Global Scan of Forest Product Markets: Selected Shocks to International Trade

Prepared by Don Roberts
CEO, Nawitka Capital Advisors & RRI Fellow

MegaForestais Working Group
Lake Tahoe, U.S.A.
June 2023

Outline

1. Introduction
2. Wood Chips
3. Pellets
4. Market Pulp

Appendix A: Wood Chip Prices

Appendix B: Wood Pellet Market Forecast

Appendix C: Bio-Direct Air Capture

INTRODUCTION

This presentation focuses on shocks to the three forest products that are most widely traded in international markets: Wood chips, Pellets and Market Pulp.

The shocks in the markets for these products may have significant implications for the management of national forests around the world.

In terms of timing:

- The change in wood chip trade has already started and is on-going;
- The change in pellet trade is in the process of occurring; &
- The change in market pulp trade is likely to occur over the next ten years.

SHOCK 1: WOOD CHIP MARKET

Secular changes in the demand for pulp & paper products have caused a structural change in the global wood chip market.

WOOD CHIP MARKET

Global trade in wood chips reached an all-time high of 37 million BDMT (Bone Dry Metric Tonne) in 2022. It was driven by strong prices for pulp & paper, which are now in the process of weakening.

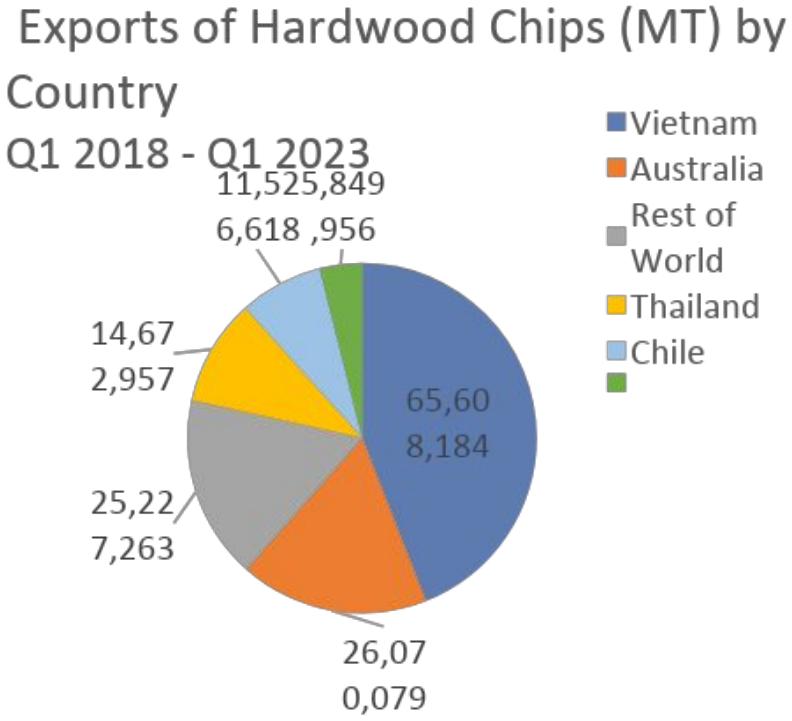
Exports of hardwood chips are over 3.5x that of softwood chips.

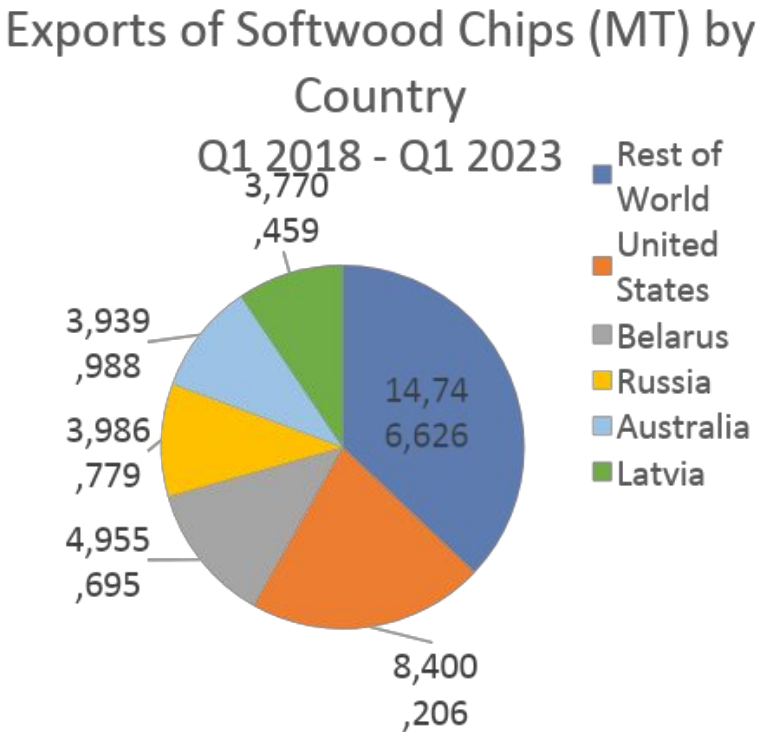
Figures 1 and 2 highlight the key exporters and importers of chips.

- For hardwood chips, the two biggest exporters are Vietnam & Australia, and the two biggest importers are China & Japan.

- For softwood chips, the biggest exporters are the U.S. & Belarus, and the two biggest importers are Japan & Finland.

FIGURE 1
Global Exports of Wood Chips

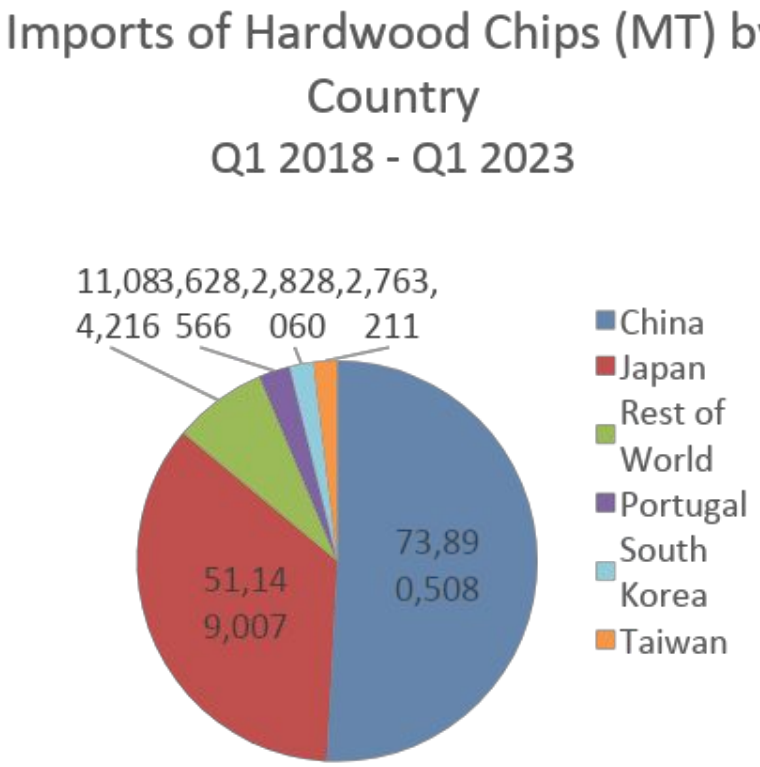


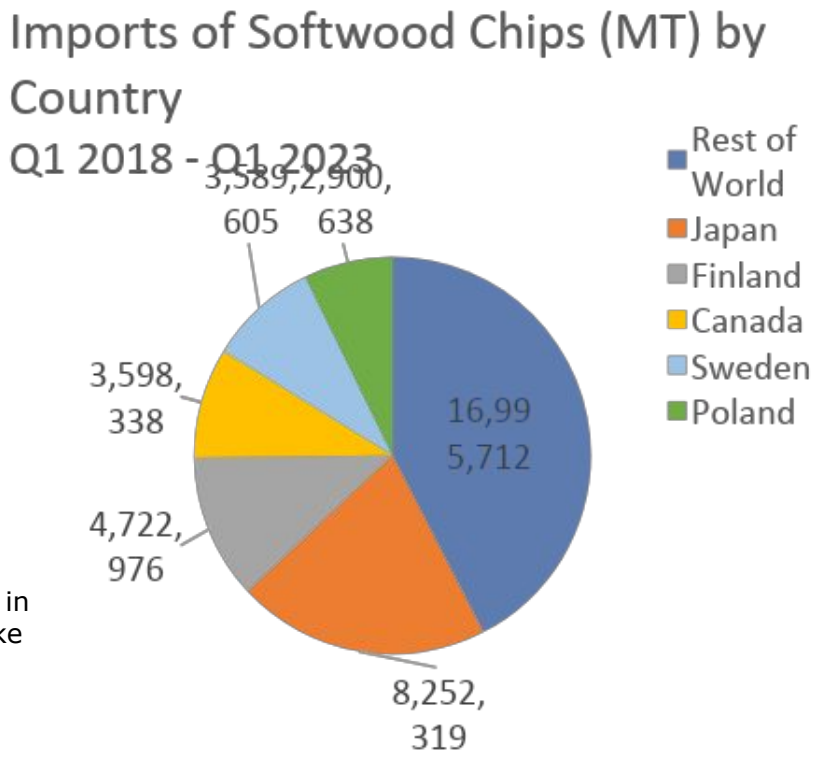


NOTE: Due to unusually high volatility in 2021/22 in trade, data is taken over a five year period to make the trade patterns more representative.

