An Overview of the Use of Pellet Fuel to Replace Coal in Power Generation

William Strauss, President, FutureMetrics

June 8, 2023

FutureMetrics LLC ™

FutureMetrics provides due diligence services, information and analysis, operations guidance, and strategic advice.

FutureMetrics combines <u>decades of experience in the pellet sector</u> with deep operational expertise, powerful sector focused financial modeling skills, and thought leading market awareness.

An Important and Needed Component for the Decarbonization of the Power Generation Sector

—

Replacing Coal with Upgraded Sustainably Produced Solid Fuel

First, the reasons that
the decarbonization matters…

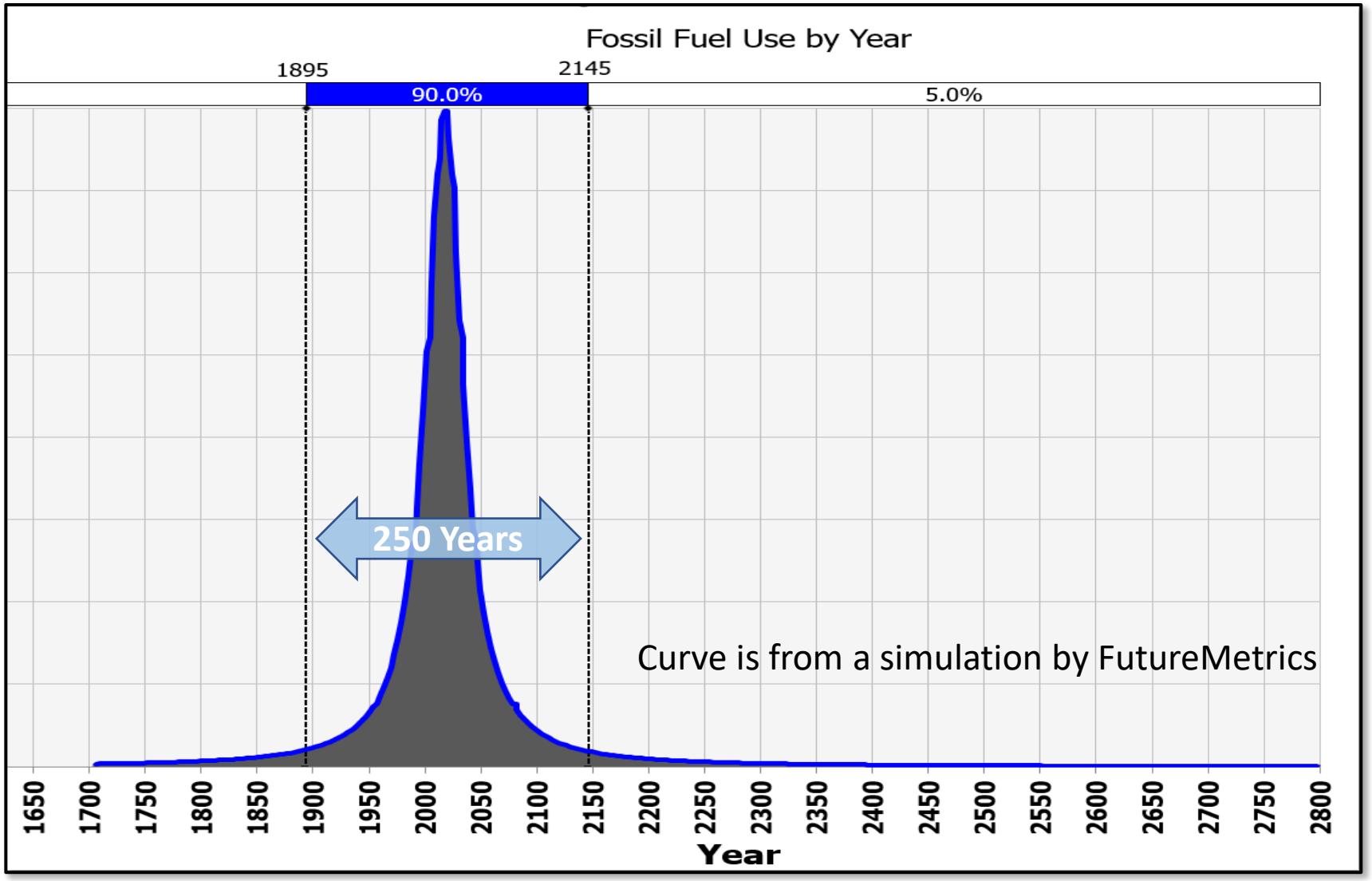
Climate change

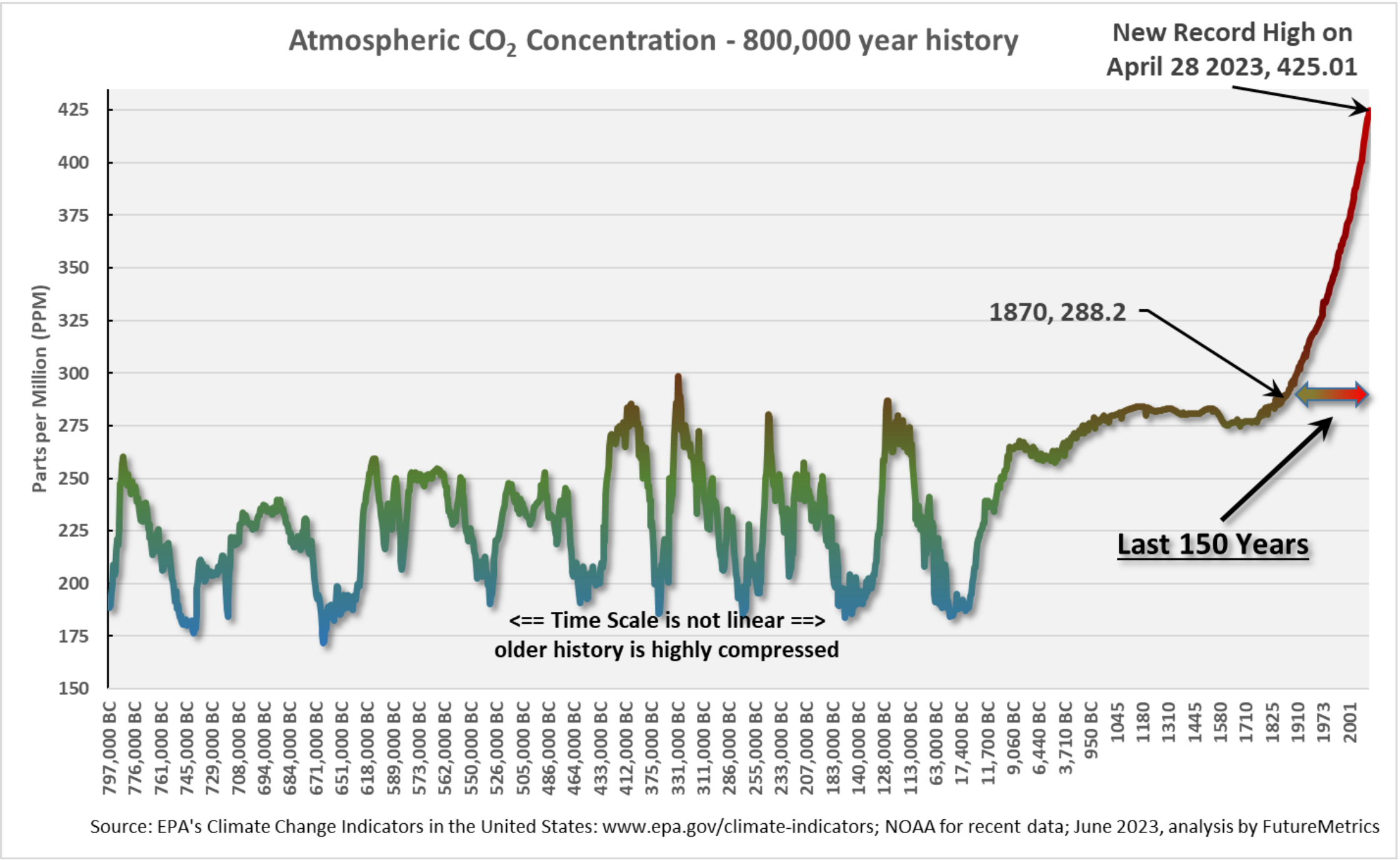
and the need to mitigate CO_2 emissions

And part of the solution for replacing depleting energy sources with renewable energy sources

Depletion and CO_2 Emissions are Linked.

We will release most of the geologic carbon sequestered over hundreds of millions of years over a span of about 250 years.

