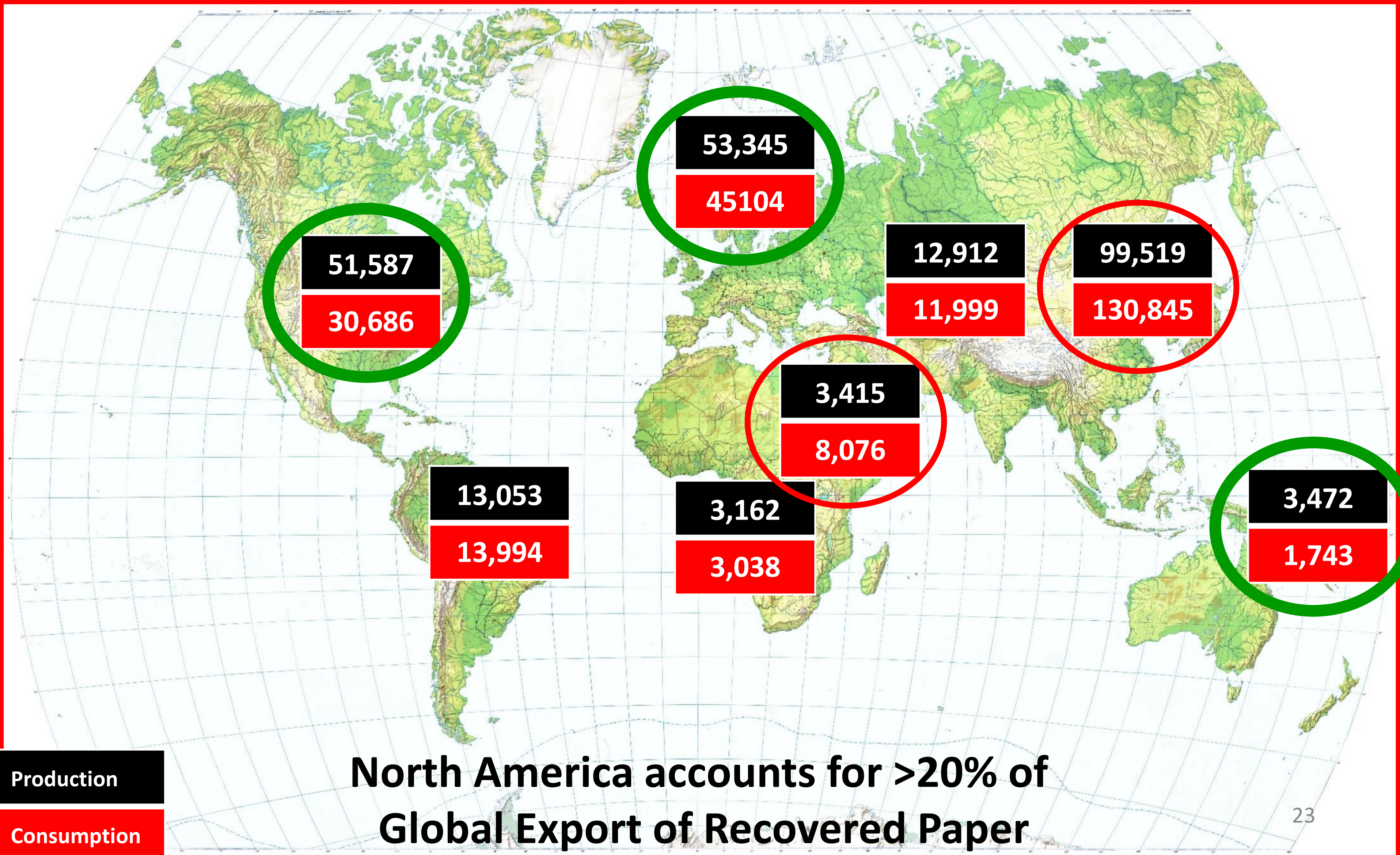
- **Slow growth of paper and board consumption**
- **Packaging board continues to grow ~2% per year, about same as USA**
- **Continued shrinkage in paper consumption**
- **Tissue continues to grow, but volumes are small**

3. Fiber Availability



2015 Global Production / Consumption of Recovered Paper

24% of Production is Exported

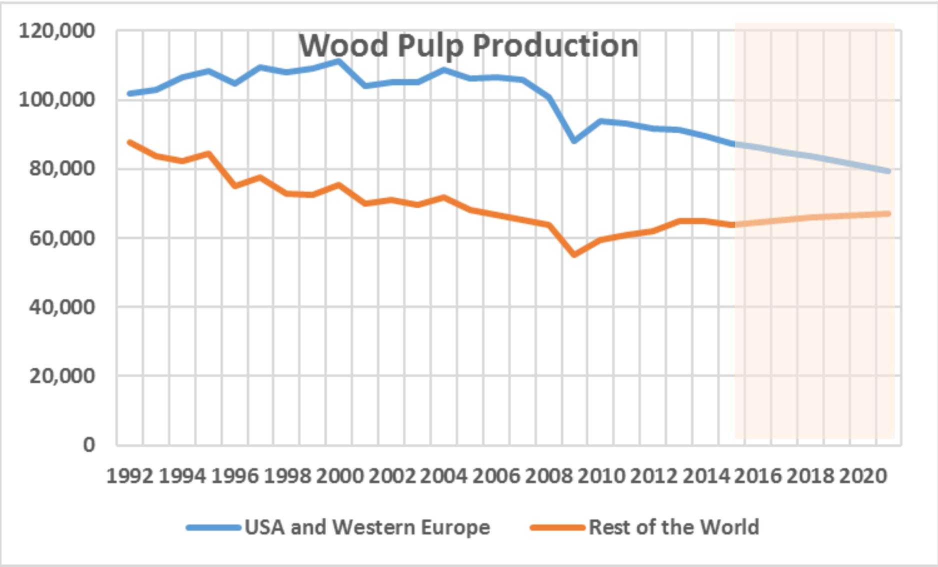


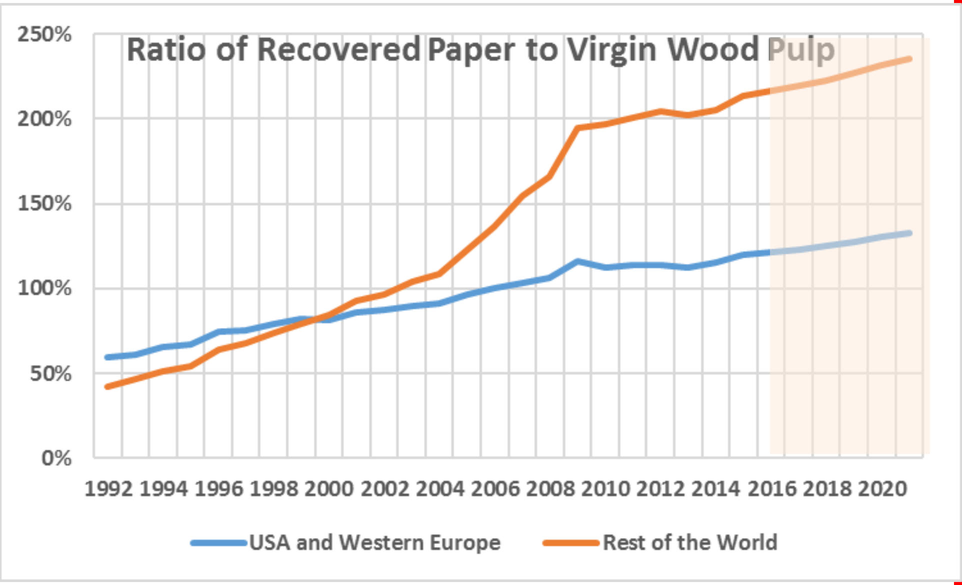
North America accounts for >20% of Global Export of Recovered Paper

Why do we care what happens in China?

- **China consumes more than 50% of the waste paper recovered in the world**
  - *Pressures local pricing*
- **China has several board machines producing over 1 MM t per year of product**
  - *Those machines will <u>always</u> outbid local producers in the USA and elsewhere to assure their supply*
- **Chinese companies now own 50% of the Canadian NBSK supply**
  - *To ensure their machines have the premium fiber they need*

Production of Fiber

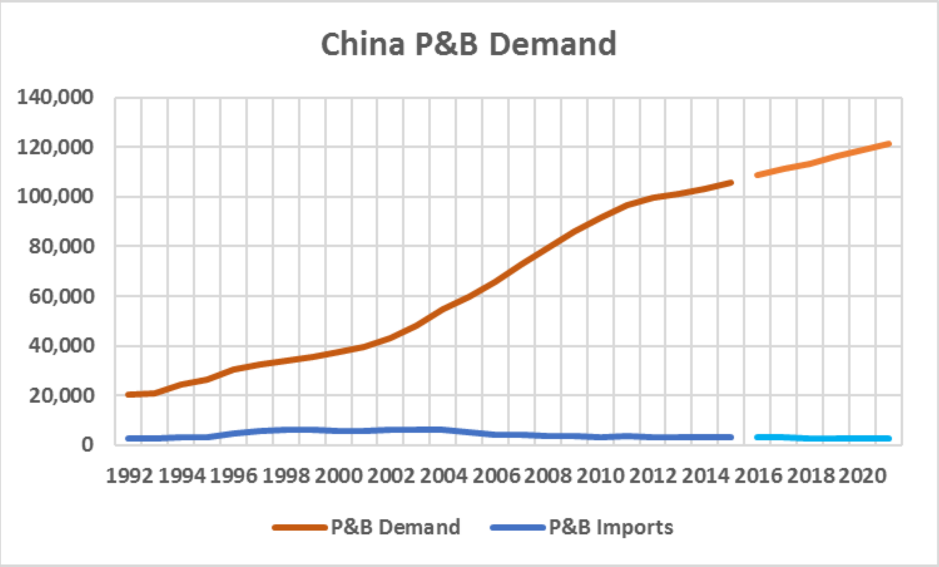


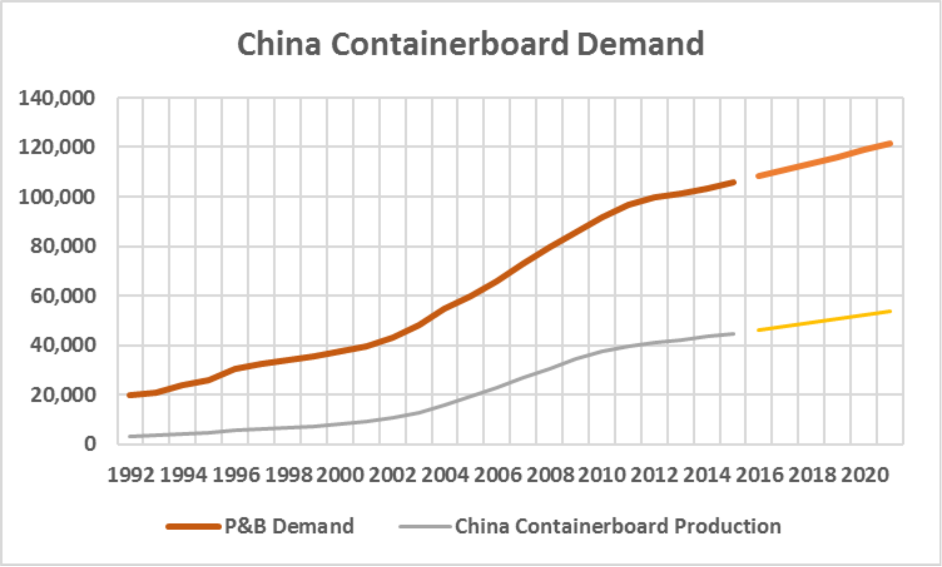


- Western World Wood Pulp Production declining
- Global RCP production exceeds virgin fiber by 40%
- Practical limit of ~70% recovery of domestic waste
- Practical limit on number of times fiber can be recycled