Source: WoodMarket Prices data

FIGURE 2:
Global Imports of Wood Chips





NOTE: Due to unusually high volatility in 2021/22 in trade, data is taken over a five year period to make the trade patterns more representative.

Source: WoodMarket Prices data

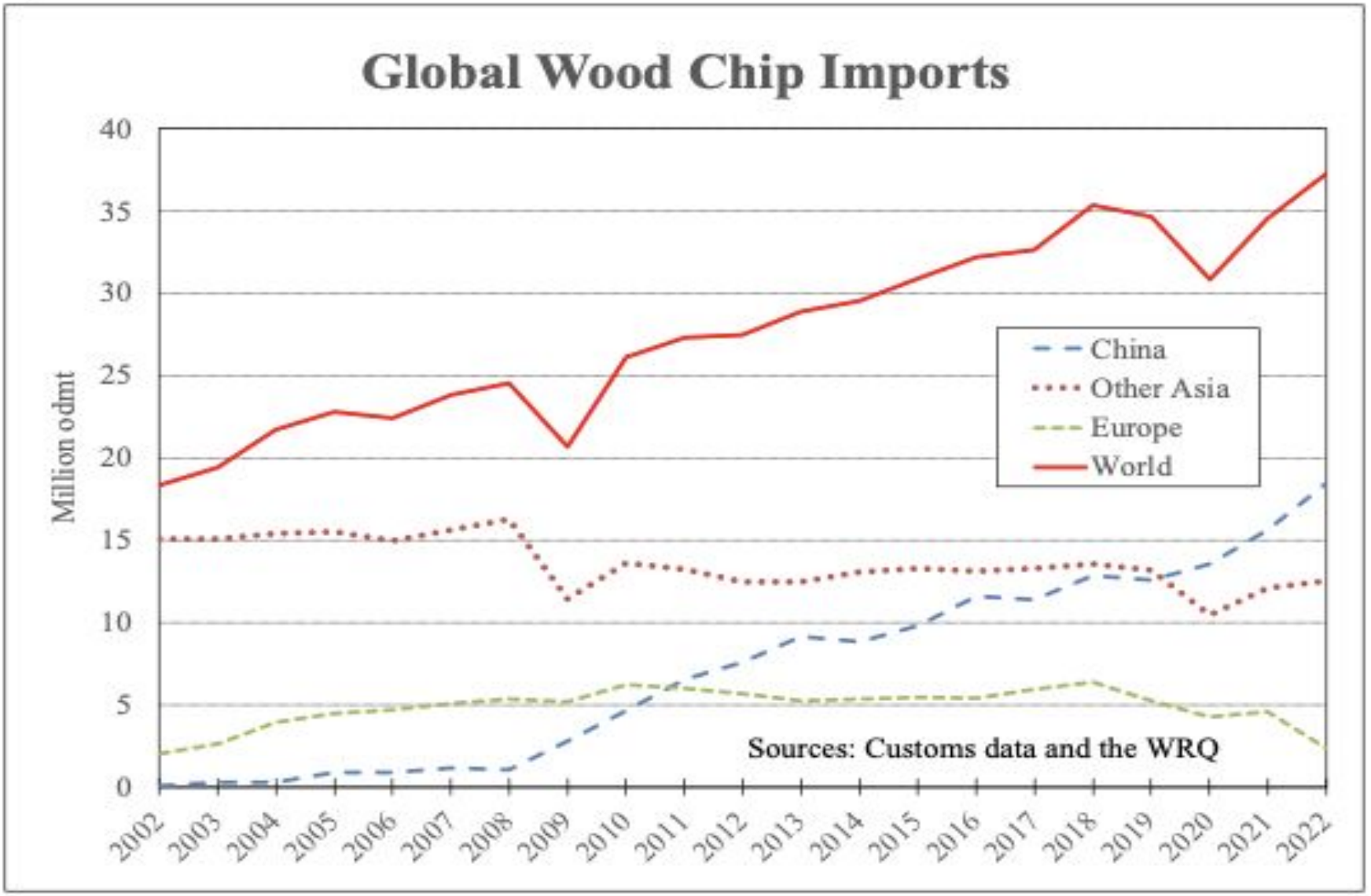
WOOD CHIP MARKET

- Between 2008 and 2022, softwood chip trade fell from 7.2 to 6.2 million bdmt, while hardwood trade almost doubled from 17.3 to 31.2 million BDMT. Much of the change in wood fiber preference has been driven by reduced consumption of newsprint and other communication papers, and the growing hygiene products markets where hardwood pulp is favored.

- China has continuously been the growth market for woodchip imports since the country first built a world-class pulp mill in 2007/08.

- The global trade of wood chips, excluding imports to China, has actually declined in the past decade. (see Figure 3).

FIGURE 3


Global Wood Chip Imports
Million odmt
40
35
30
25
20
15
10
5
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
China
Other Asia
Europe
World
Sources: Customs data and the WRQ

WOOD CHIP MARKET - SUMMARY

Fundamental changes in the demand for pulp & paper products have caused a structural change in the global wood chip market.

Implications:

- The volume of trade in hardwood chips is much larger than for softwood chips, and this generally favors developing countries
- Exports of wood chips are only growing because of rising demand from China.

SHOCK 2: PELLET MARKET

War in Ukraine & associated trade sanctions is the on-going shock to the global pellet market.

WOOD PELLET MARKET

Global trade in wood pellets reached an all-time high of just over 45 million BDMT in 2022, driven by the desire to reduce the consumption of fossil fuels.

Wood pellets are mainly made from the by-products of traditional forestry operations such as sawmills and finished wood products manufacturing. Harvest residues are also used as raw material though to a much lesser extent.

The main reason to pelletize biomass is to make it easier to handle & cheaper to transport long distances. If wood residues are consumed locally there is little reason to incur the extra cost of converting them to pellets.

WOOD PELLET MARKET

- By far the majority of global pellet consumption occurs in Western Europe and Eastern Asia.

- The pellet market is segmented into the heating market and the power market. (See Figure 4)

    - The heating market almost doubled in size from 2012 to 2021. Demand is mainly residential in nature, and located in Western Europe.

    - The industrial power market has grown even faster, with a 3.7x increase over the same period. Demand is mainly located in Europe, Japan and S. Korea.