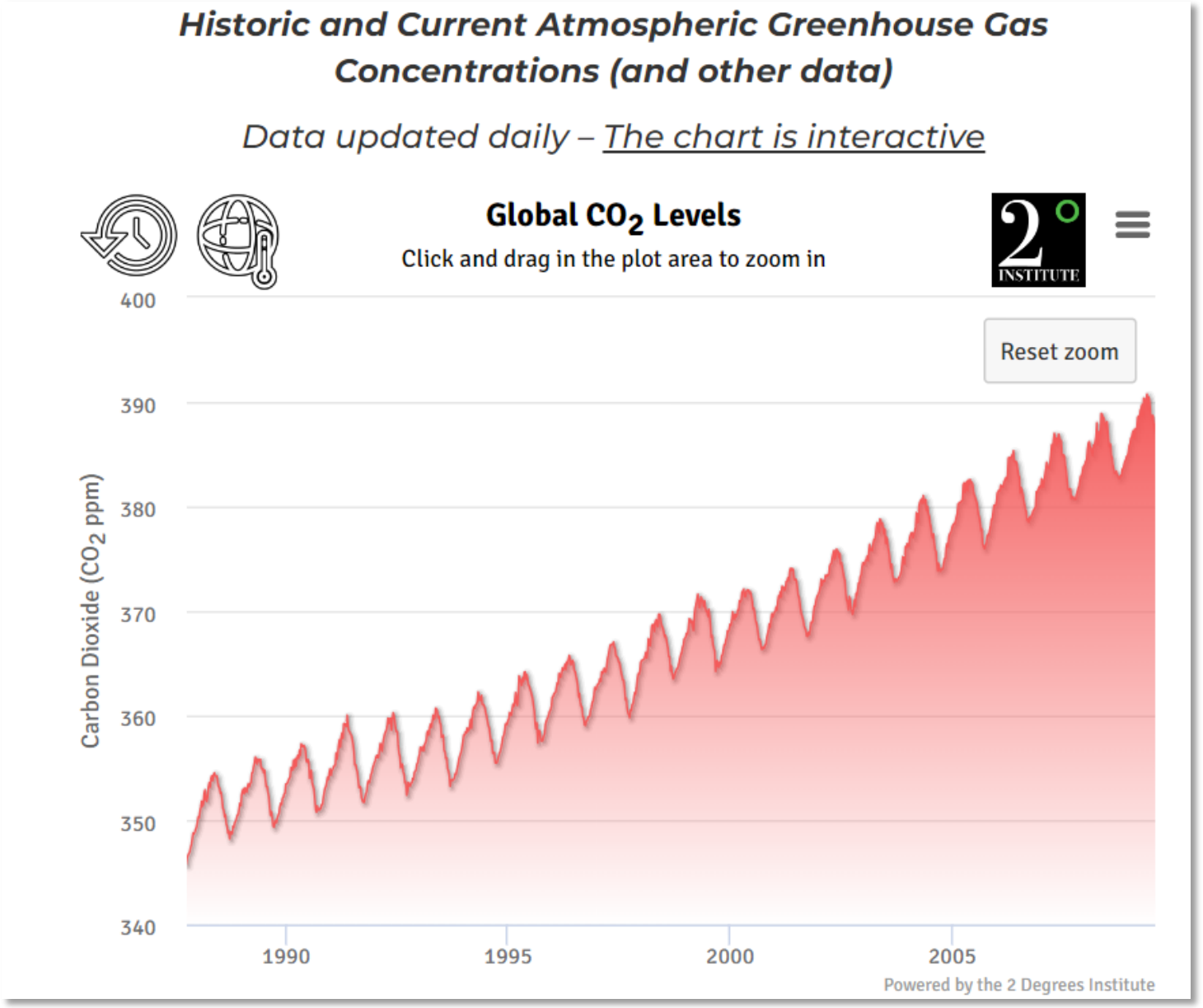




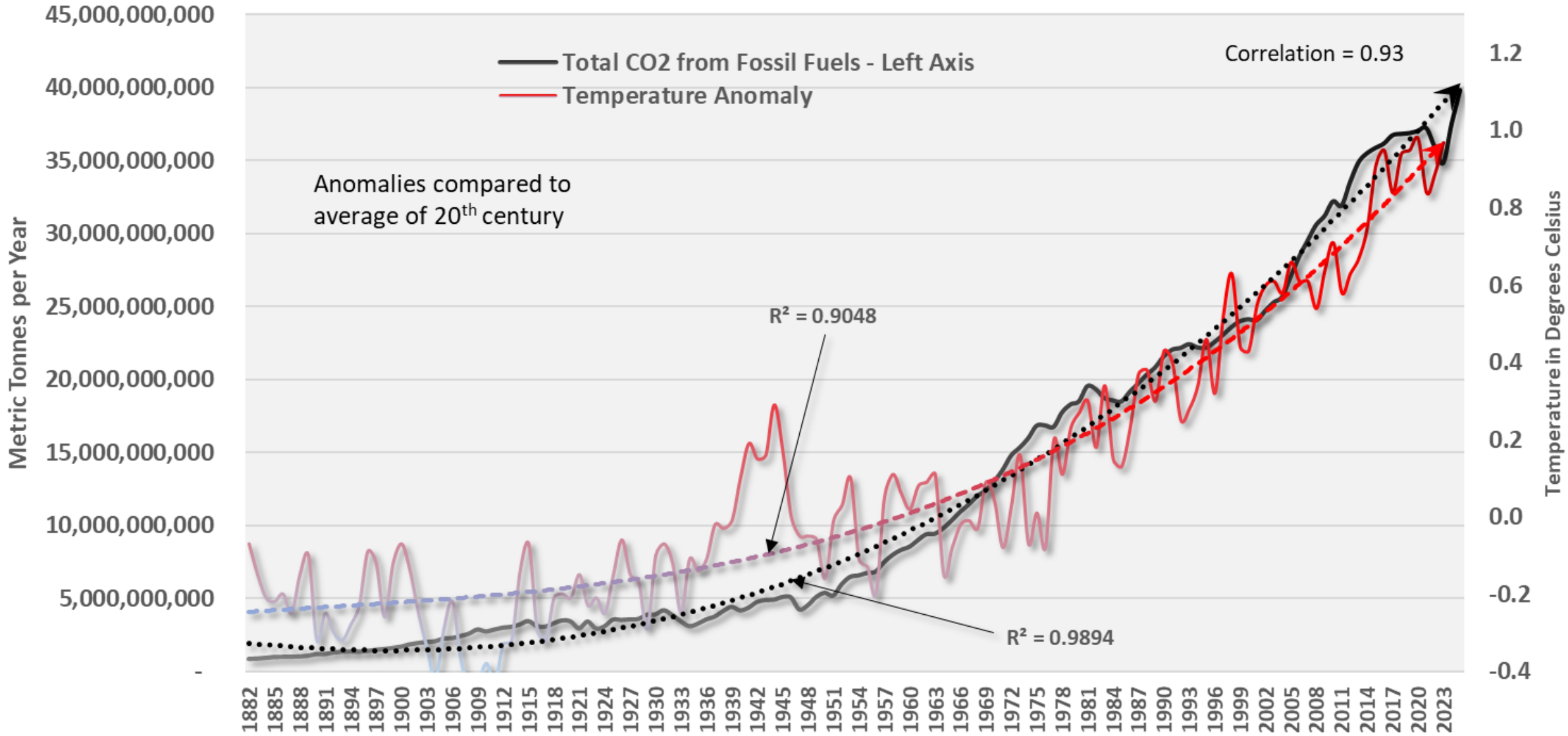
Source: EPA's Climate Change Indicators in the United States: www.epa.gov/climate-indicators; NOAA for recent data; June 2023, analysis by FutureMetrics