Source: RISI

China Packaging

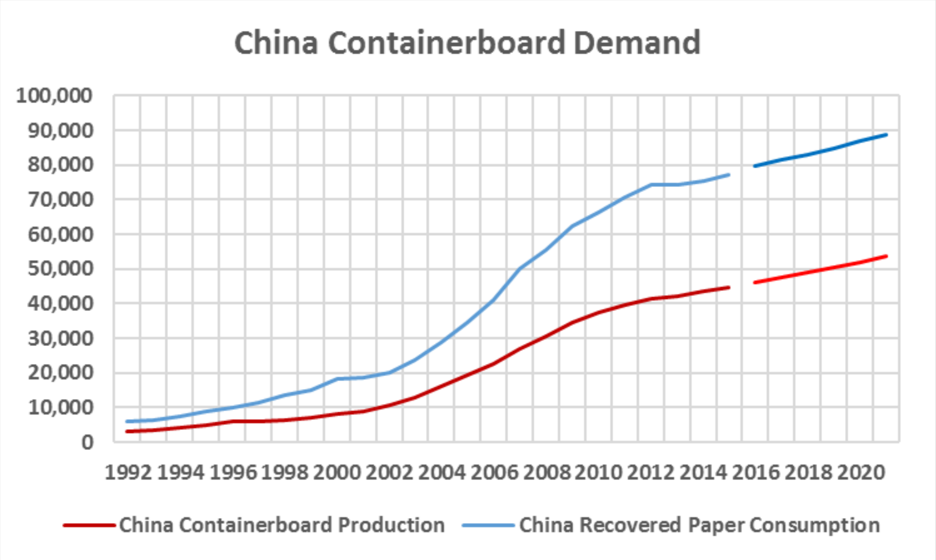


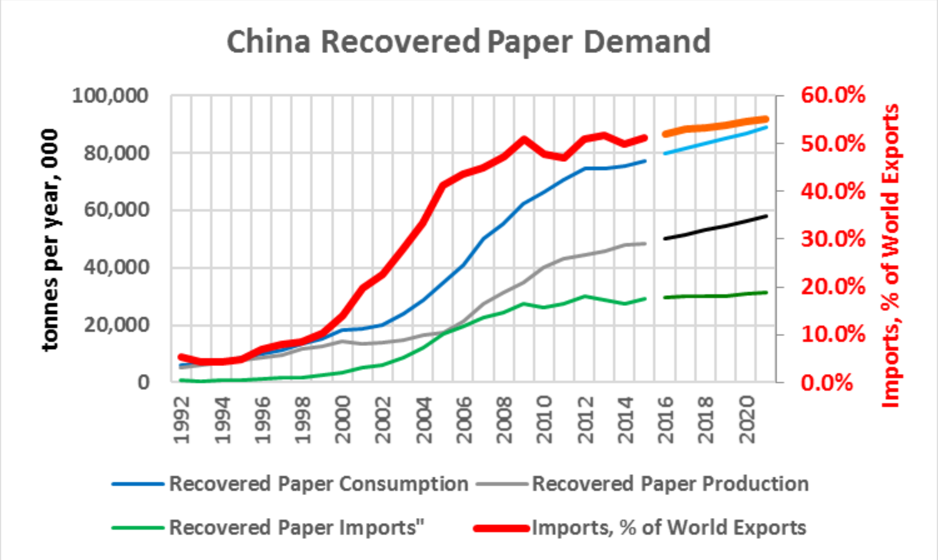


- China production of P&B continues to grow at 2.5% per year
- China Production of Containerboard grows at 3% per year
- Chinese Containerboard 100% Recycled fiber

Source: RISI

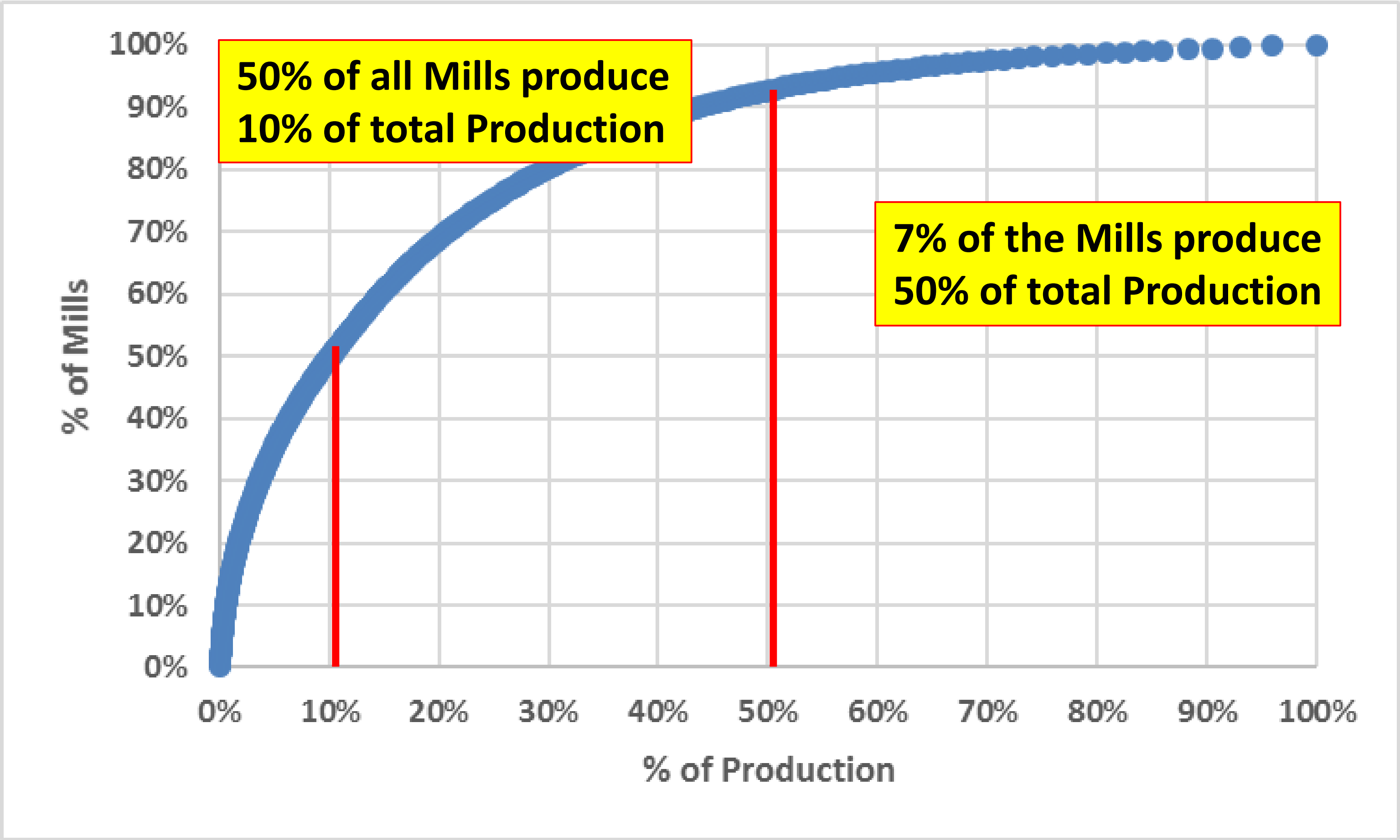
China Packaging





- **Not all Recovered Fiber goes to containerboard manufacture, but machine scales are enormous and will be satisfied as first priority**
- **Consume ~ 50% of all World exports of Recovered Paper, forecast to go to 55%**
- **How can P&B be recovered from Western Europe and North America when regional demand is declining?**

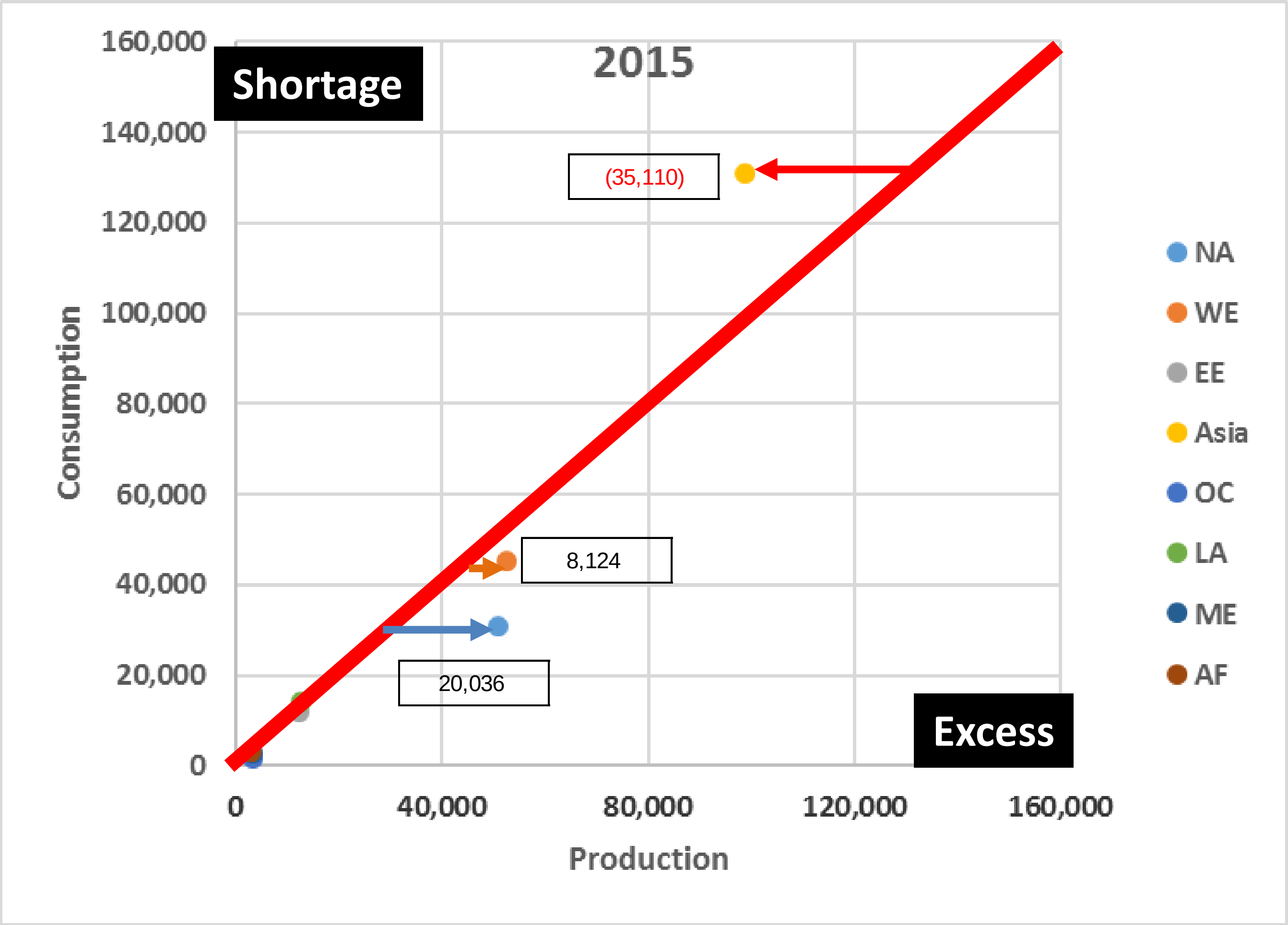
The largest Chinese Mill produces 5 Million tonnes of 100% recycled liner per year