FIGURE 4:
Global Wood Pellet Demand and Estimated Supply

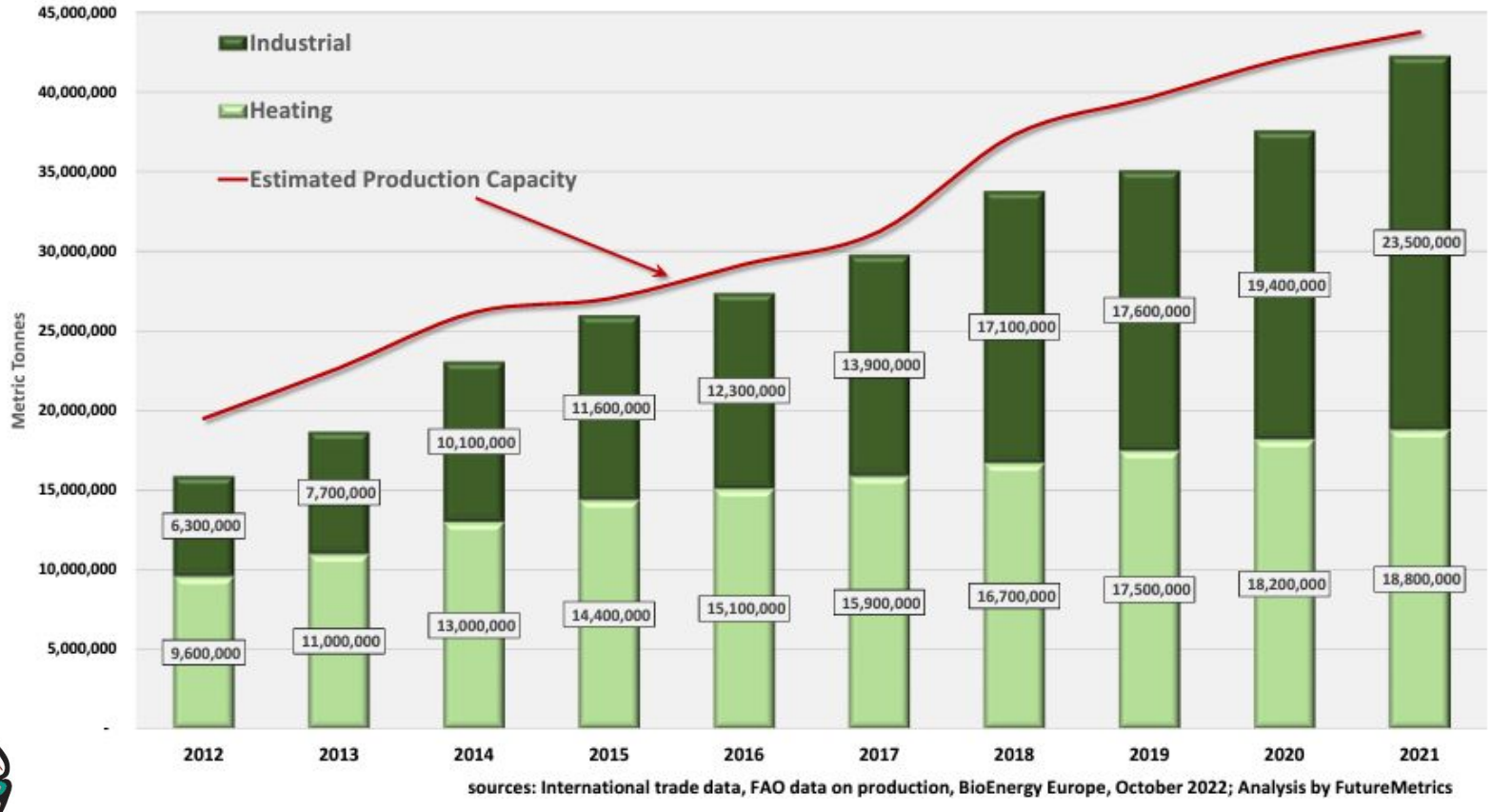
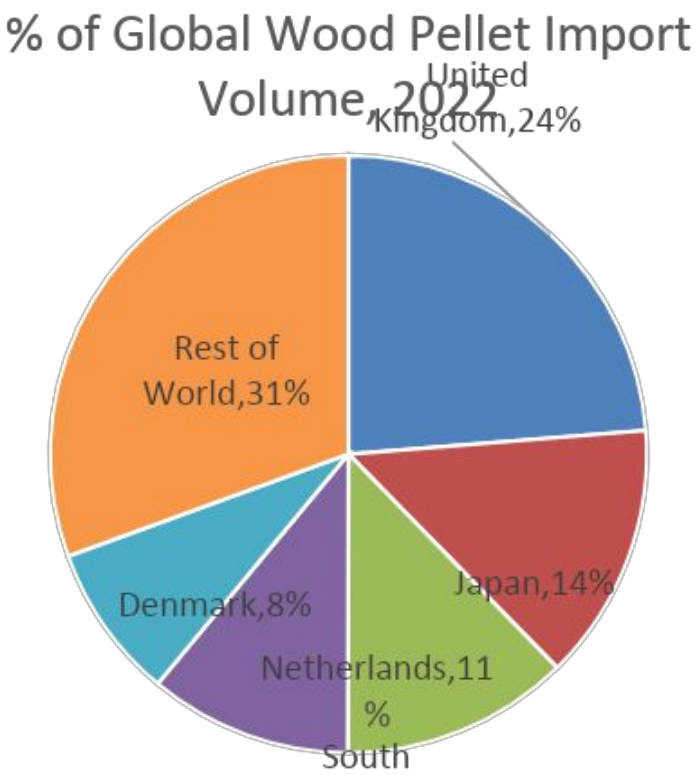


FIGURE 5



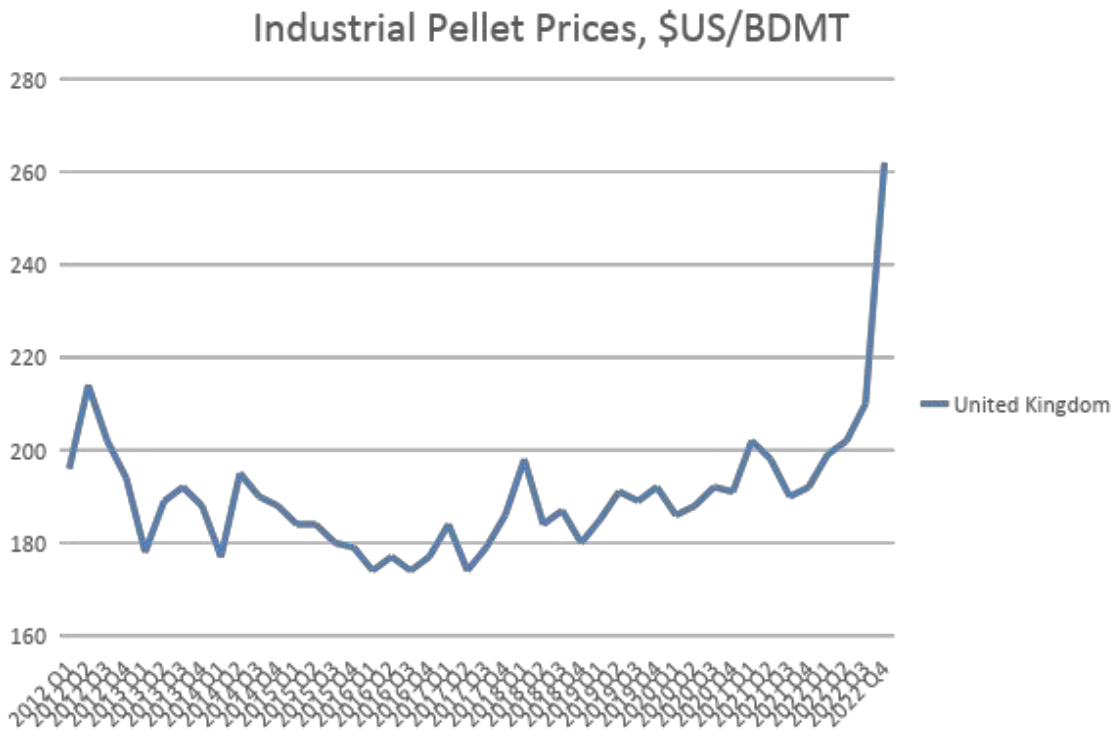
Source: WoodMarket Prices data

Country	2022 Imports (MT)	CAGR 2012-2022
United Kingdom	75,156,940	15.87%
Japan	44,074,060	45.36%
South Korea	39,171,969	37.03%
Netherlands	34,843,665	11.69%
Denmark	26,596,383	2.50%
Rest of World	96,715,400	3.73%

The UK is the largest national market for pellets, with Japan and S. Korea being the 2nd and 3rd largest.

Asian imports have been growing by far the fastest, and this is expected to continue.

FIGURE 6



Source: WoodMarket Prices data

- Pellet prices remained relatively stable over the period 2012-2021.
- However, prices spiked up sharply (+36%) in 2022 and reached a historical high of $262/BDMT in 1Q2023.

WOOD PELLET MARKET

- The catalyst for the rapid price increase in 2022 was the War in Ukraine and associated trade sanctions on Russia and Belarus. (See Figures 7 and 8).

- These three countries accounted for 11.3% of global pellet exports in 2021, and this dropped to 2.6% in 2022.

- The gap in the market has initially been filled with higher cost pellets from the U.S., Canada and Vietnam.

- An important source of uncertainty in the pellet market is when/if these countries re-enter the global market. Even if they do, responses in the interim are expected to result in permanent changes in the market.

FIGURE 7:

Major Exporting Regions Annual Exports: 2012-2022 (BDMT))

	2012	CAGR 2012 to 2021	% of Market in 2021	2022	%of Market in 2022
US	7,447,183	14.6%	24.4%	8,977,162	30.4%
Russia, Belarus, Ukraine	3,440,109	38.6%	11.3%	772,407	2.6%
Vietnam	3,215,665	60.1%	10.5%	3,935,269	13.3%
Canada	3,153,192	8.7%	10.3%	3,492,510	11.8%
Baltics	4,672,240	9.3%	15.3%	3,557,115	12.1%
Rest of world	8,571,611	8.7%	28.1%	8,759,925	29.7%

Source: WoodMarket Prices data

FIGURE 8:

Wood Pellet Exports from Russia

Source: WoodMarket Prices data

WOOD PELLET MARKET - SUMMARY

The war in Ukraine and associated trade sanctions is having an impact on a range of global forest product markets. However, the largest impact is arguably on the pellet market.

Pellet prices are expected to fall from their current all-time highs, but are likely to normalize at a meaningfully higher level than what existed pre-2022.

Implications:

- Stimulate supply from both traditional (North America) and nontraditional sources (South America, S.E. Asia & Africa).
- Due to significant concerns in major consuming markets, all producing regions will be under close scrutiny to ensure that the biomass is sourced sustainably.
- Potential for biomass going to higher value-added forest products being bid away due to a superior Return on Capital for pellets?

SHOCK 3: PULP MARKET

Emergence of Direct Air Capture of Carbon technologies is the impending shock to the global pulp market.