June 4, 2023
➔ Almost a new record at 424.87

From an interactive chart on the FutureMetrics homepage

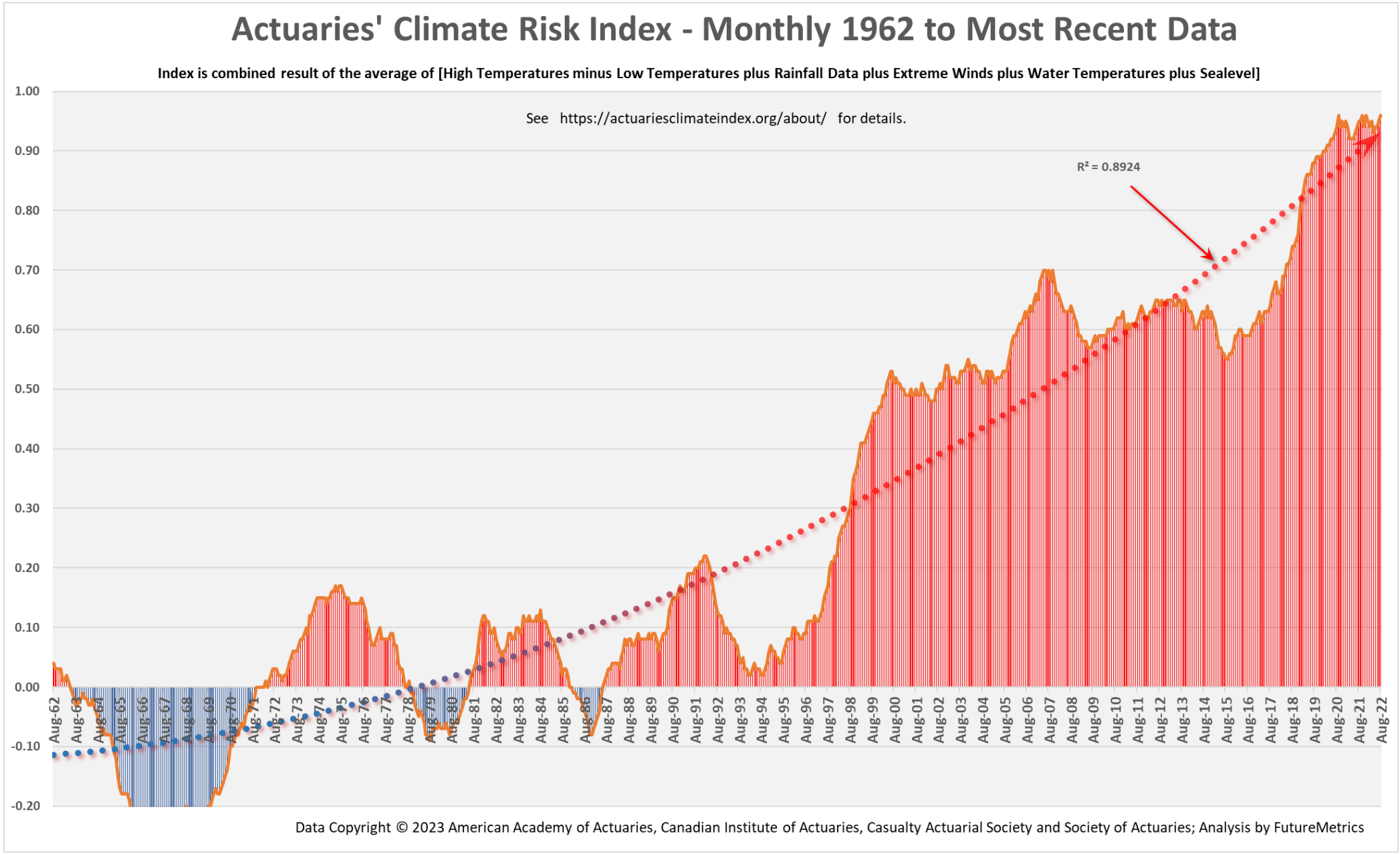


CO_2 Released from Fossil Fuel Combustion and Global Land and Sea Temperature Anomalies



source: National Fossil-Fuel CO2 Emissions, Carbon Dioxide Information Analysis Center, World Bank, Temperature Anomalies from NOAA, June 2023; 2023 estimates and analysis by FutureMetrics

The consequences are not only Environmental and Ecological but are also Economic!