Source: FisherSolve database on mills producing more than 50 tonnes per day

Asia currently imports 35 Million Tonnes of waste

Current collection rate of ~50%

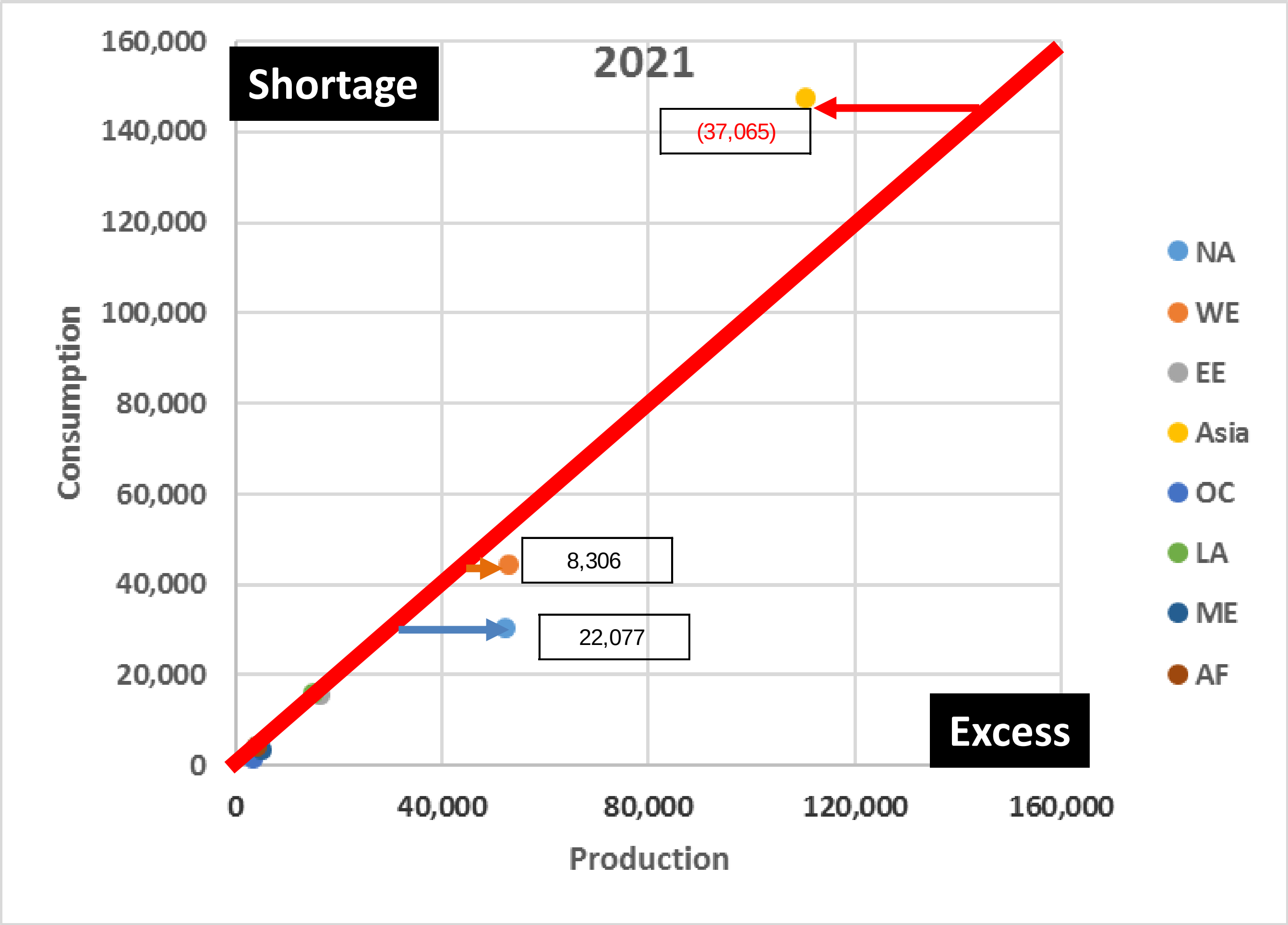


Waste for Asia comes principally from North America and Western Europe

Source: RISI

Shortage grows to 37 Million Tonnes in 2020

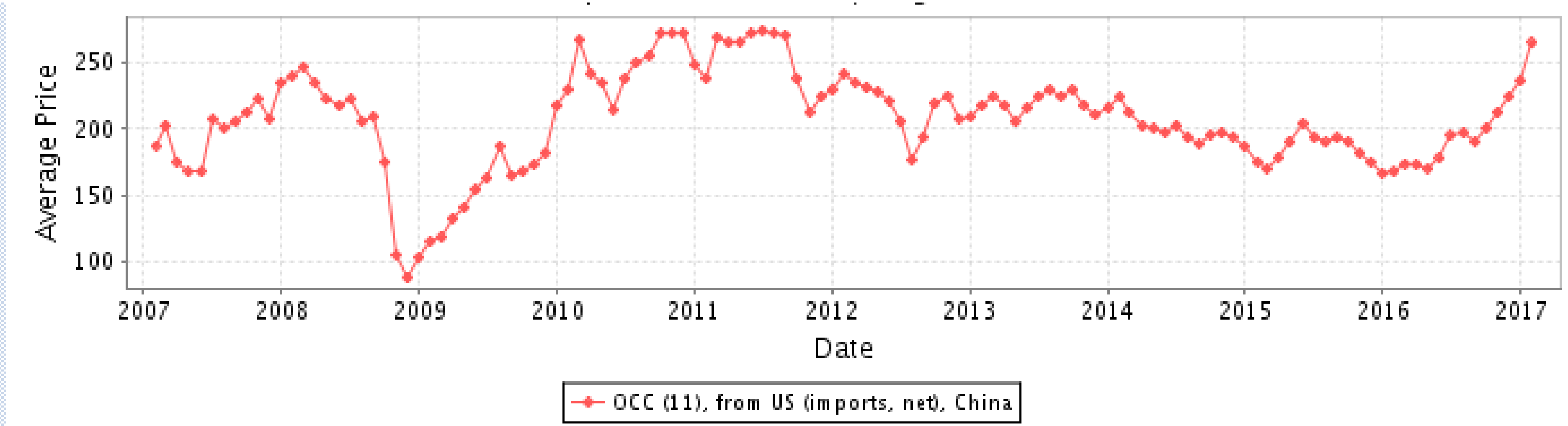
If recovery rate grows to 64%

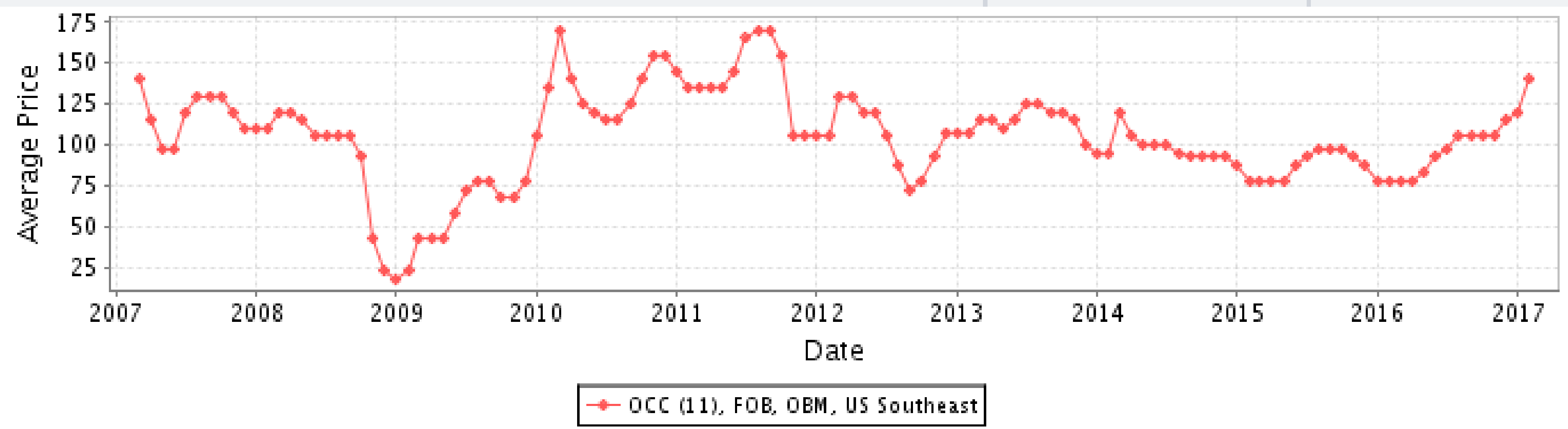


Waste availability from North America and Western Europe cannot grow because local consumption of P&B declines

Source: RISI

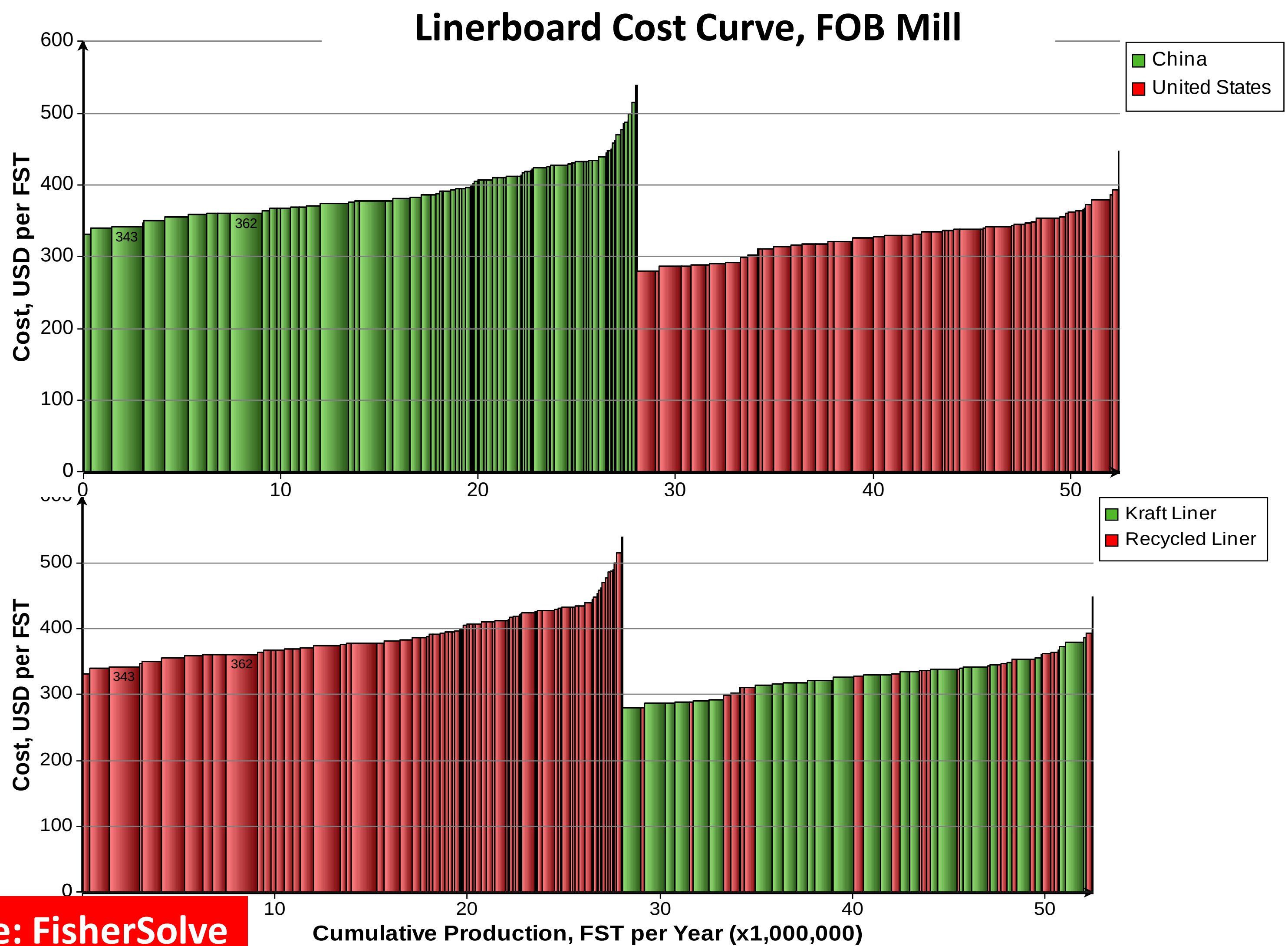
Demand / Supply Imbalance partly reflected in pricing trends