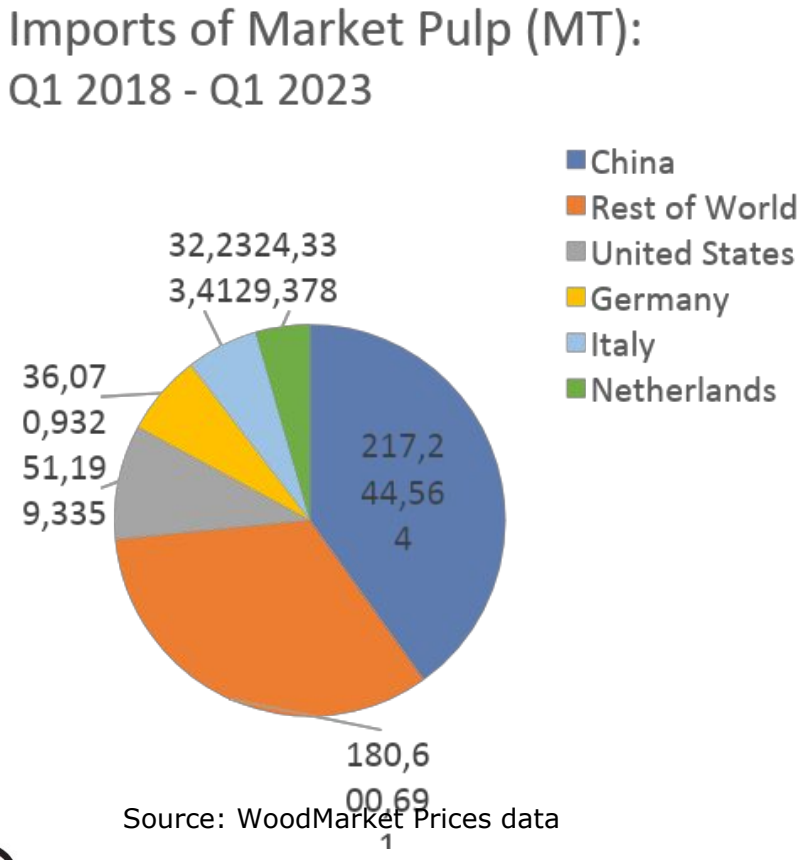
PULP MARKET

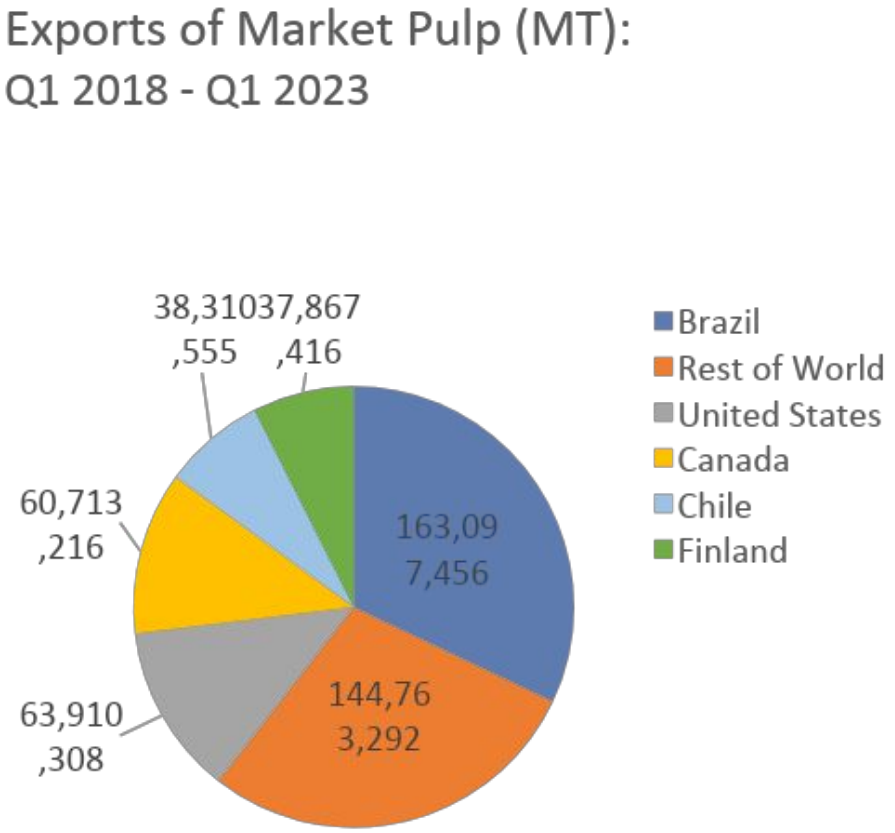
Before discussing Direct Air Capture projects, it is important to first identify the key countries involved in the global market for pulp which will be ultimately affected.

Figure 9 summarizes the key exporters and importers of market pulp.

- The two biggest exporters are Brazil & U.S.
- The two biggest importers are China & US
- The U.S. tends to export softwood pulp and import hardwood pulp.

FIGURE 9
Global Imports & Exports of Pulp





Source: WoodMarket Prices data

NOTE: Due to unusually high volatility in 2021/22, data is taken over a five year period to make the trade patterns more representative.

PULP MARKET

The voluntary carbon market is placing increasing value on projects that result in Carbon Dioxide Removal (as opposed to Carbon Offsets), and make a greater move toward net negative emissions.

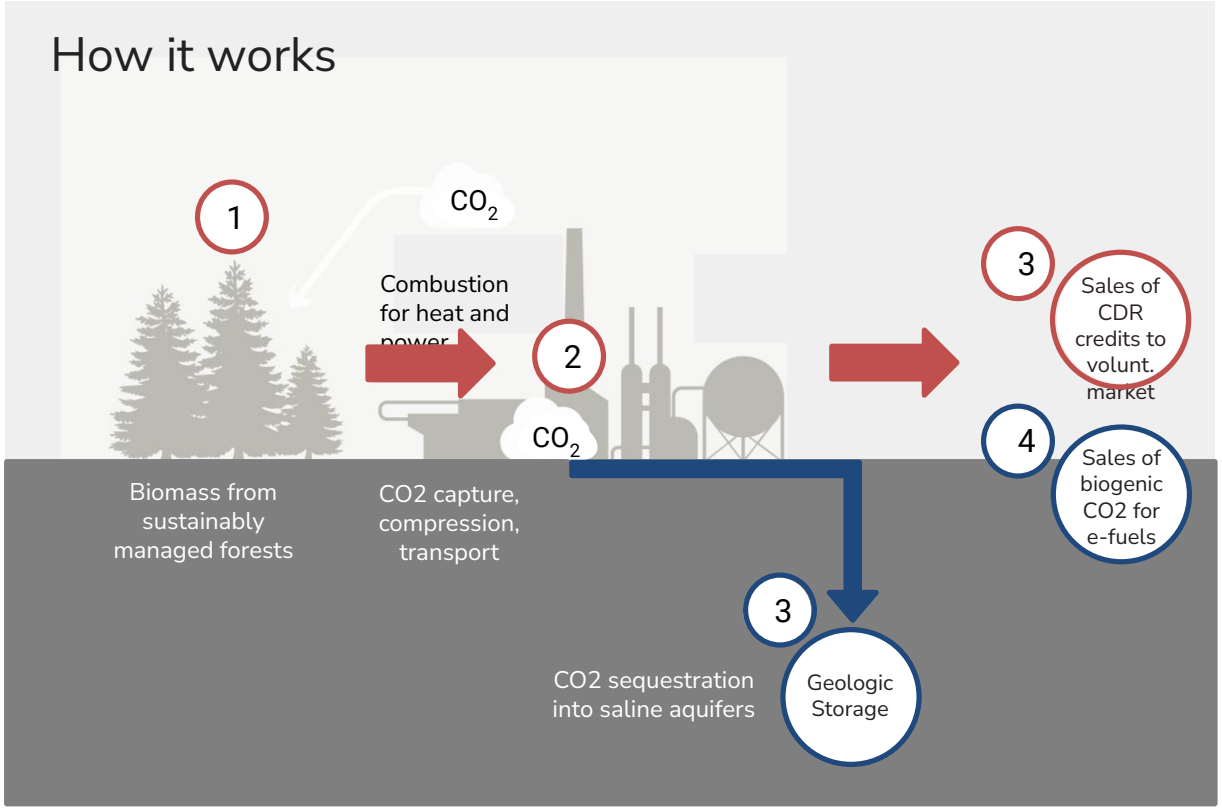
Removing biogenic carbon emissions (as opposed to fossil-based emissions) is especially attractive because it makes a greater contribution toward the goal of Net Zero Emissions.

Biogenic Carbon Capture (BioDAC) projects in the pulp & paper industry are particularly interesting since:

- Roughly 75% of the sector's emissions are in the form of biogenic carbon (assuming the forest resource is sustainably managed).
- They provide a concentrated source of biogenic emissions.