Insurer cites "growing catastrophe exposure" as it stops new sales in California

Rebecca Falconer

Firefighters battle the Coastal Fire in Laguna Niguel, California, in May 2022. Photo: Wally Skalij/Los Angeles Times via Getty Images

State Farm says it's no longer accepting homeowner insurance applications in California due to "historic increases in construction costs outpacing inflation" and "rapidly growing catastrophe exposure" to extreme weather events like wildfires.

Why it matters: Multiple studies show climate change is influencing the frequency and severity of extreme weather events, increasing the risk of wildfires and also the proportion of storms that reach major hurricane status of Category 3 or above.

Upgraded Sustainably Produced Solid Fuel?

These are advanced pellets produced using the Valmet continuous steam treatment process. Produced at the EdB 120,000 tonnes per year plant in Reims, France.

Pellets are waterproof, higher bulk and energy density than white pellets, produce almost zero dust in handling, and do not self heat.

Carbohydrates replacing Hydrocarbons

Biomass derived solid fuel substituting for coal is a pragmatic and rational strategy for the transition to a decarbonized power sector.

- Leverages existing coal power stations and can be deployed NOW.

- Produces baseload or load-following renewable power.
  - Compliments and supports the variability and intermittency of wind and solar power.

- Creates many more jobs per MWh than any other renewable power source.

- Is **carbon neutral in combustion**.

Carbon Neutral?

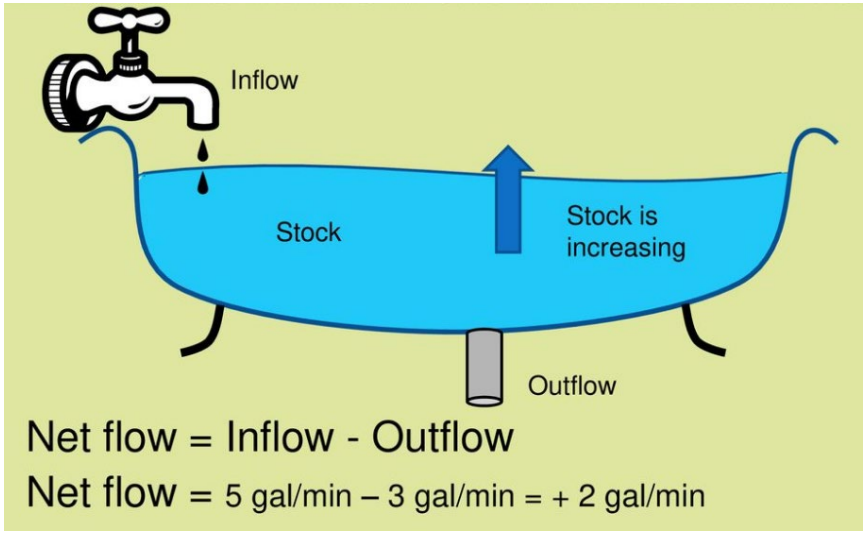
If sourced from the harvest residuals of sustainably managed forests and the residuals from sawmill operations, wood pellets are carbon neutral in combustion*.

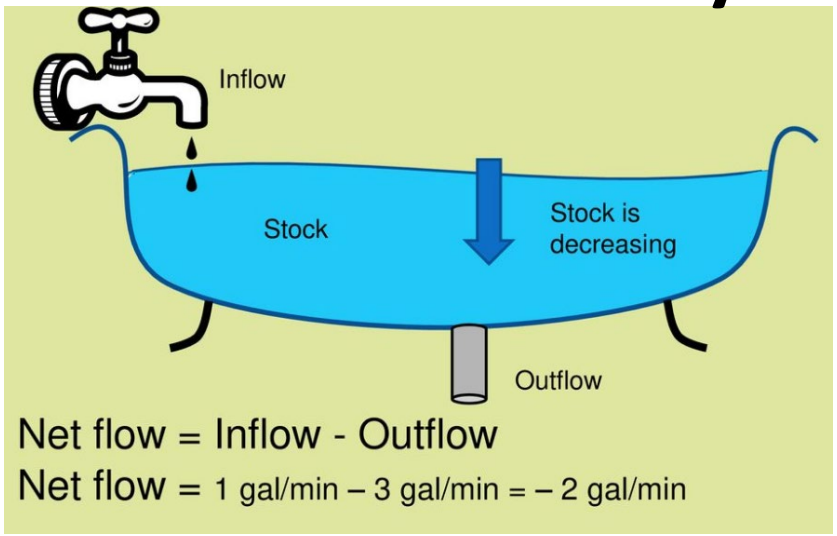
FIRST and ABSOLUTELY NECCESARY CONDITION:
If the annual harvest rate across the managed forest landscape
is less than or equal to the annual growth rate,
then the stock of carbon held in the forest is not shrinking.