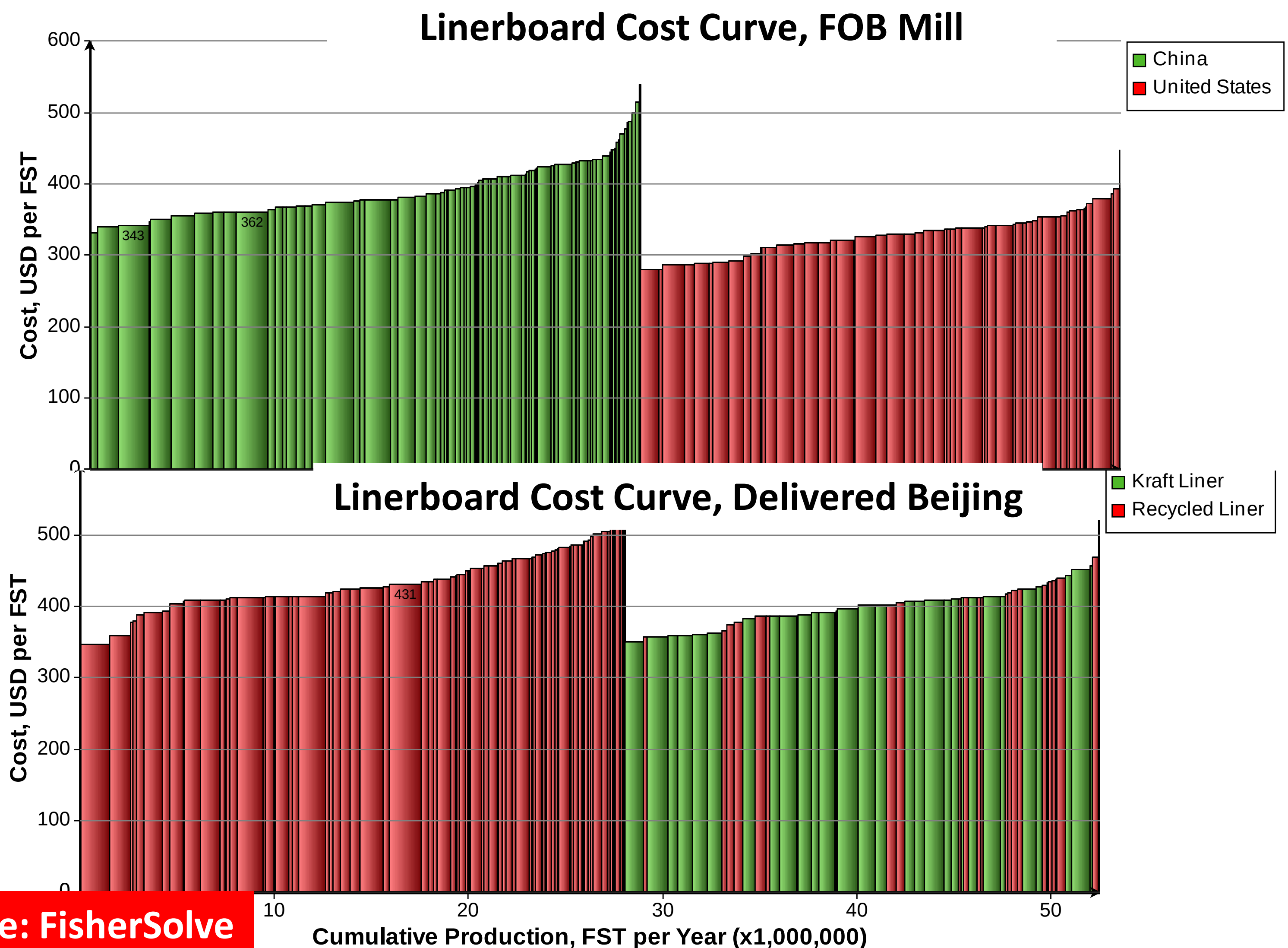
Source: RISI

Linerboard Cost Curve, FOB Mill



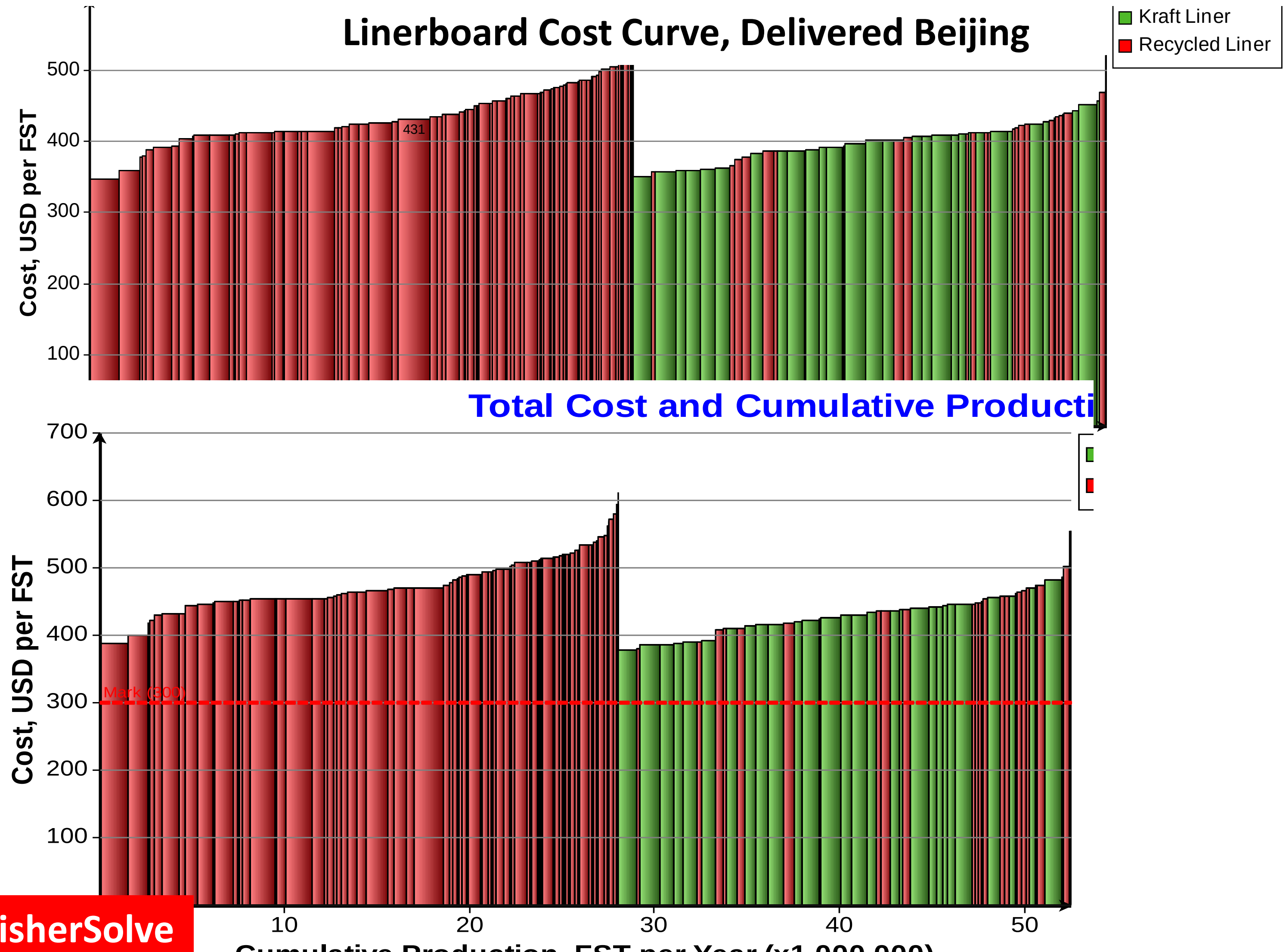
Source: FisherSolve

Delivered to Beijing



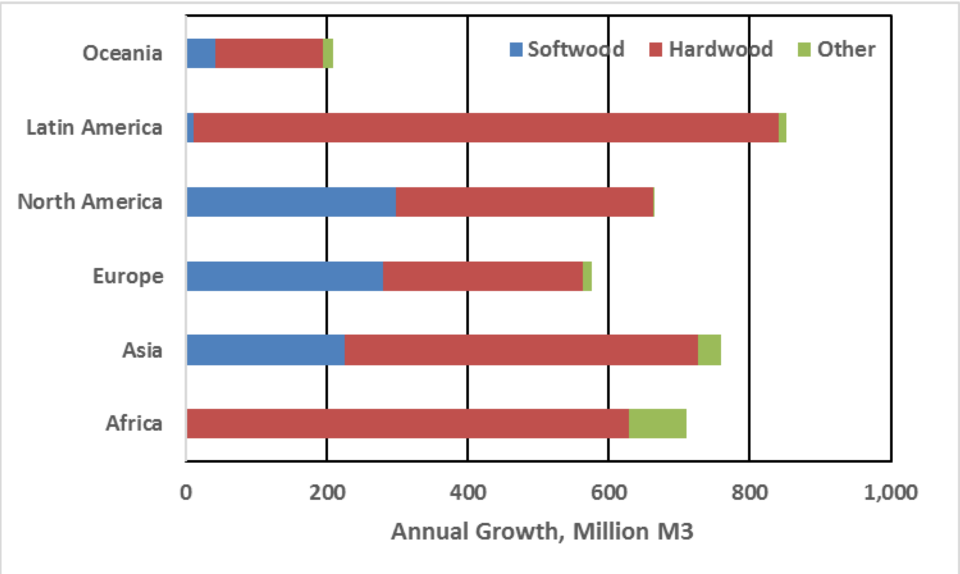
Source: FisherSolve

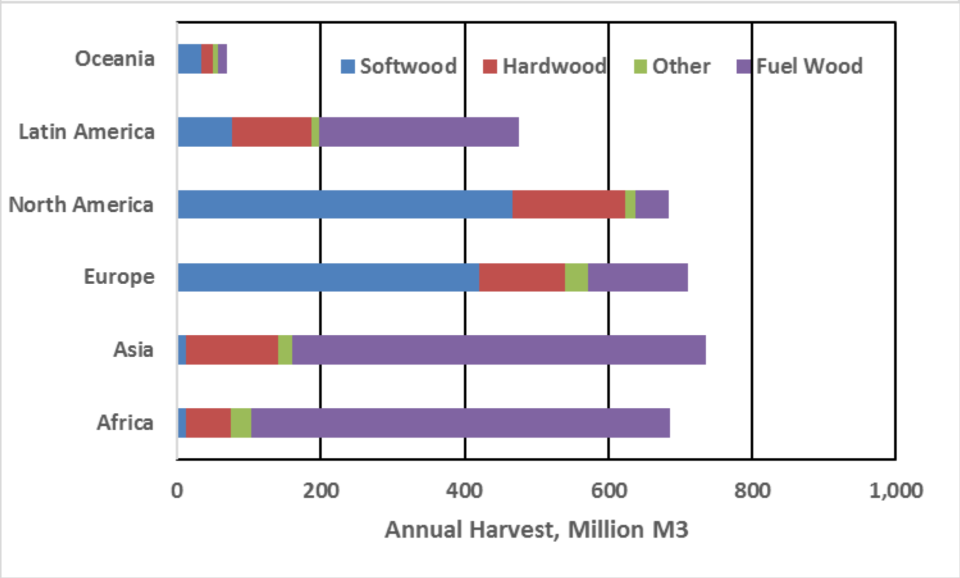
20% Increase in OCC



Source: FisherSolve

World will not run out of Wood fiber…



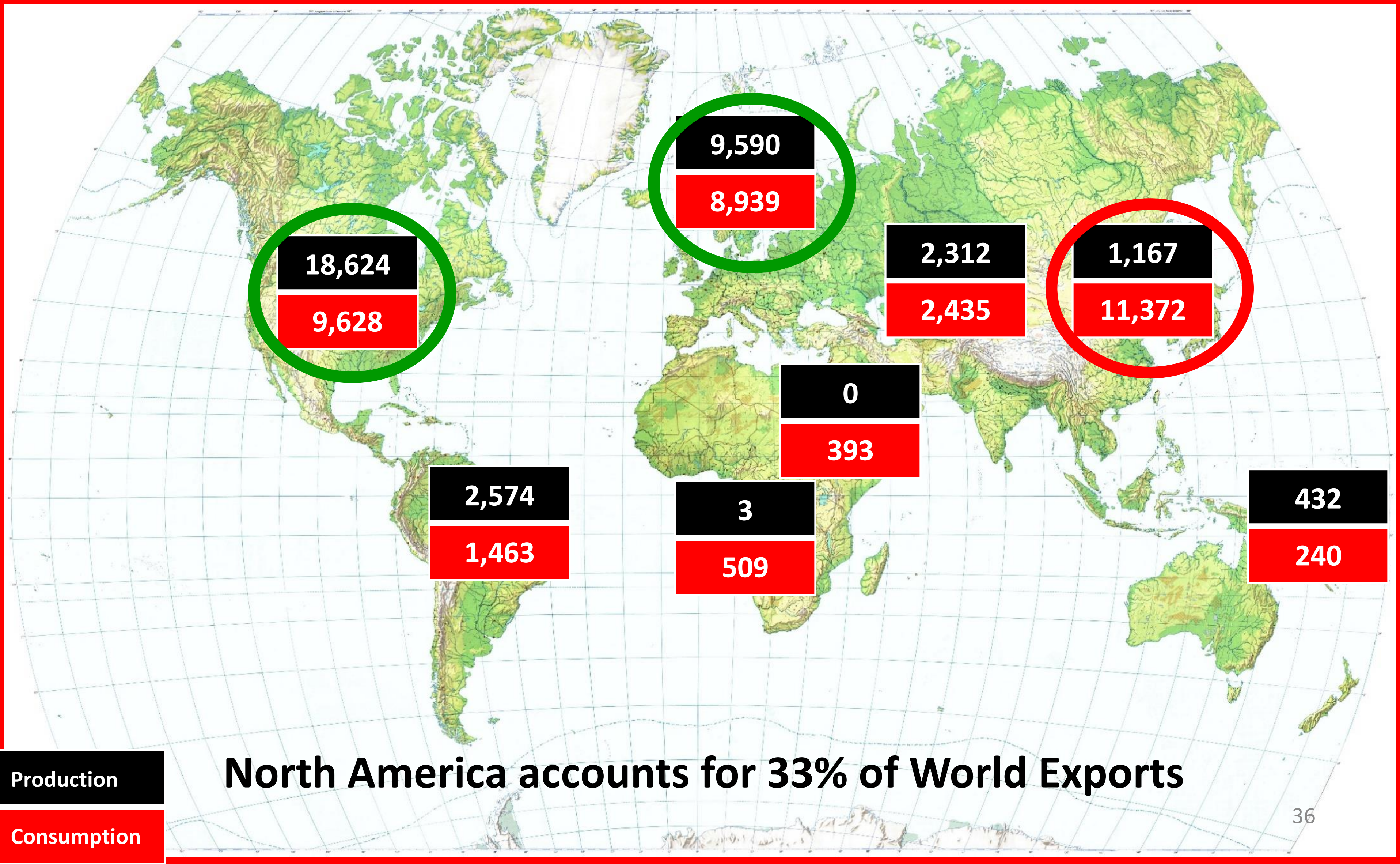


- Global Growth exceeds removals, even accounting for fuel wood harvest
- But only by small margin
- Planted forests versus natural forests are the key to future growth
    - Grow 5-10 times faster
    - But grown only for a profit

Source: FAO

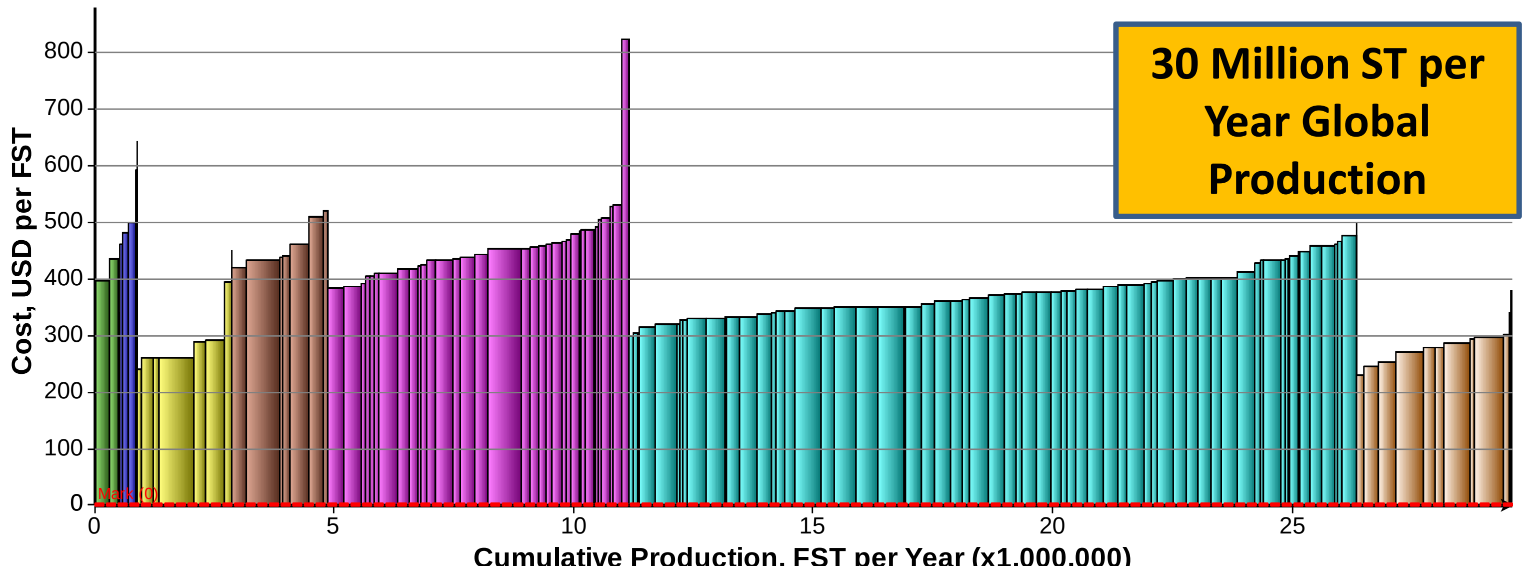
2015 Global Production / Consumption of Bleached Softwood Pulp