.

Bio-**D**irect **A**ir **C**apture (DAC): Pulling CO2 from the Atmosphere



BioDAC is biogenic industrial point source carbon capture & storage or use.

FIGURE 10

1. Atmospheric CO2 is absorbed by trees in sustainably managed forests.
2. Waste biomass is combusted to make heat & power for mill operations. That CO2 is captured.
3. The CO2 is sequestered, and the credits are sold to buyers in the voluntary carbon market + 45Q

or

4. Biogenic CO2 is sold for e-fuels production

PULP MARKET

By far the largest concentrated sources of biogenic carbon are Pulp & Paper mills.

- If just fossil-based CO2 emissions are considered in the U.S., Pulp & Paper mills correspond to roughly 20% of the those from Oil refineries. This rises to ~85% when biogenic carbon is also considered.

- For Canada, the corresponding figures are roughly 50% and 235%, respectively.

- When adding biogenic carbon emissions, the increase should also be particularly high in Brazil & Scandinavia where the Pulp & Paper sector is a relatively large contributor to the national economy.

PULP MARKET

BioDAC is on the verge of becoming commercial due to a combination of:

- Improved Carbon Capture technologies
- Generous government incentives in certain countries (eg., Q45 Production Tax Credit in the U.S).
- Development of CO2 pipelines and emerging DAC to e-fuels technologies which allow the source and storage of the carbon to be geographically separated.

PULP MARKET

BioDAC is as effective as DAC, but at a fraction of the cost (<$100 vs $400-$1000/tonne), and less energy intensive.

EXAMPLE PROJECT:

Proposed Bio-DAC project storing 600,000 tpy of carbon at a pulp mill in the U.S. South (see Figure 11):

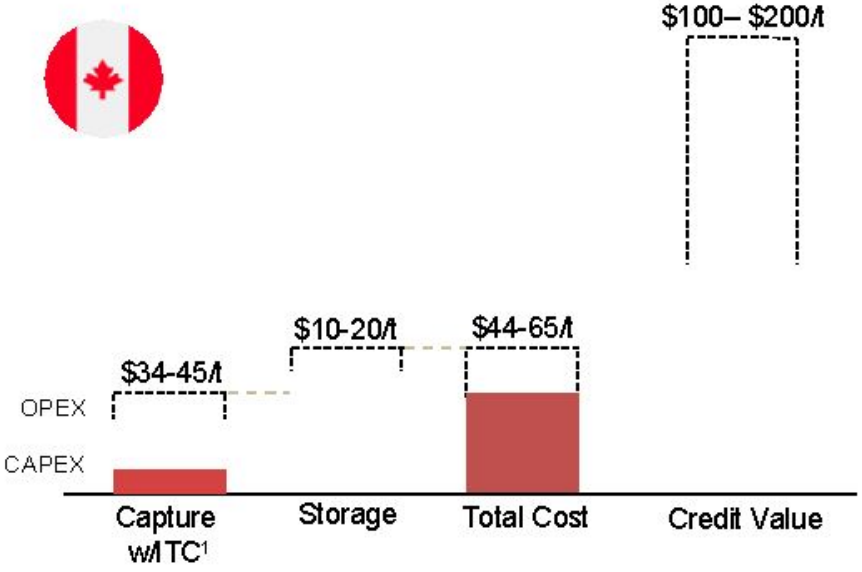
- Total cost ~$75/tonne (= Cap Ex + Op Ex + Storage)
- Total revenue ~$210/tonne (= $85 from 45Q Production Tax Credit + $125 in carbon credits.)
- Internal Rate of Return > 40%

FIGURE 11

High-level Bio-DAC Project Economics

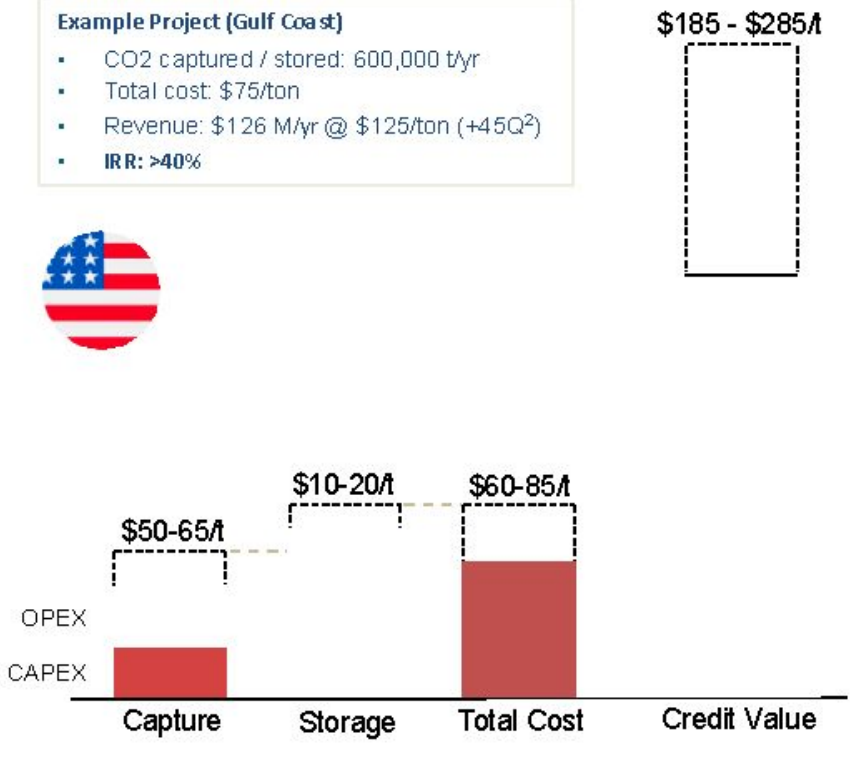
Example Project (Alberta)

- CO2 captured / stored: 770,000 t/yr
- Total cost: $52/ton (incl. 50% CCUS ITC[1])
- Revenue: $96 M/yr @ $125/ton
- **IRR: >30%**



Example Project (Gulf Coast)

- CO2 captured / stored: 600,000 t/yr
- Total cost: $75/ton
- Revenue: $126 M/yr @ $125/ton (+45Q[2])
- **IRR: >40%**



(1) Canadian 50% Investment Tax Credit (ITC) for Carbon Capture Utilization and Storage (CCUS) projects with geologic storage
(2) US $85/t 45Q Production Tax Credit (PTC) requires projects to be under construction before 2033

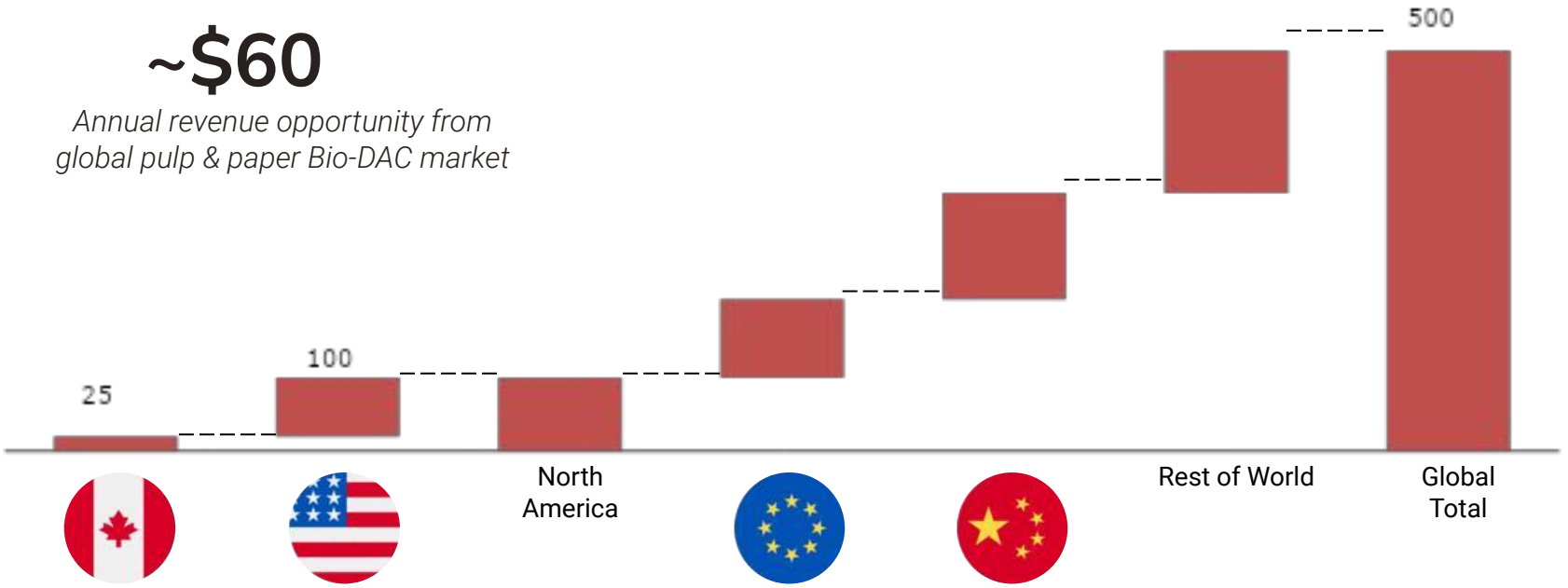
FIGURE 12

Global Pulp and Paper Market Opportunity

Millions of tonnes/yr of biogenic CO2

~$60

Annual revenue opportunity from global pulp & paper Bio-DAC market



Source: Fisher; US EPA; Canadian Government;

It is estimated that roughly 500 million tpy of biogenic carbon is emitted each year from the global pulp & paper industry.