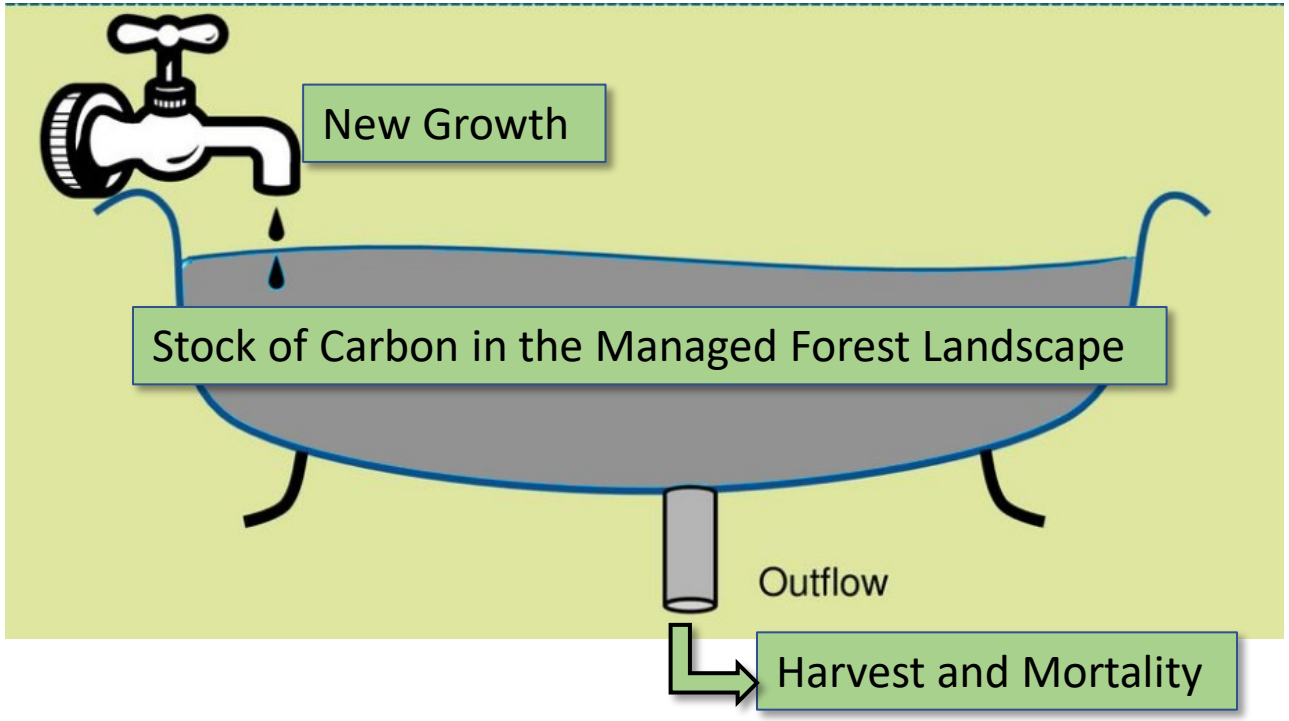
So, every molecule of CO_2 that is emitted in combustion is absorbed by the new growth more or less contemporaneously.

*As with any fuel that must be mined, refined, and transported,
there is a carbon footprint associated with the fossil fuels used within the supply chain.