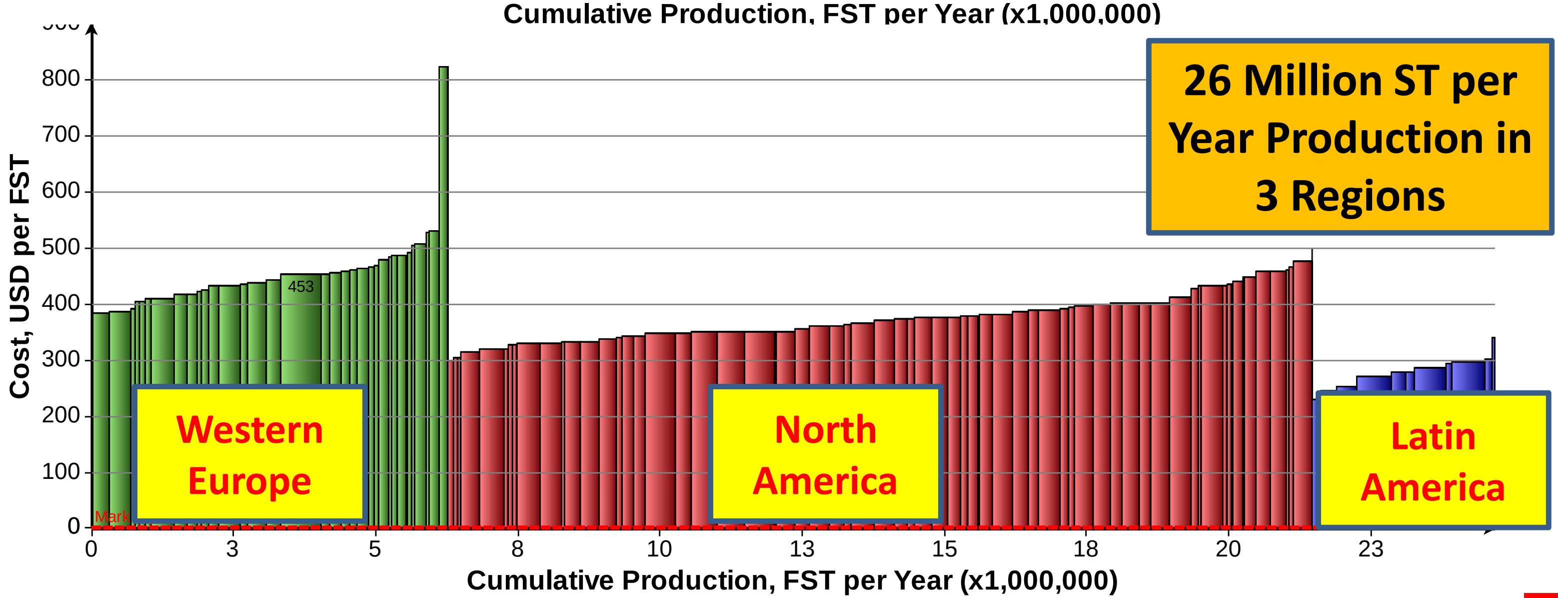
61% of Production is Exported



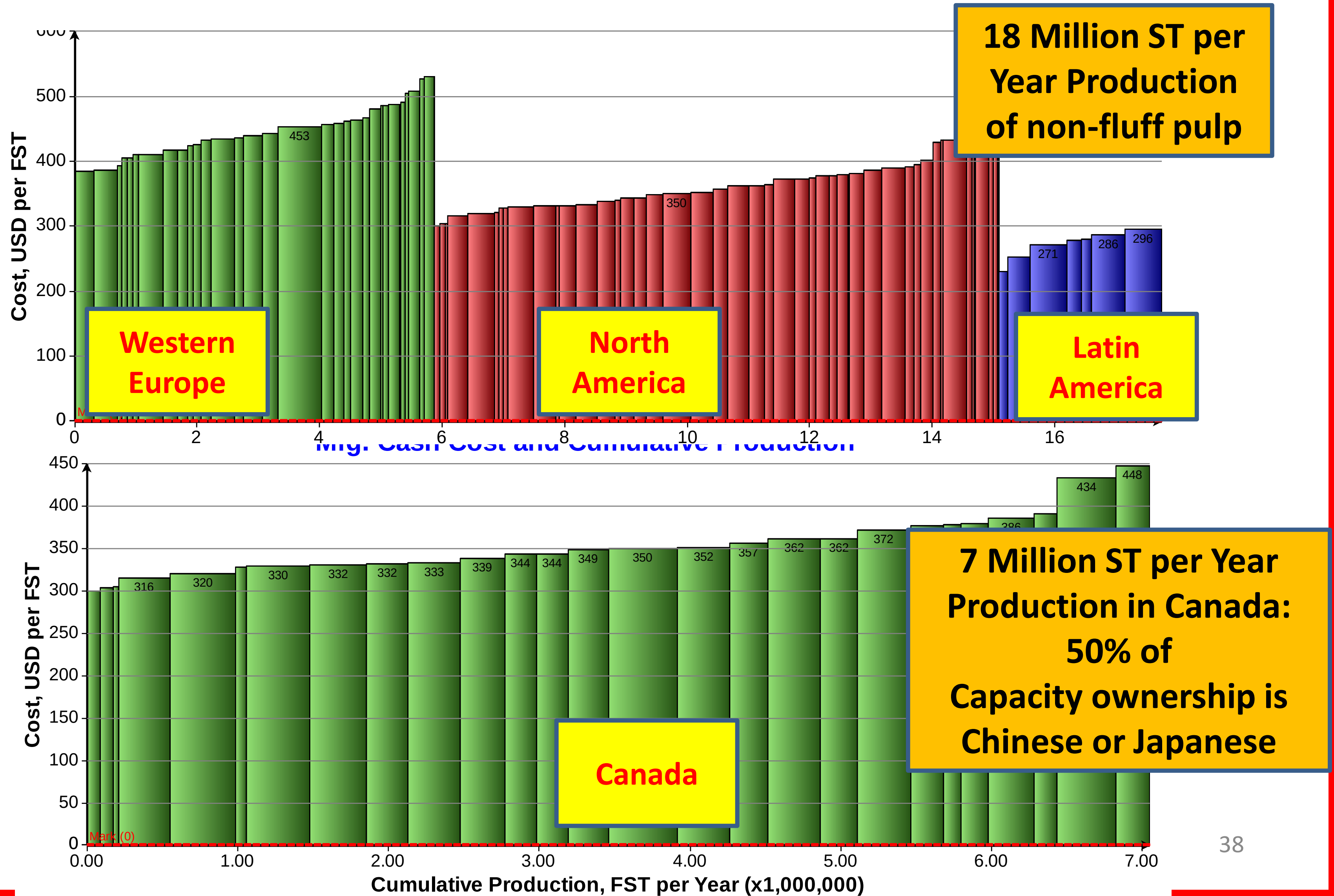
North America accounts for 33% of World Exports

Global Production of Softwood Market Pulp not the same as Global availability



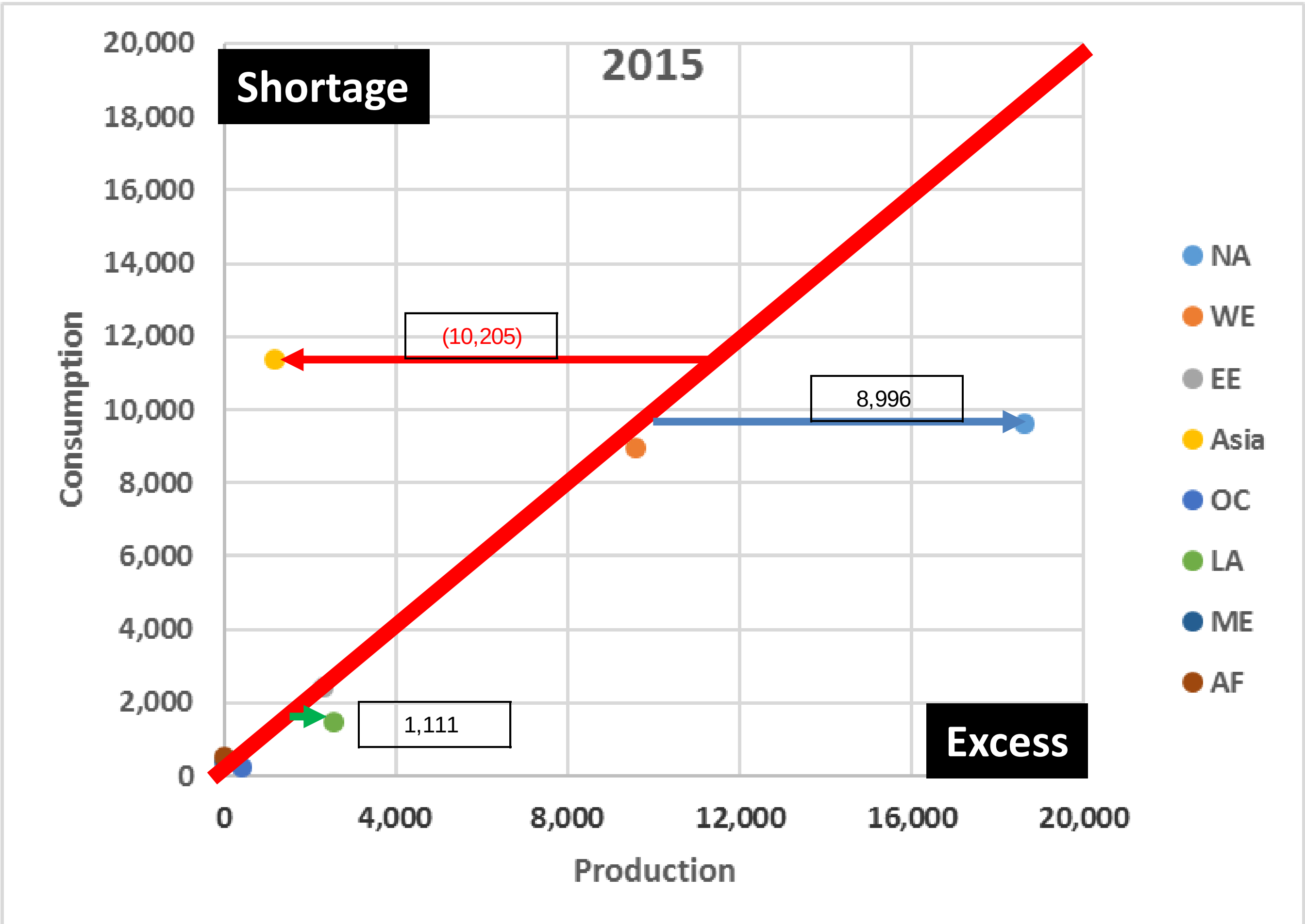


1/3 of Softwood Pulp Sold as Fluff
½ Canadian Production owner by Asians



Purchased Softwood Pulp in Balance

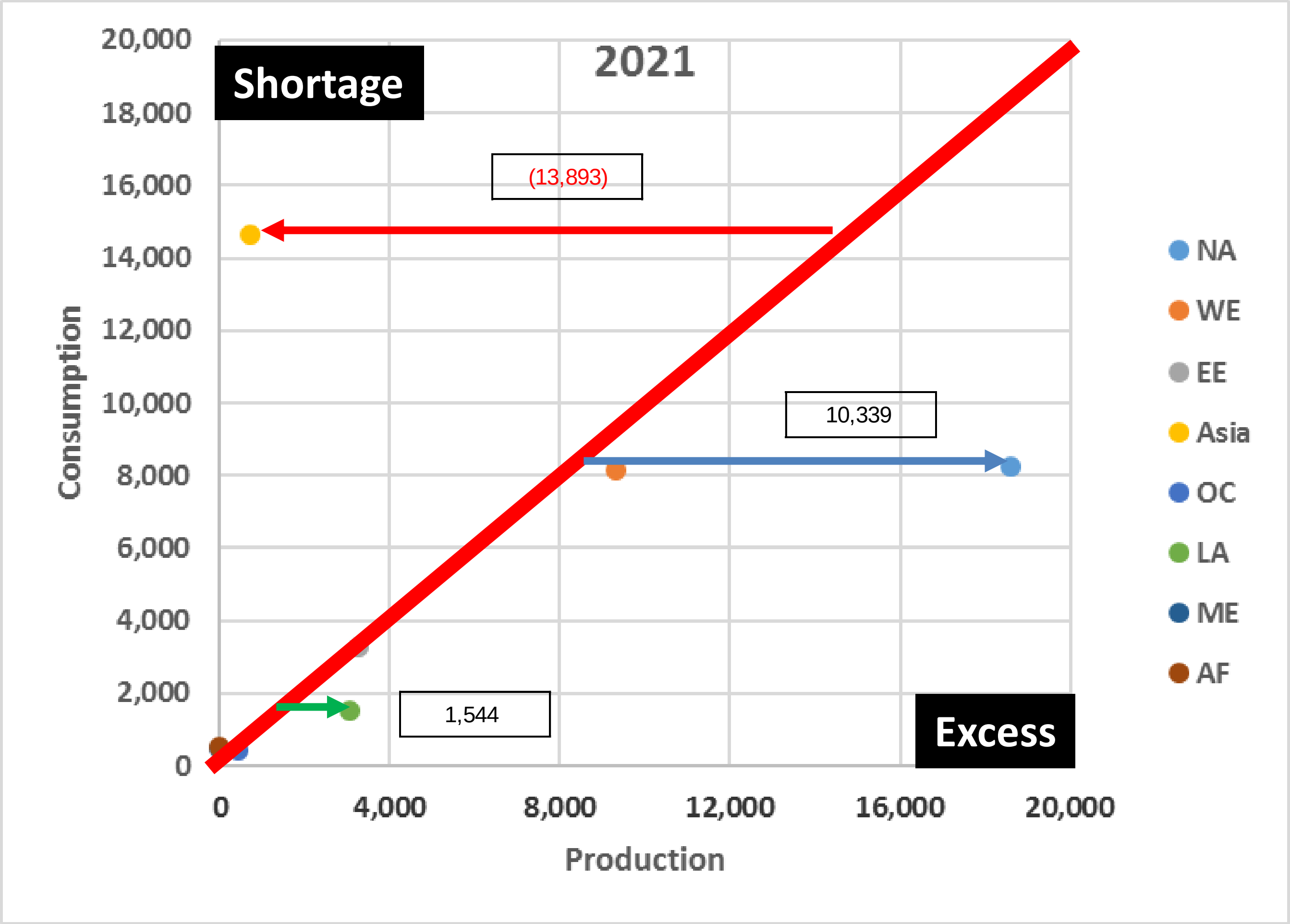
Today's supply adequate but little capacity being built