Given $125/tonne, this suggests ~$60 billion in revenue

Value Proposition of Bio-DAC (**D**irect **A**ir **C**apture) for Pulp and Paper

☑ Increases revenue & profits	Adding large, green revenue streams (up to 20% increase in top line revenue), improves profitability and competitiveness
☑ Diversifies revenue	Diversifying more stable carbon revenue, reduces the impact of fluctuations in pulp and paper commodity prices
☑ Reduce carbon intensity	Reducing the carbon intensity of pulp and paper products, may enhance market access, product differentiation, and pricing
☑ Carbon tax hedge	Decarbonizing operations provides a natural hedge against the impact of carbon taxes and/or other carbon liabilities
☑ Accelerates ESG goals	Rapid, large-scale CO2 reduction accelerates ESG/sustainability goals; opportunity to differentiate "*carbon negative*" facilities

PULP MARKET

- CO280 is the leading developer of Bio-DAC projects, and it is initially focused on the Western Hemisphere. In Scandinavia, Sodra has partnered with Verdane and Equinor on a BioDAC project.

- Within 10 years we expect almost every pulp & paper mill that can economically deploy Direct Air Capture (DAC) of Carbon will have done so.

WOOD PULP MARKET - SUMMARY

Due to technological innovation and government incentives, there is a growing opportunity for pulp/paper mills to capture and store biogenic carbon over the next 10 years.

Implications:

- The forest sector's potential for contributing to the goal of Net Zero Carbon Emissions is bigger than many realize. This could meaningfully improve the Sector's "social license to operate".
- Direct air capture & storage of carbon promises to both improve the profitability of pulp/paper mills and stabilize their revenue through diversification.
- The market potential of Bio-DAC projects will only be realized if the underlying forest resource is sustainably managed…..global buyers of the associated carbon credits are insisting upon it.
- Given existing government incentives and CO2 pipelines, the pulp/paper industry in the South East United States is expected to be the first to benefit from this opportunity.

- .

APPENDIX A: Global Wood Chip Prices

WOOD CHIP PRICES

Figures A1 and A2 provide a comparison of regional prices for chips around the world as of 1Q2023, and give insight into which countries have a cost advantage/disadvantage in supplying this market.

In terms of softwood chip prices:

- At the high end are Finland, Sweden, Austria and Japan.
- At the low end are Northwest Russia, Eastern Canada, U.S. South, Brazil, Chile and New Zealand.

WOOD CHIP PRICES

- In terms of hardwood chip prices:
  - China, Japan and Germany are at the high end.
  - Northwest Russia, Indonesia, Brazil are at the low end.
  - Given its dominant position in the pulp industry, it is worth focusing on Brazil. Fibre prices in Brazil are by far the most volatile of any producing country. After hitting a 20-year low in late 2020, pulplog prices have risen 76% in U.S$ terms (71% in the Real). The increase is driven by increased competition for logs, longer transportation distance and higher labor costs. Current price levels in Brazil are now close to their 20-year average.

FIGURE A2

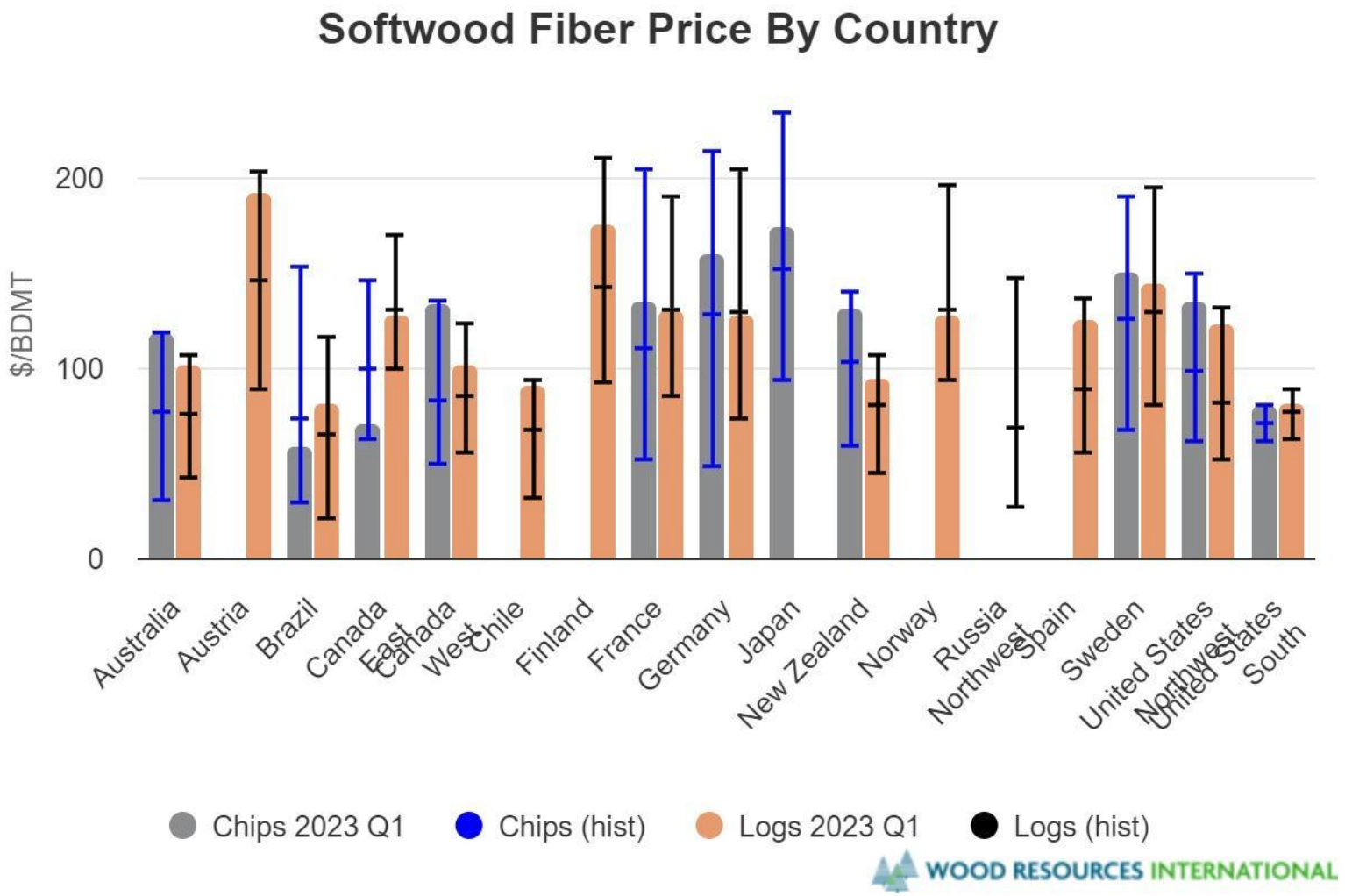
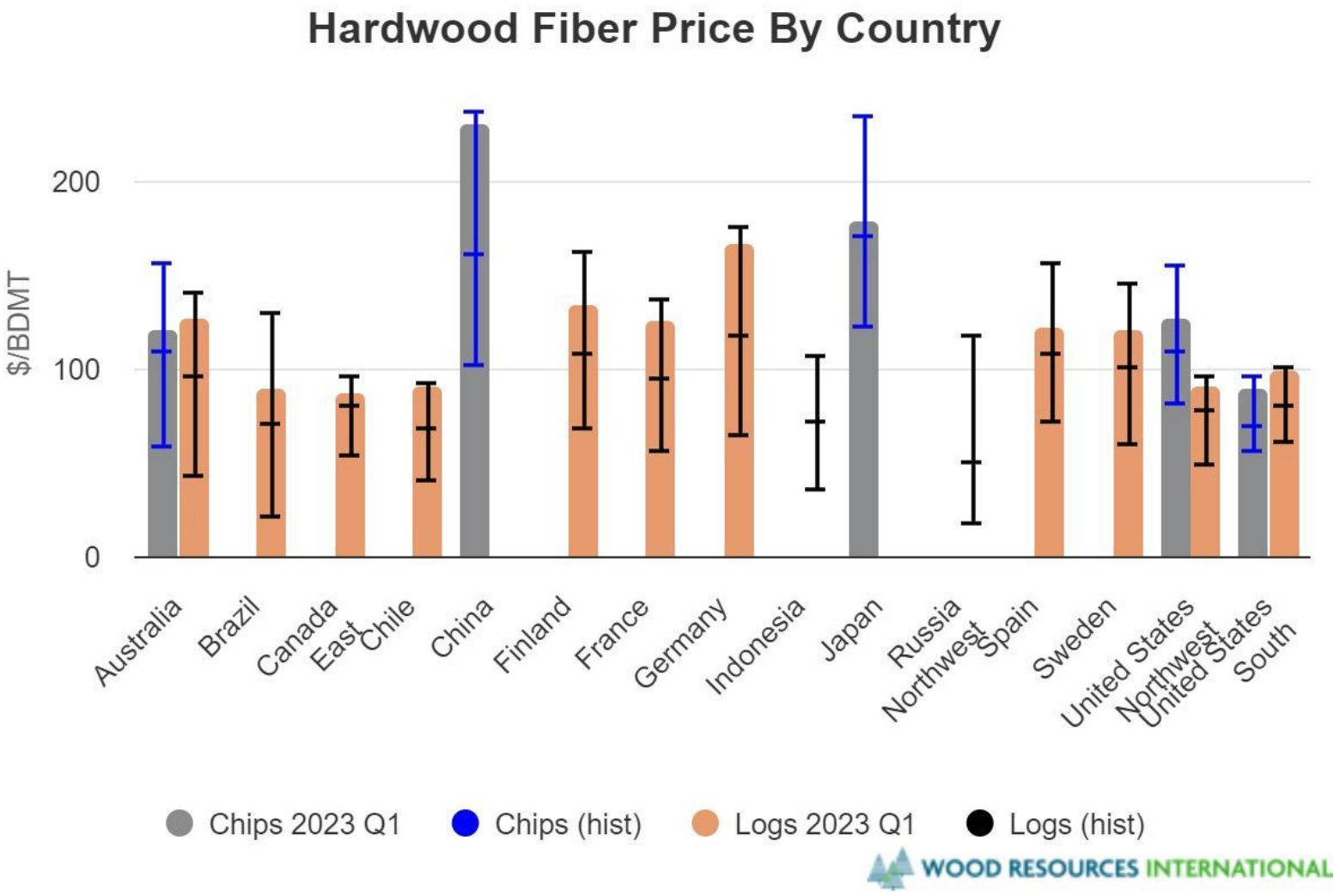