The basics of net carbon steady state…







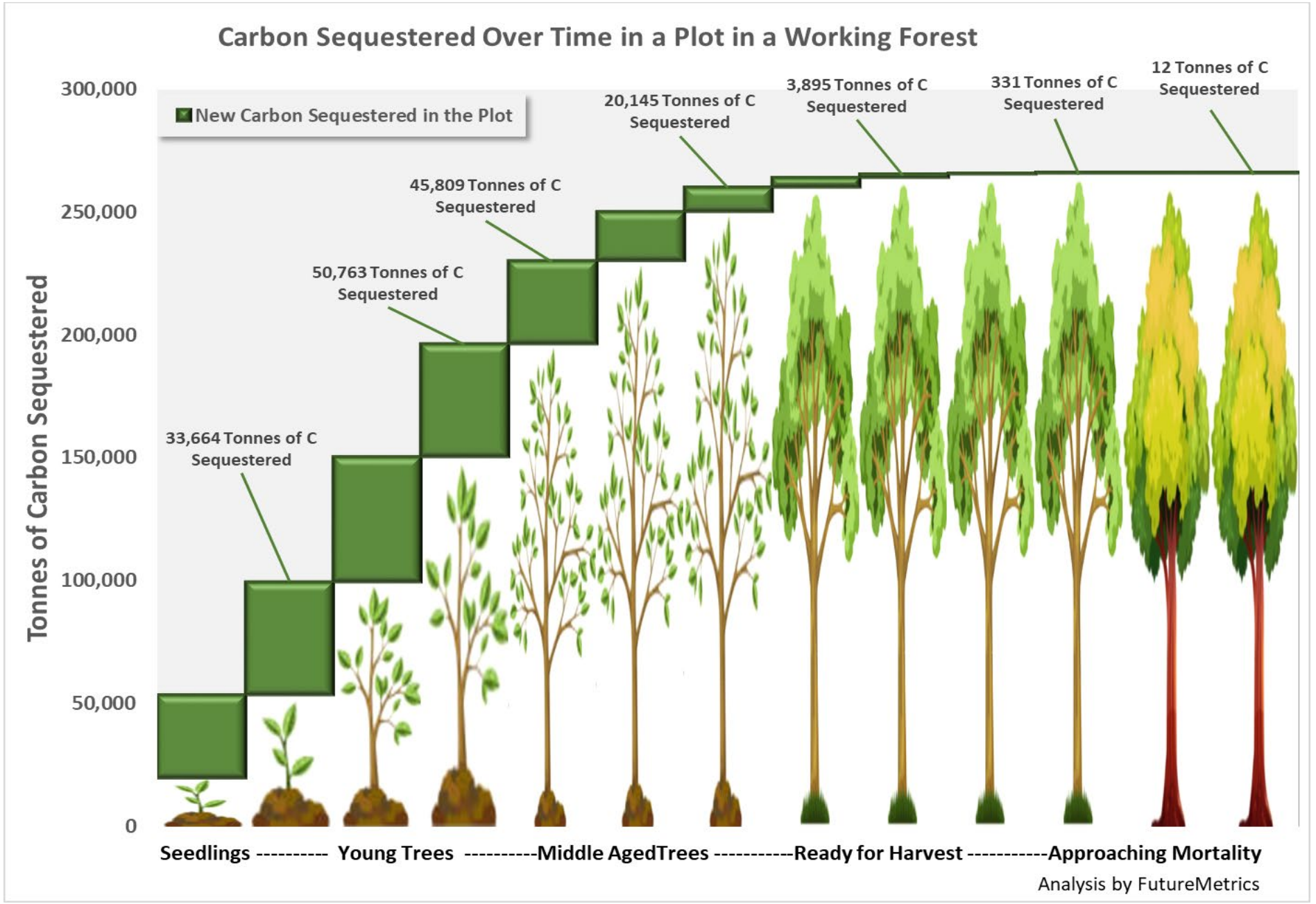
If the growth rate equals or exceeds the drain rate, the net carbon held in the forest is not decreasing.

The equivalent quantity of molecules of CO_2 emitted from the biomass from that managed landscape that is used for energy are absorbed by the new growth.

The atmosphere sees no net new CO_2.

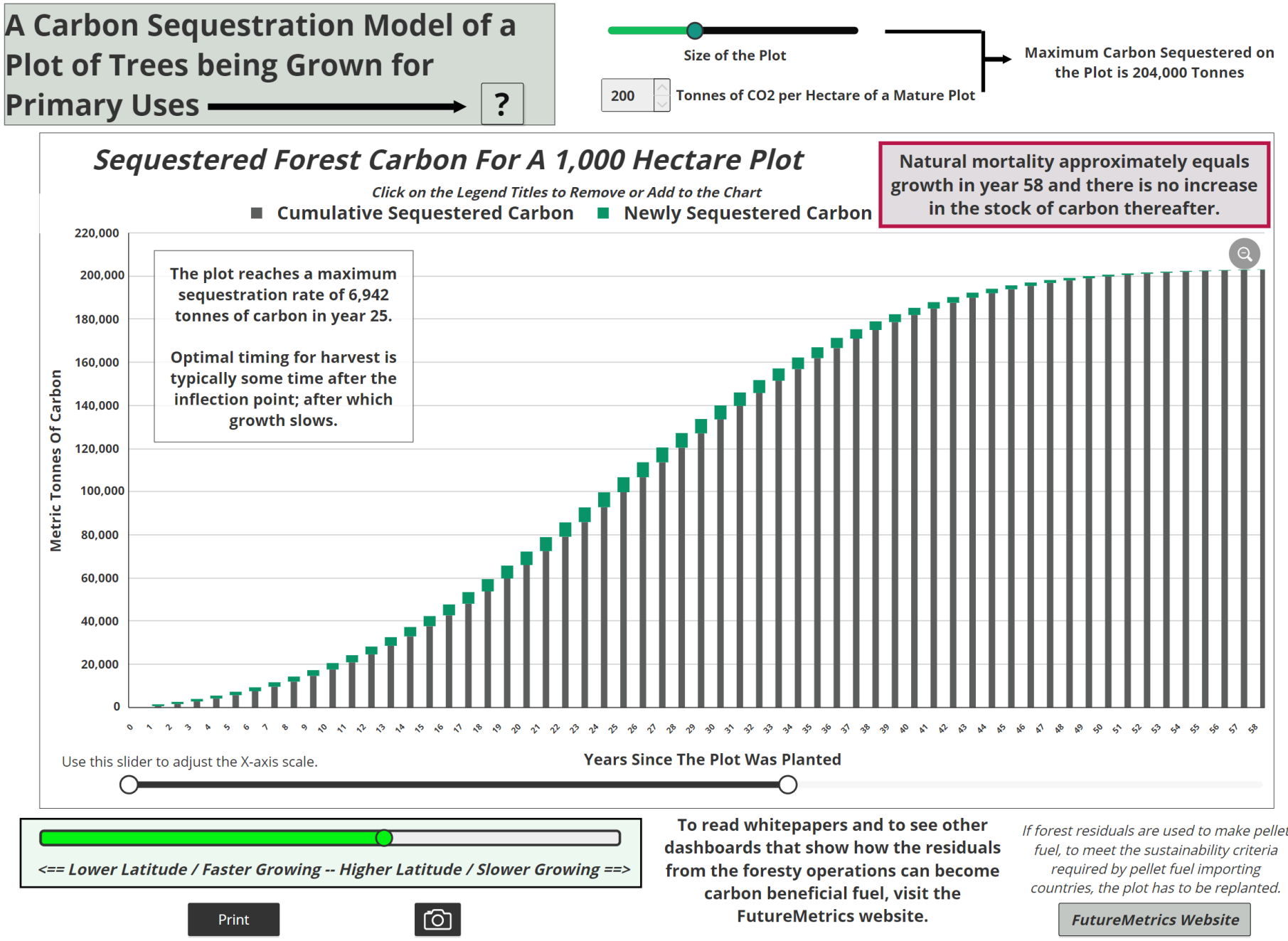
Carbon neutral in combustion!