Softwood well–balanced today globally with North American Surplus supplying Asia Deficit

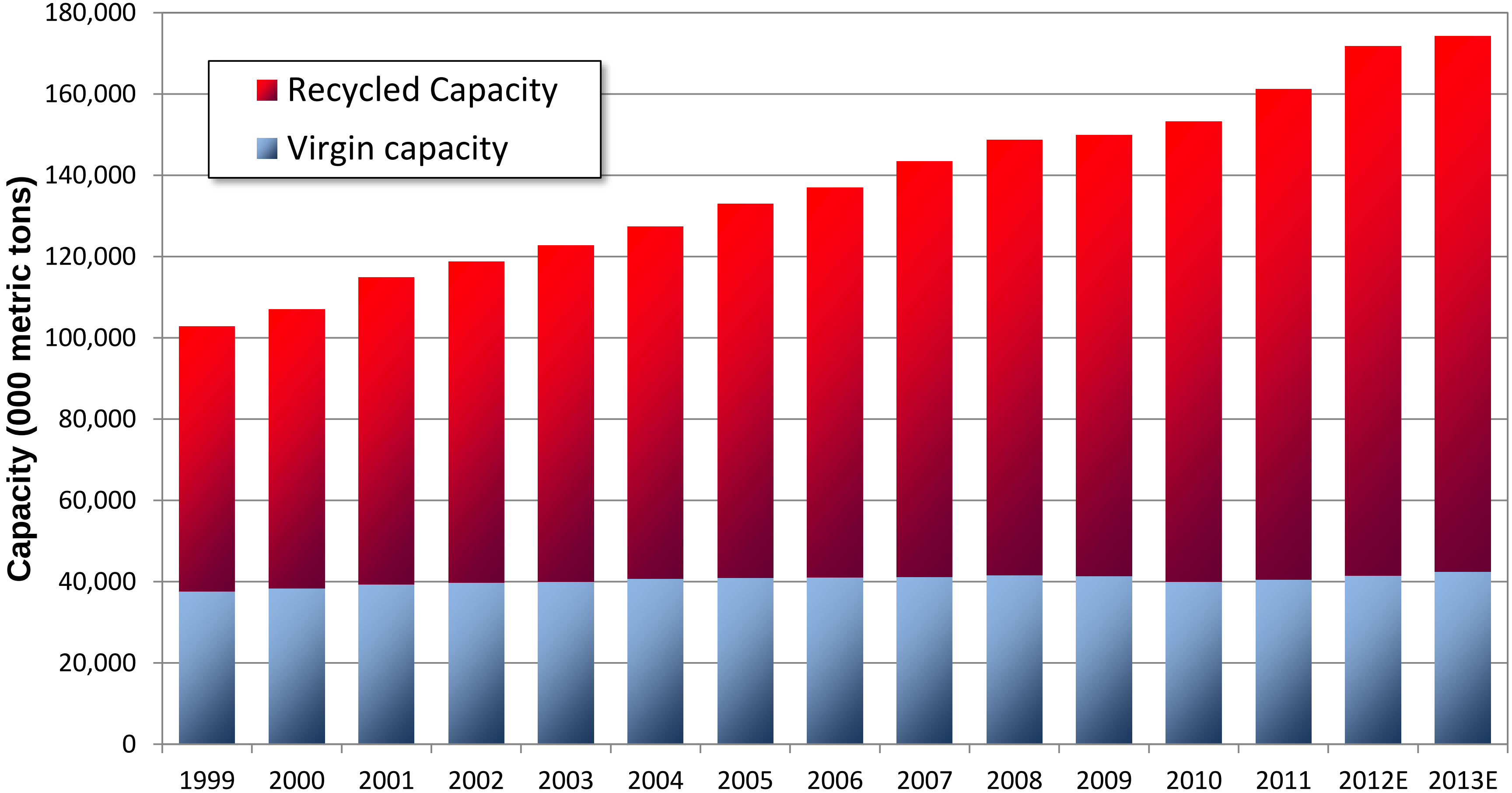
Purchased Softwood Pulp Must Grow

Softwood Pulp will likely be in shortfall



Shortage in Asia not balanced by Excess produced elsewhere

Little growth in virgin liner capacity…



… And won't be until a jump in Virgin Liner price is established

NCSU Model of Greenfield Liner Mills startup in 2020

$700 per FT

NPV (10%)	($225,164,642)
% IRR	6.9%

$630 per FT

NPV (10%)	$100,941,612
% IRR	12.7%

$750 per FT

NPV (10%)	($43,816,267)
% IRR	9.4%

$675 per FT

NPV (10%)	$252,717,588
% IRR	16.5%

$800 per FT

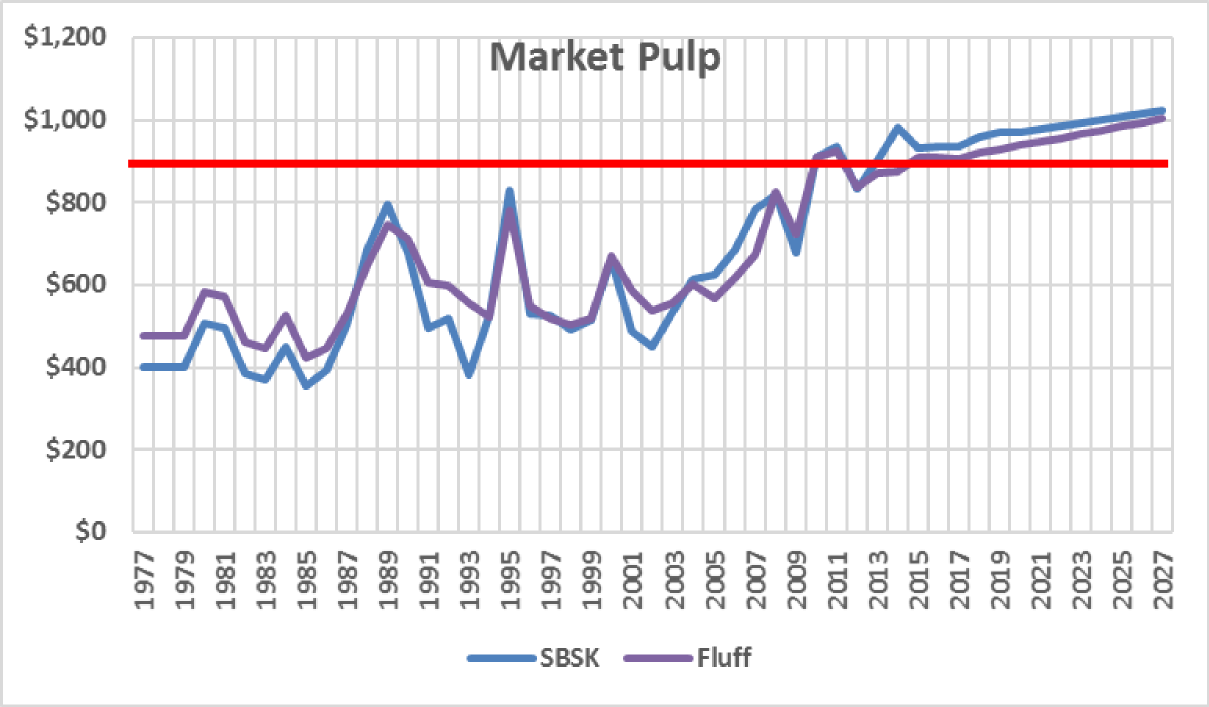
NPV (10%)	$157,308,675
% IRR	12.1%

$720 per FT

NPV (10%)	$404,493,563
% IRR	19.9%

U.S. SBSK moving to Fluff Pulp
Slightly lower return but faster growing market

	2020 Price	FT per Year	Capex	IRR – US MW	IRR – Far East
SBSK	$867	918,441	$1,666,684	11.8%	10.3%
Fluff	$927	957,381	$1,867,239	11.0%	9.5%



Technology Impacts

Technology Impacts

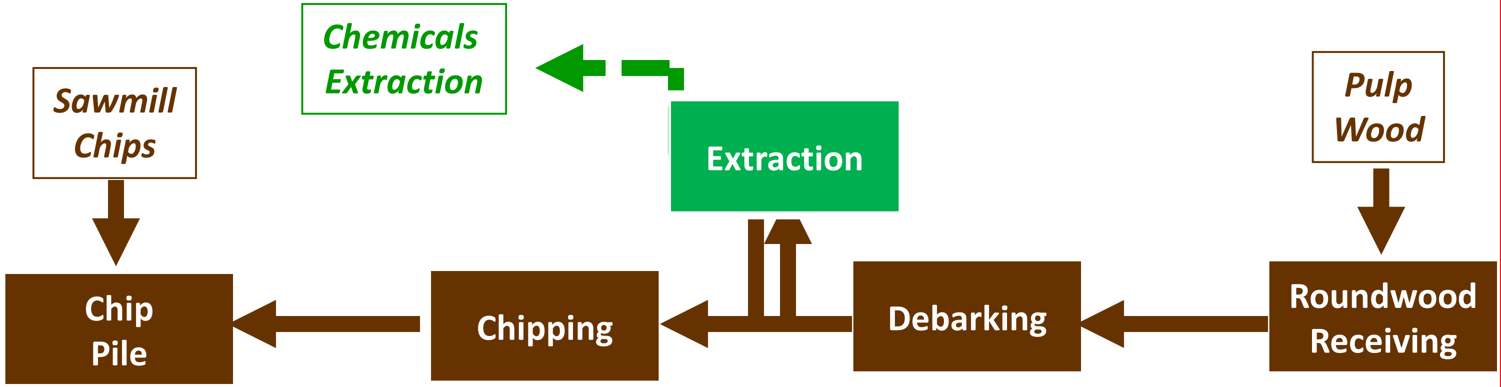
- **For Greenfield Mills**
  - ***In the 5-Year Horizon – None, other than new mills are getting bigger***
  - ***In the 10-Year Horizon – possibly***
    - **Black Liquor Gasification**
    - **Production of "Nano" materials with a small part of production**
- **For Existing Mills**
  - ***Conversion to Bioproducts by Repurposing Kraft Mill equipment***
- **In general, minor impacts**

Greenfield nvestment cost
not supported by Market Price

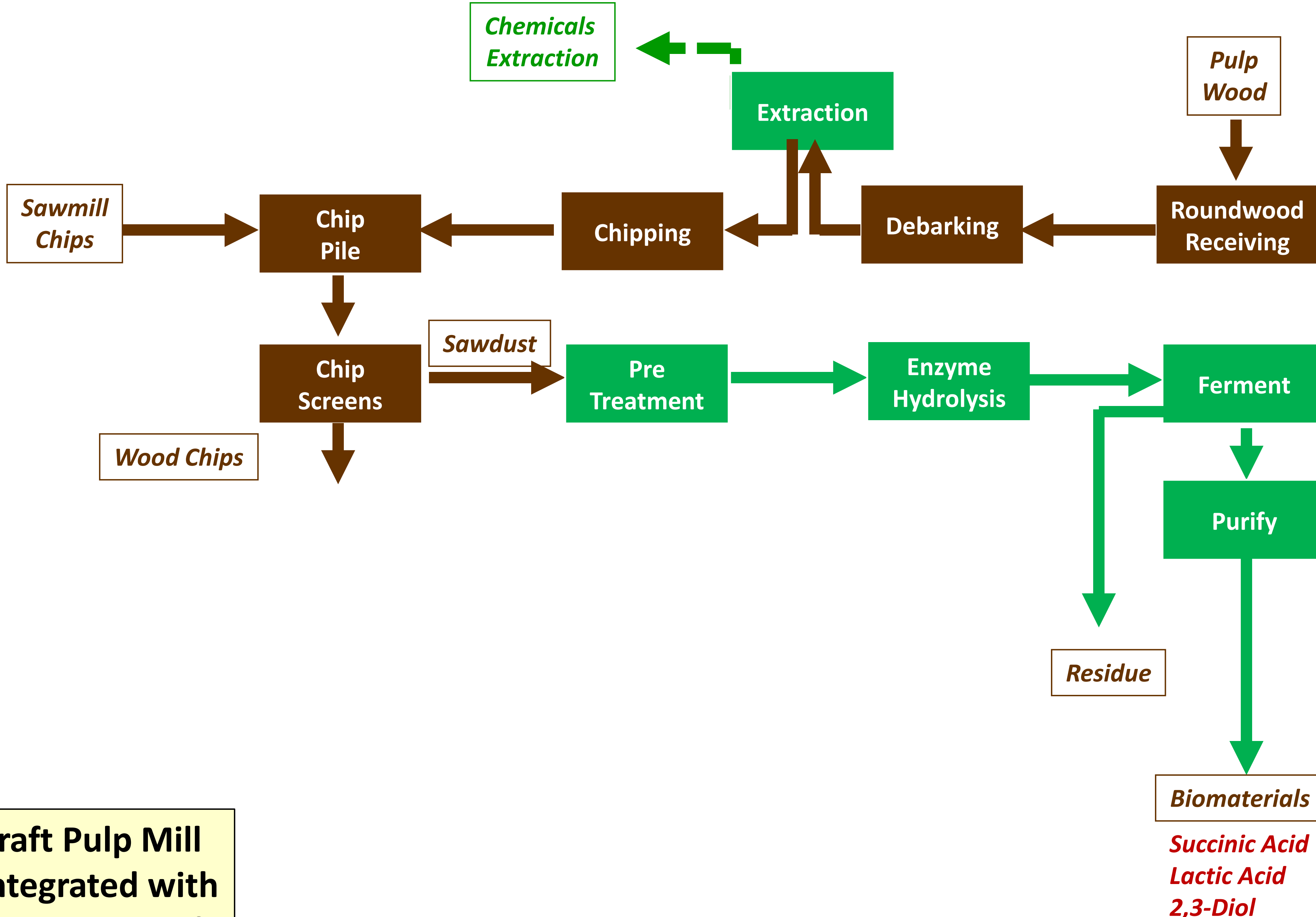
Mill Economics don’t support
higher Market Price