Softwood Fiber Price By Country
$/BDMT
200
100
0
Australia
Austria
Brazil
Canada East
Canada West
Chile
Finland
France
Germany
Japan
New Zealand
Norway
Russia
Northwest
Spain
Sweden
United States
Northwest
United States
South
Chips 2023 Q1
Chips (hist)
Logs 2023 Q1
Logs (hist)
WOOD RESOURCES INTERNATIONAL

FIGURE A1


Hardwood Fiber Price By Country
$/BDMT
200
100
0
Australia
Brazil
Canada East
Chile
China
Finland
France
Germany
Indonesia
Japan
Russia
Northwest
Spain
Sweden
United States
Northwest
United States
South
Chips 2023 Q1
Chips (hist)
Logs 2023 Q1
Logs (hist)
WOOD RESOURCES INTERNATIONAL

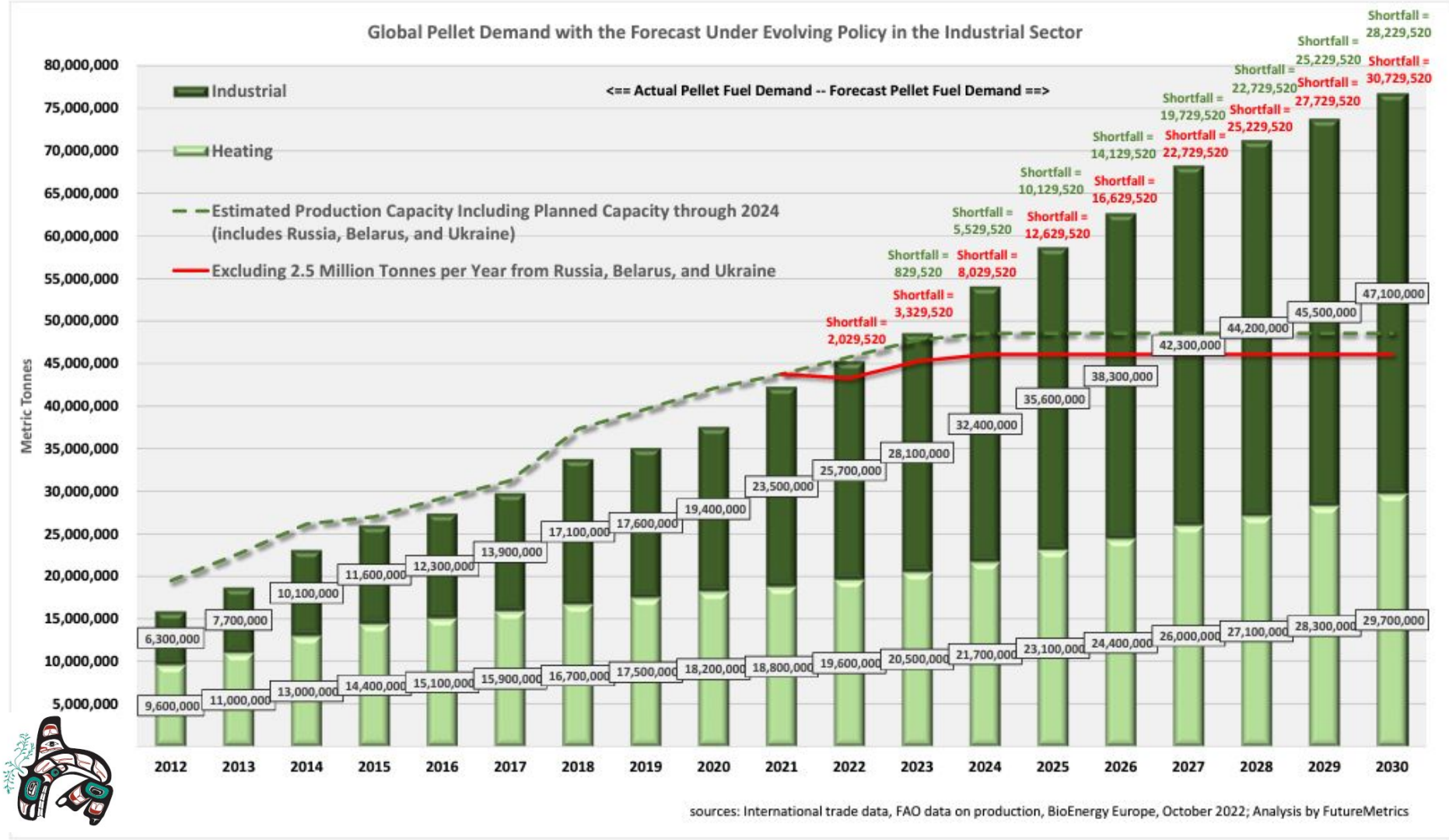
APPENDIX B: Wood Pellet Market Forecast

WOOD PELLET MARKET

- The consultancy FutureMetrics has modelled the global wood pellet market through 2030, with the highlights of the forecasts as follows*:
  - Demand for pellets for fuel is expected to grow roughly 70% between 2022 and 2030, exceeding 75 million BDMT by the end of the decade.
  - Pellet capacity will have to grow by ~30 million BDMT to satisfy demand.
  - By 2030, roughly 60% of the total is expected to be used for Industrial Power and 40% for Residential Heating.

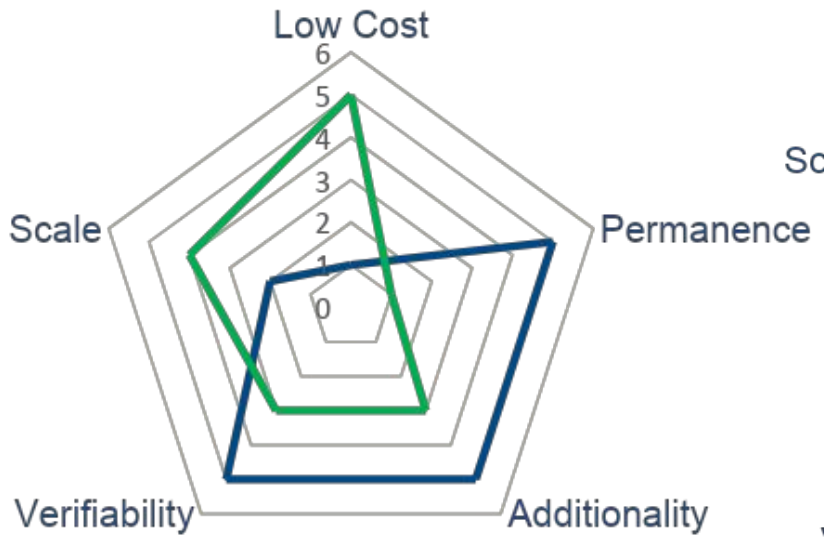
*Source: *Global Wood Pellet Fuel Markets in 2022: Supply Shock!,* October 31,2022, FutureMetrics LLC