Innovation Required

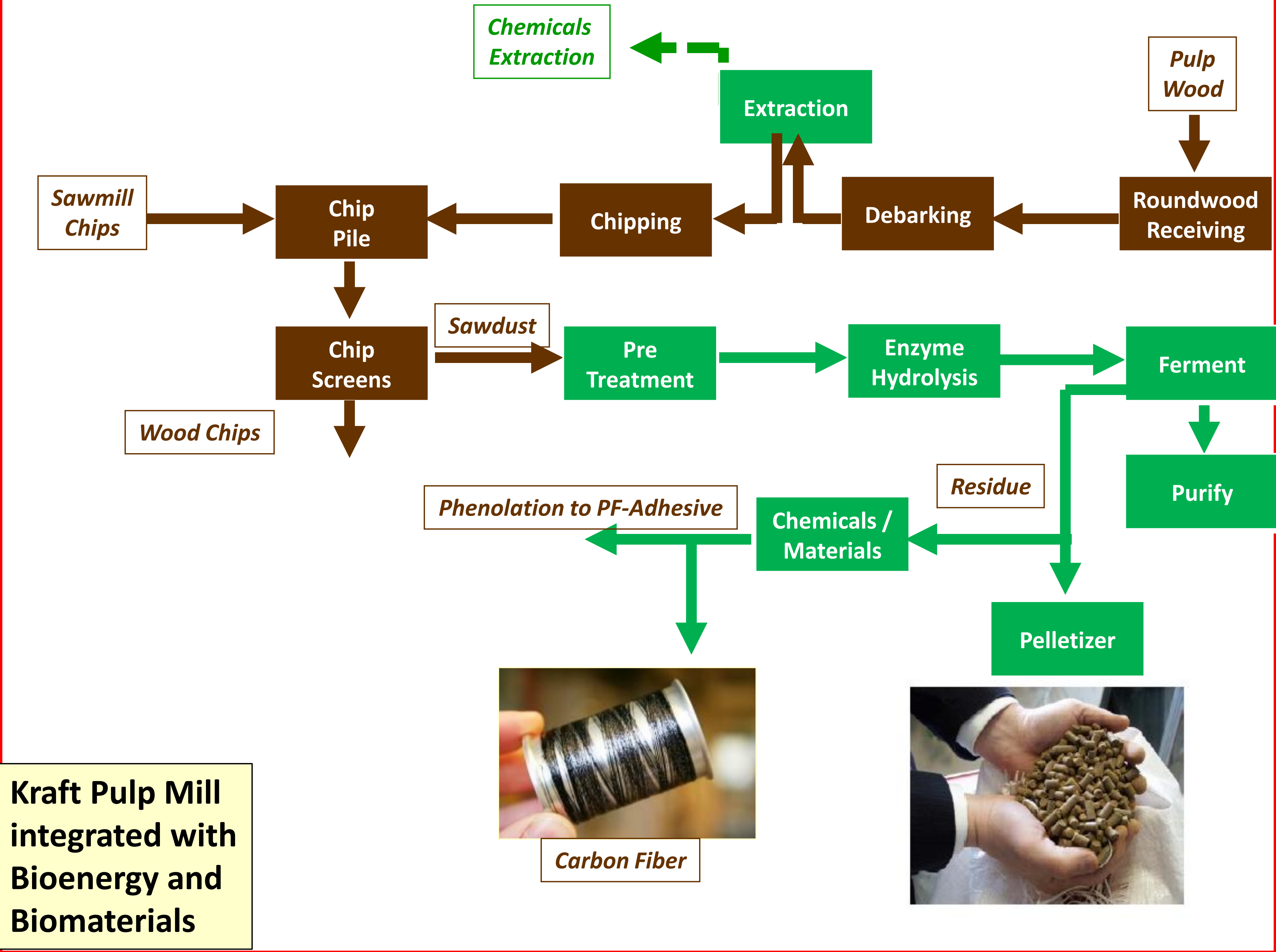
4. Survival of Western Paper Mills requires radical solutions fueled by Innovation

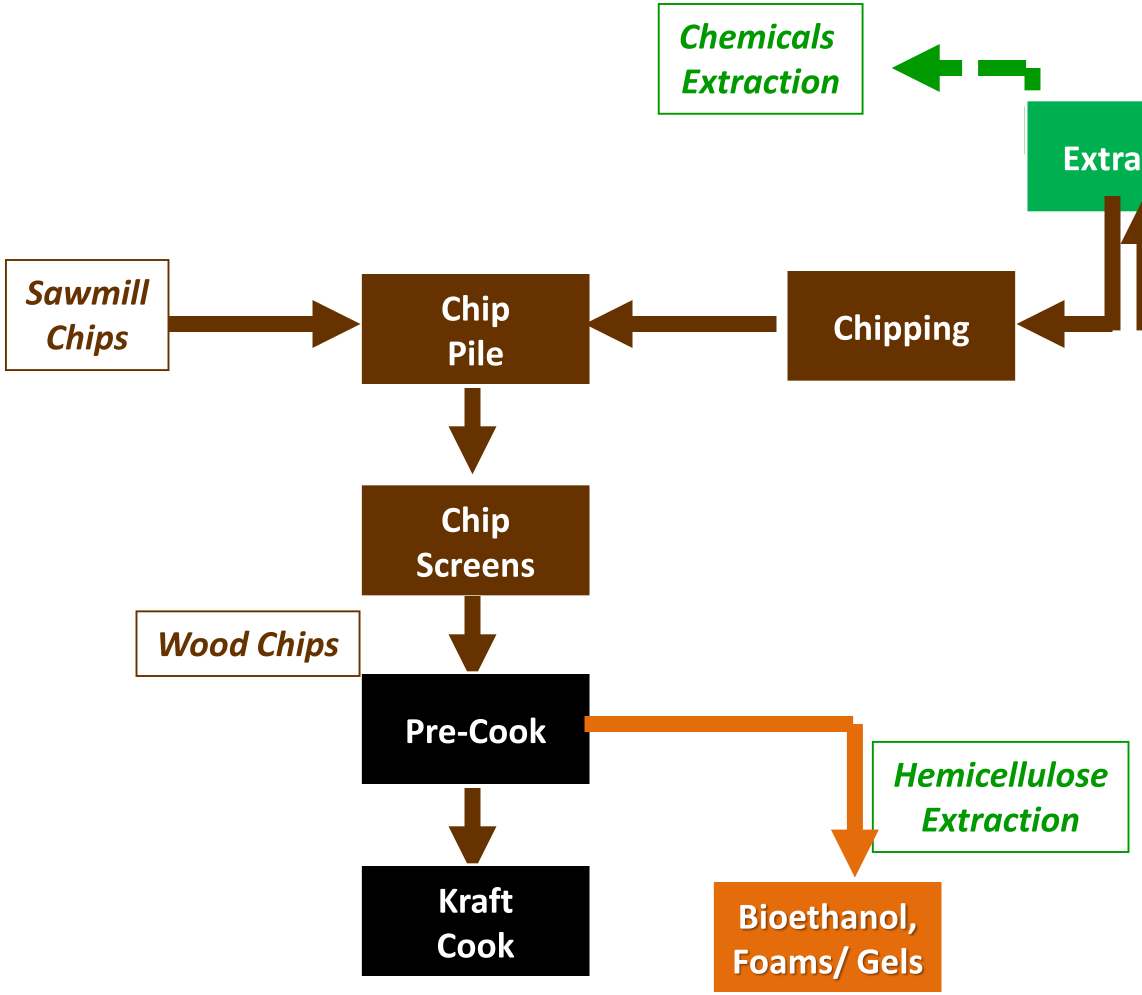


Kraft Pulp Mill integrated with Bioenergy and Biomaterials

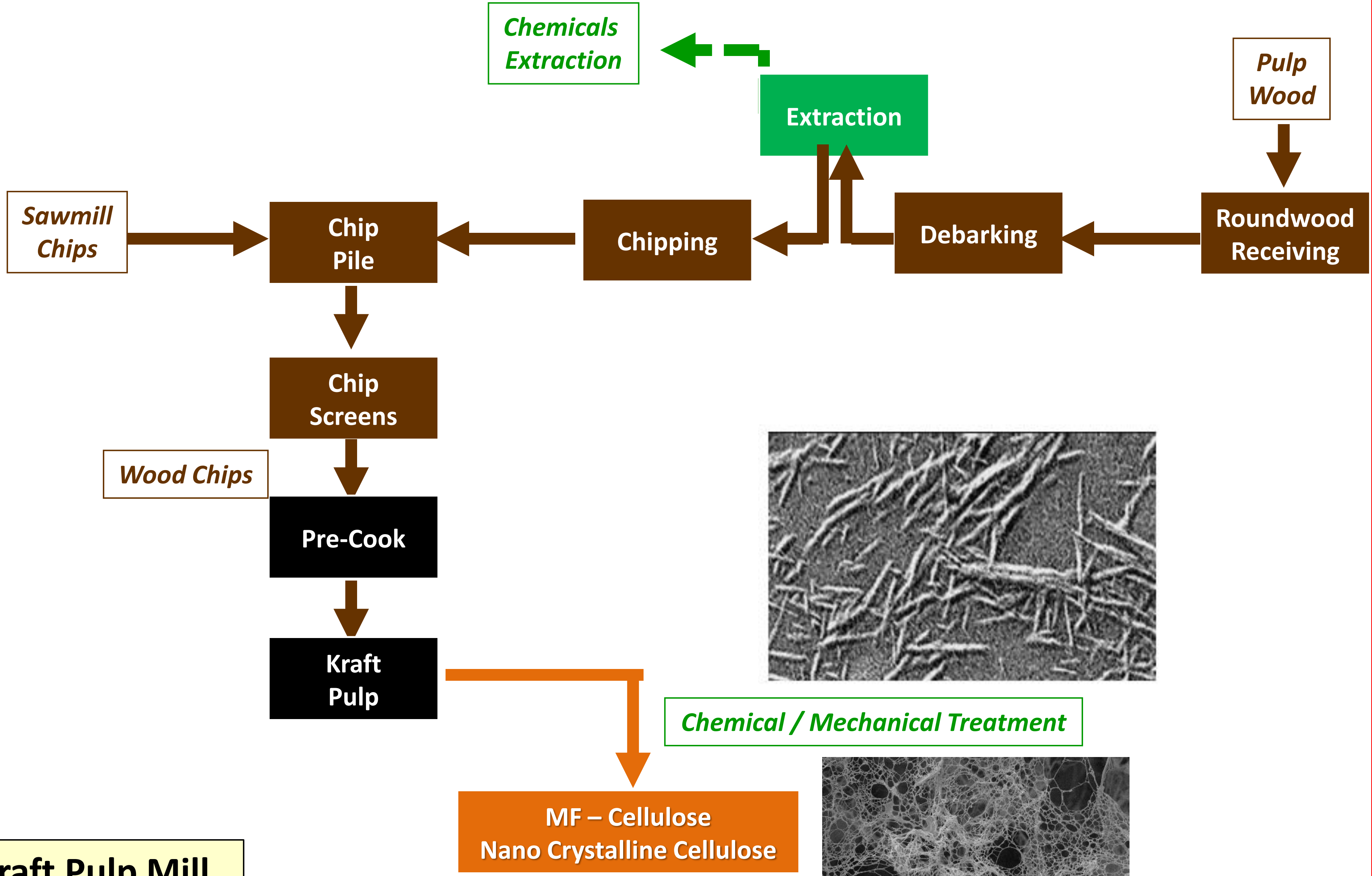


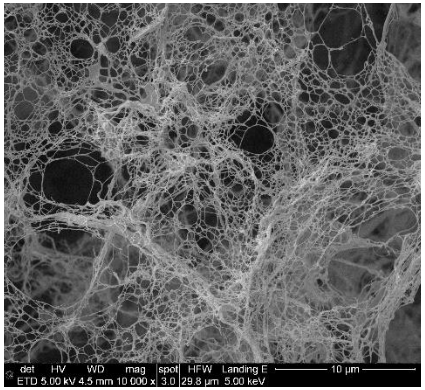
Kraft Pulp Mill integrated with Bioenergy and Biomaterials


Chemicals Extraction
Extraction
Pulp Wood
Sawmill Chips
Chip Pile
Chipping
Debarking
Roundwood Receiving
Sawdust
Chip Screens
Pre Treatment
Enzyme Hydrolysis
Ferment
Wood Chips
Purify
Residue
Phenolation to PF-Adhesive
Chemicals / Materials
Pelletizer
Carbon Fiber
Kraft Pulp Mill integrated with Bioenergy and Biomaterials



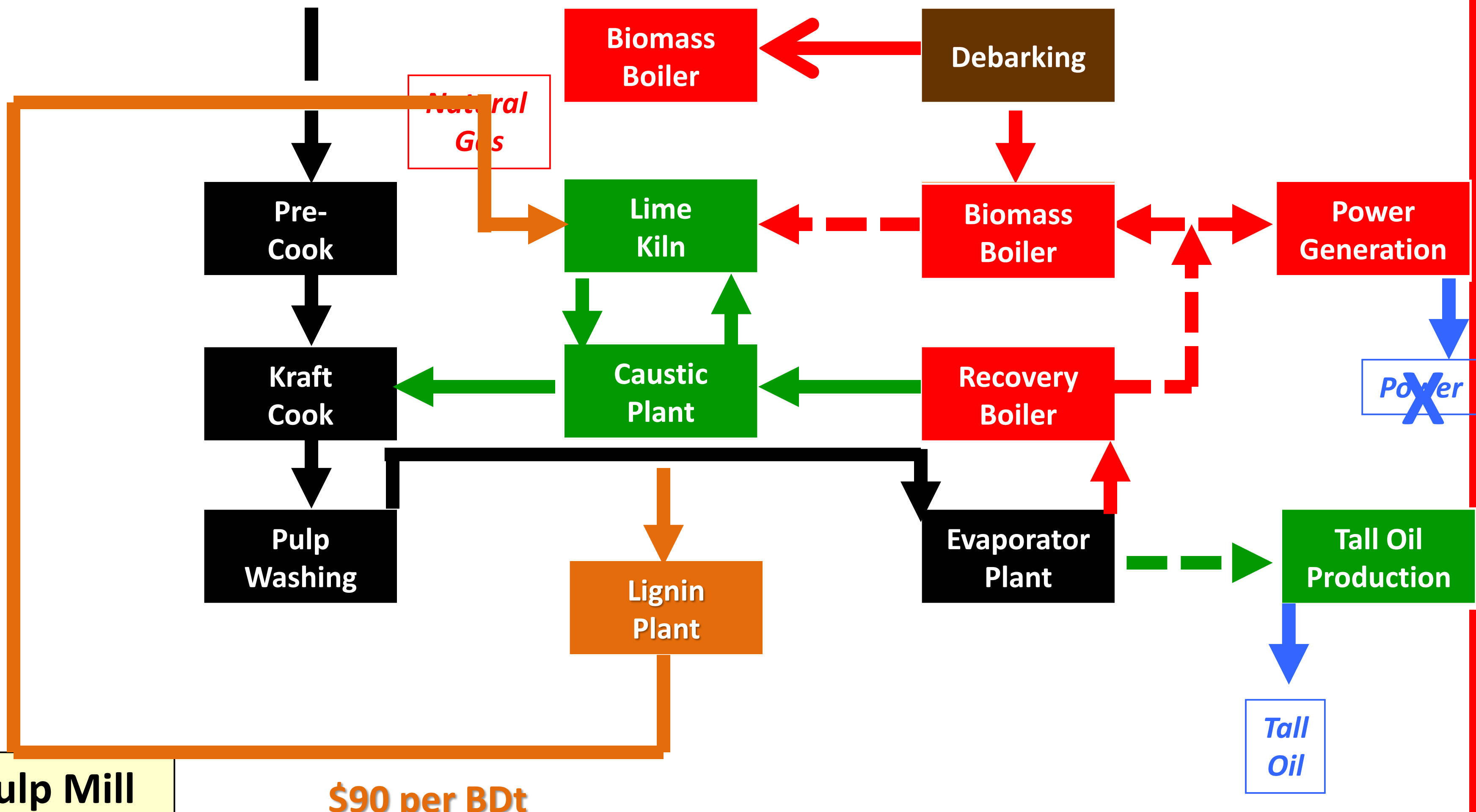
Kraft Pulp Mill integrated with Bioenergy and Biomaterials





Kraft Pulp Mill integrated with Bioenergy and Biomaterials

Lignin Recovery - Energy



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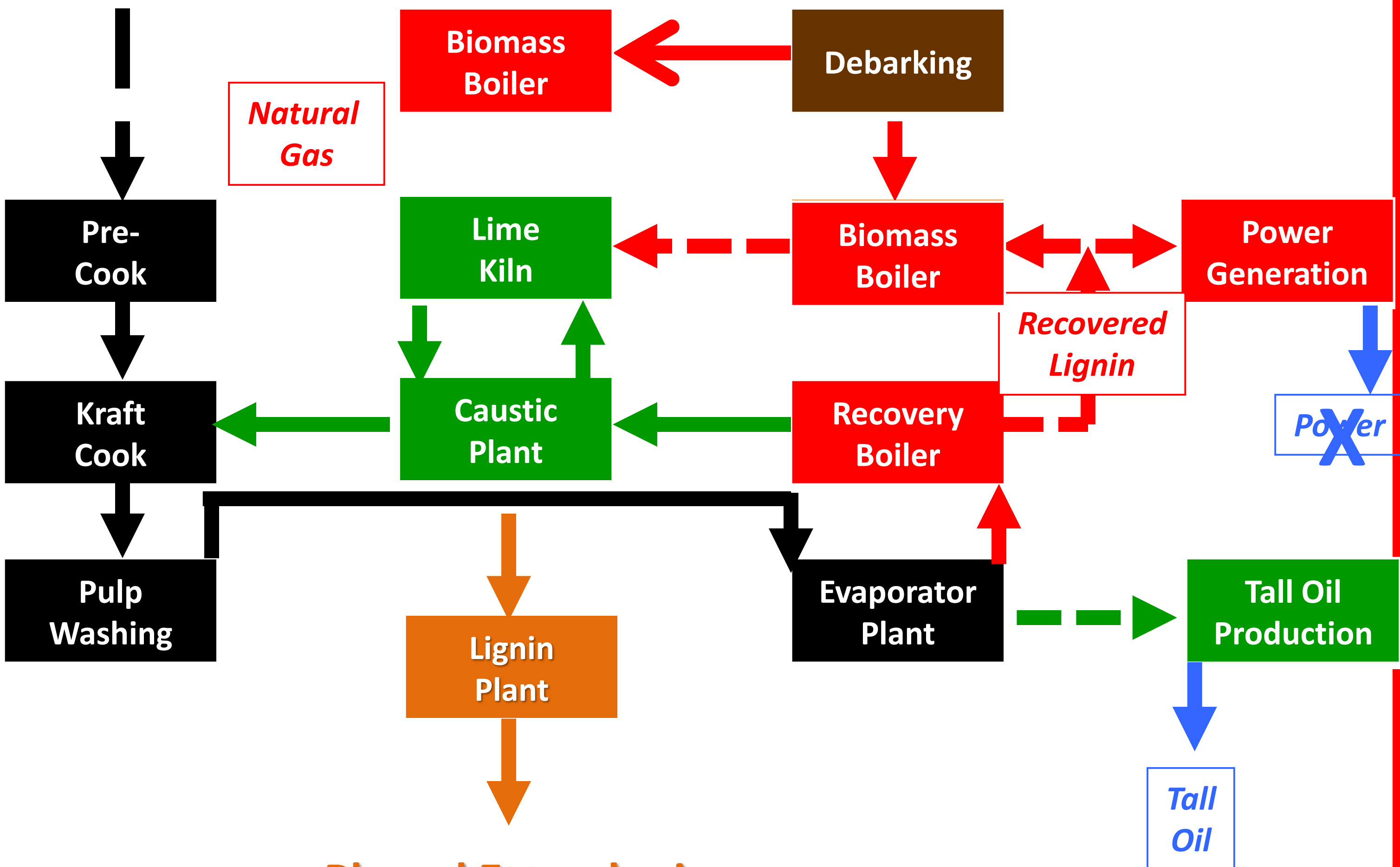
Lignin Recovery - Chemicals



Phenol Extender in Phenol-Formaldehyde Adhesives - $600 per BDt

Kraft Pulp Mill integrated with Bioenergy and Biomaterials

Example – Lignin Products

	Recovered Lignin Valued as Fuel Pellets - $150 per Ton			
	Base	5% Lignin Removal	10% Lignin Removal	20% Lignin Removal
Finished Tons per Year	1,069,461	1,099,836	1,130,786	1,199,318
Power Sales, $ per Year	$17,212,983	$15,060,444	$12,797,147	$7,873,528
Lignin Sales, $ per Year	$0	$5,331,677	$10,963,428	$23,255,757
Net Present Value, $	-$124,434,154	-$82,515,933	-$19,460,279	$150,388,200
IRR, %	8.94%	9.29%	9.84%	11.23%

Selling lignin in pellets better than burning and selling power

Example – Lignin Products

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Power Sales, $ per Year	$17,212,983	$15,060,444	$12,797,147	$7,873,528
Lignin Sales, $ per Year	$0	$21,326,708	$43,853,713	$93,023,028
Net Present Value, $	-$124,434,154	-$12,184,946	$125,161,210	$457,165,821
IRR, %	8.94%	9.90%	11.04%	13.62%

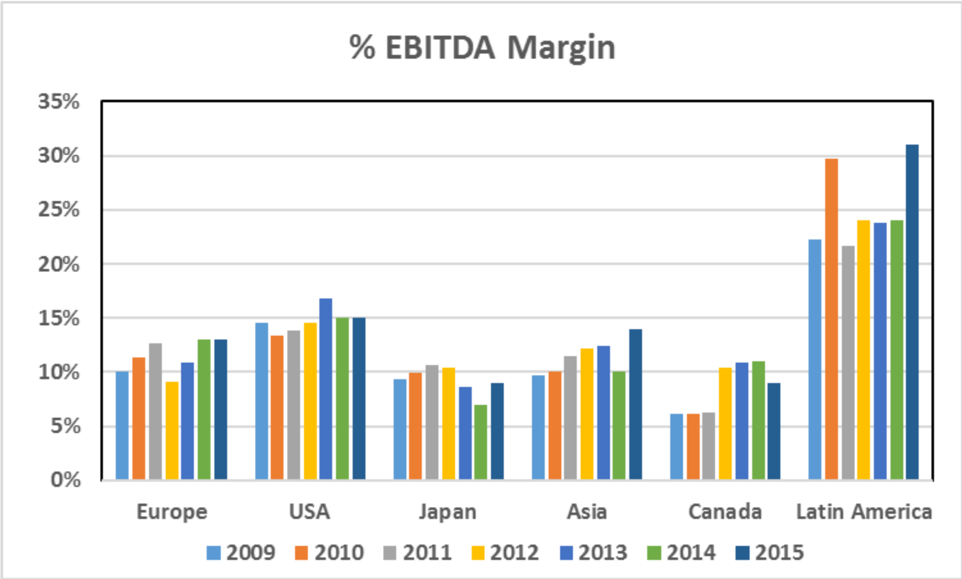
Selling lignin for chemical value can turn an unattractive pulp mill investment into one that can attract investor funding

Summing Up

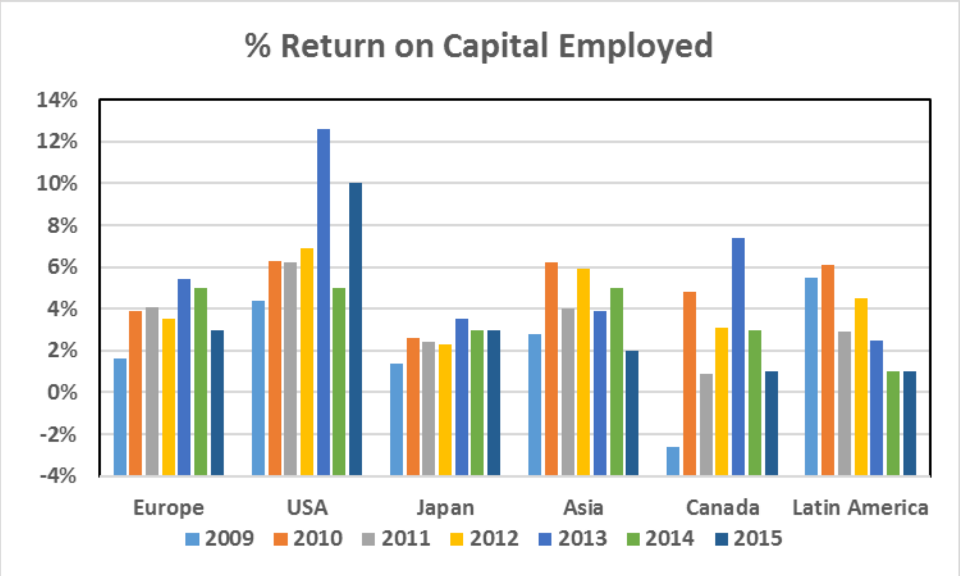
What does this mean for you?

- Tissue and Containerboard good growth and excellent returns
- Graphic papers (coated, uncoated, newsprint) will stabilize at about 50% of peak consumption
- Users of recovered papers be prepared for shortage and to pay more
- Users of bleached softwood pulp be prepared to pay more
- Freight will always provide a barrier to imports, but can be substantially lower cost difference than fiber
- No substitute for being low cost in the domestic market as protection against imports and potential

Final thing to keep in mind …



Latin America has had the best EBITDA Margin for the last 10 Years



USA has done the best job of investing while shareholders in Latin America are banks making slim margins