FIGURE B1

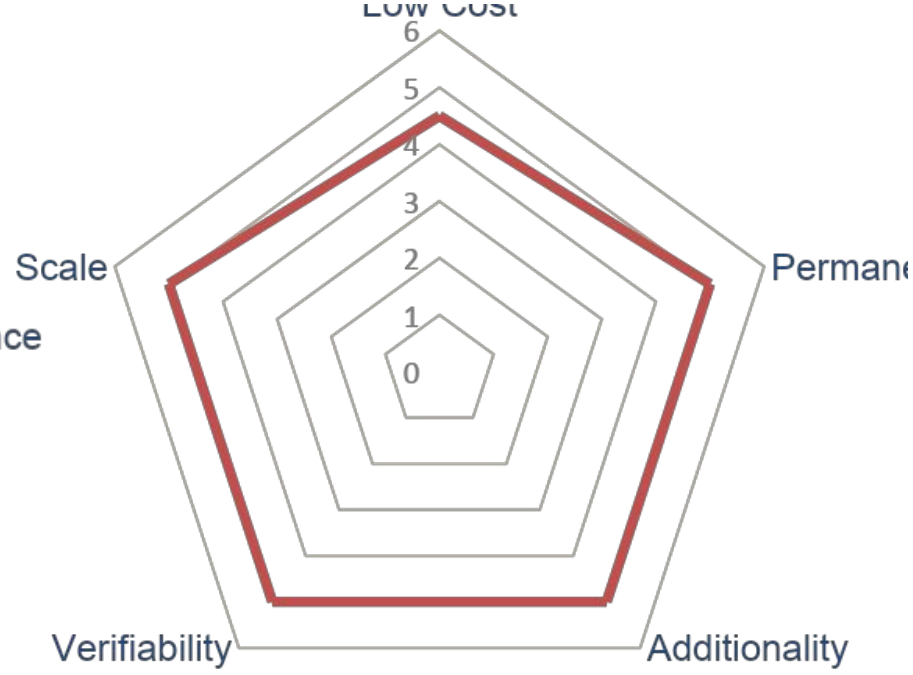

Global Pellet Demand with the Forecast Under Evolving Policy in the Industrial Sector
Industrial
Heating
Estimated Production Capacity Including Planned Capacity through 2024 (includes Russia, Belarus, and Ukraine)
Excluding 2.5 Million Tonnes per Year from Russia, Belarus, and Ukraine
<== Actual Pellet Fuel Demand -- Forecast Pellet Fuel Demand ==>
Metric Tonnes
80,000,000
75,000,000
70,000,000
65,000,000
60,000,000
55,000,000
50,000,000
45,000,000
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
6,300,000 7,700,000 10,100,000 11,600,000 12,300,000 13,900,000 17,100,000 17,600,000 19,400,000 23,500,000 25,700,000 28,100,000 32,400,000 35,600,000 38,300,000 42,300,000 44,200,000 45,500,000 47,100,000
9,600,000 11,000,000 13,000,000 14,400,000 15,100,000 15,900,000 16,700,000 17,500,000 18,200,000 18,800,000 19,600,000 20,500,000 21,700,000 23,100,000 24,400,000 26,000,000 27,100,000 28,300,000 29,700,000
Shortfall = 2,029,520
Shortfall = 829,520
Shortfall = 3,329,520
Shortfall = 5,529,520
Shortfall = 8,029,520
Shortfall = 10,129,520
Shortfall = 12,629,520
Shortfall = 14,129,520
Shortfall = 16,629,520
Shortfall = 19,729,520
Shortfall = 22,729,520
Shortfall = 22,729,520
Shortfall = 25,229,520
Shortfall = 25,229,520
Shortfall = 27,729,520
Shortfall = 28,229,520
Shortfall = 30,729,520
sources: International trade data, FAO data on production, BioEnergy Europe, October 2022; Analysis by FutureMetrics

The market wants permanent, high quality, low cost, Carbon Dioxide Removal at scale

Current

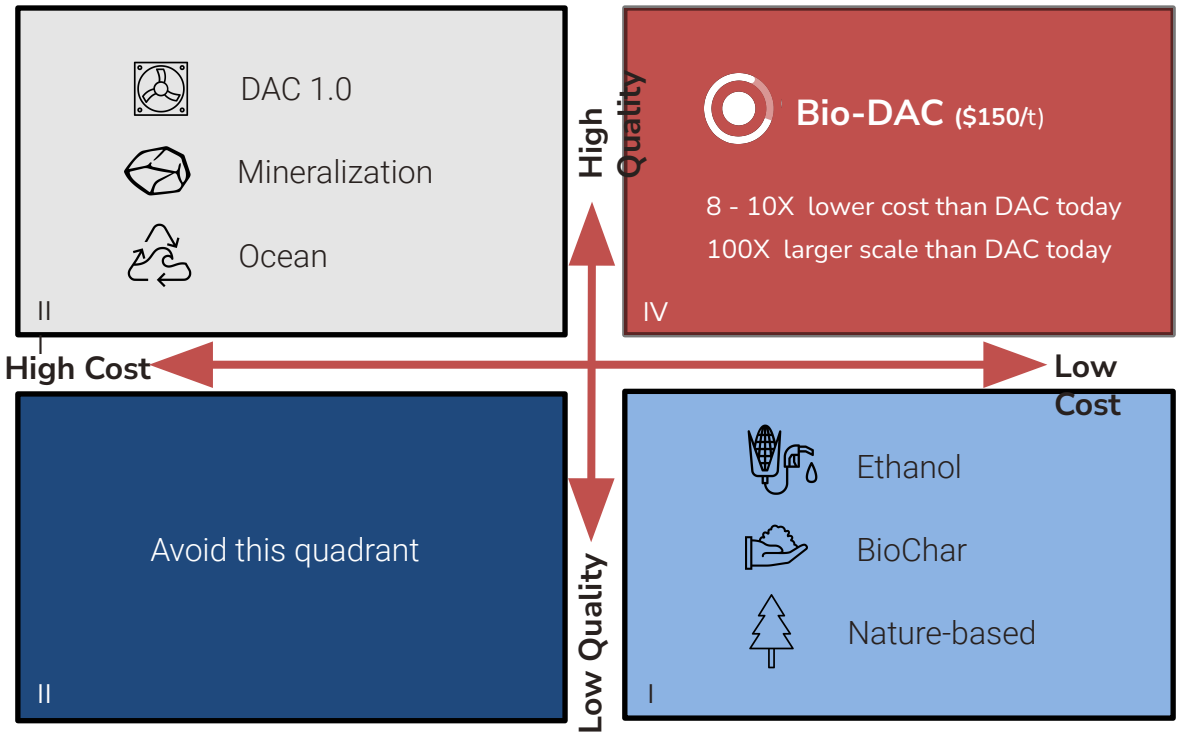


Bio-DAC



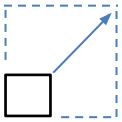
Technical DAC Nature Based Solutions CO280

Pulp & Paper is Uniquely Positioned



- Pulp & paper is uniquely positioned to supply the market with low-cost, high quality Carbon Dioxide Removal at scale by adoption of CCS. This is called BioDAC.
- The CO2 can be sequestered in geologic storage or used to manufacture e-fuels
- Technologies such as Direct Air Capture (DAC), mineralization and ocean CO2 capture can meet the highest standards of quality, but are currently very expensive at >$500/tonne.
- Carbon credits from sources such as nature-based solutions (eg., avoided deforestation., biochar and ethanol are lower cost, but can also have low or questionable quality.

Bio-DAC is a new standard of Carbon Dioxide Removal (CDR)

	Storage permanence	Sustainability impacts	Scalability	Energy Use	Price per ton
Forests and soil	1-100 y	Food security risk Water intensive Land use		minimal	$20-$100*
Biochar	50-1000 y	Food security risk Water intensive Inconsistent + unknown ecosystem effects		medium	$100-$500*
DAC	10'000+ y	Substantial Energy use Low TRL		very high	$500-$2000
BECCS	10'000+ y	Food security risk Water intensive Feedstock acquisition/ forestry concerns		medium	$150-$350*
BioDAC	10'000+ y	No negative impact		low	$100-$200

* Price has gone up ~30% in the past year

Bio-DAC applications: Storage and e-fuels

1. Bio-DAC to geological storage (IMMEDIATE)

(where geological storage available)

CO2 Capture → CO2 Concentration & Compression → CO2 Transport and Geological Storage → Sell CO2 Credits to Voluntary Market

2. Bio-DAC to e-fuels (EMERGING)

(where geological storage is unavailable + access to low cost, green power)

CO2 Capture → CO2 Concentration & Compression → Sell Biogenic CO2 to e-fuel Producers → E-fuels Manufacturing