The "bathtub" has a limit to what it can hold. Plots in a managed forest reach a carbon stock equilibrium. There is no sequestration benefit after XX years of growth.

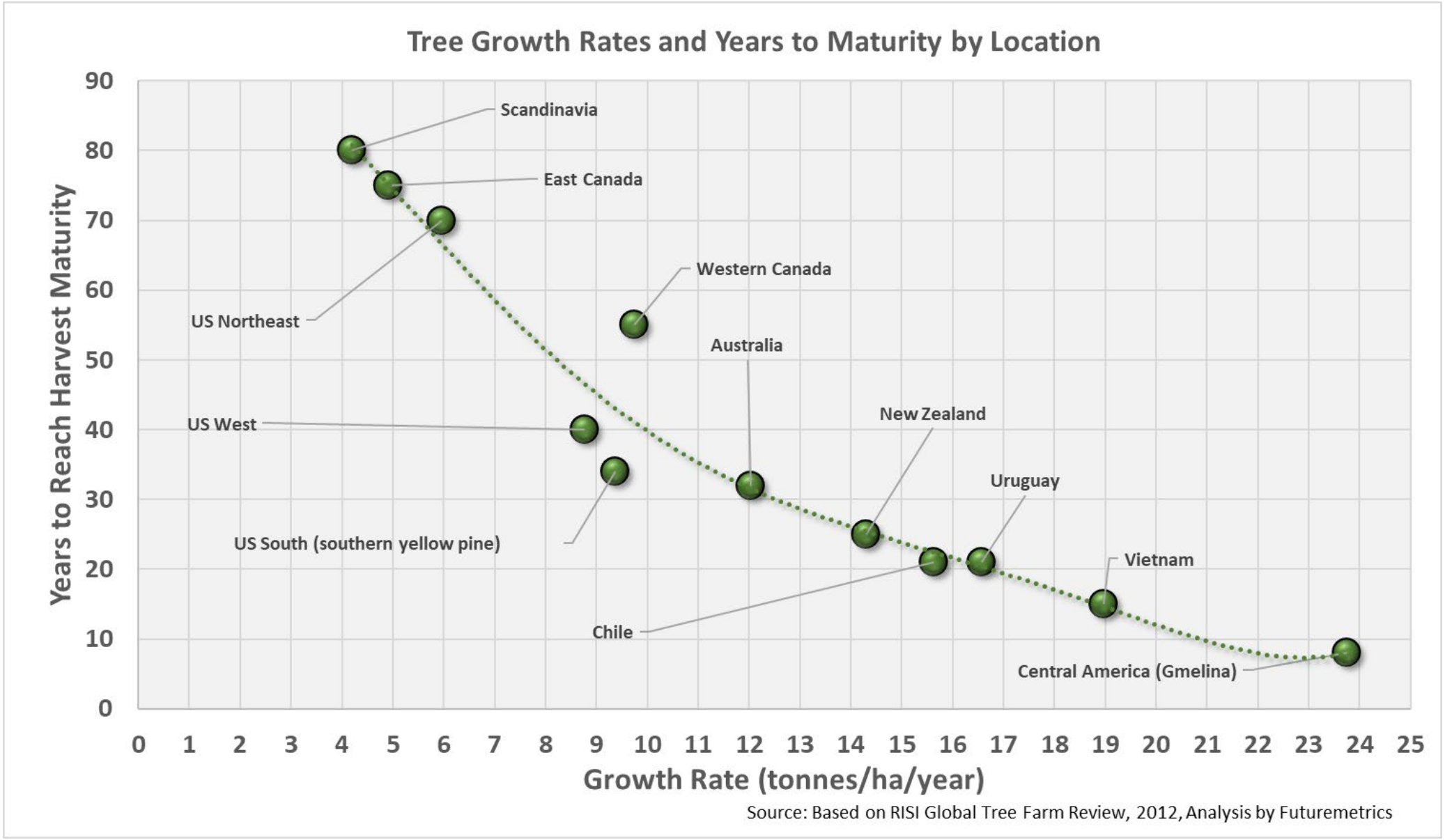


Dashboard

HERE



The farther north (northern hemisphere) you go, the more patient the tree farmer must be…

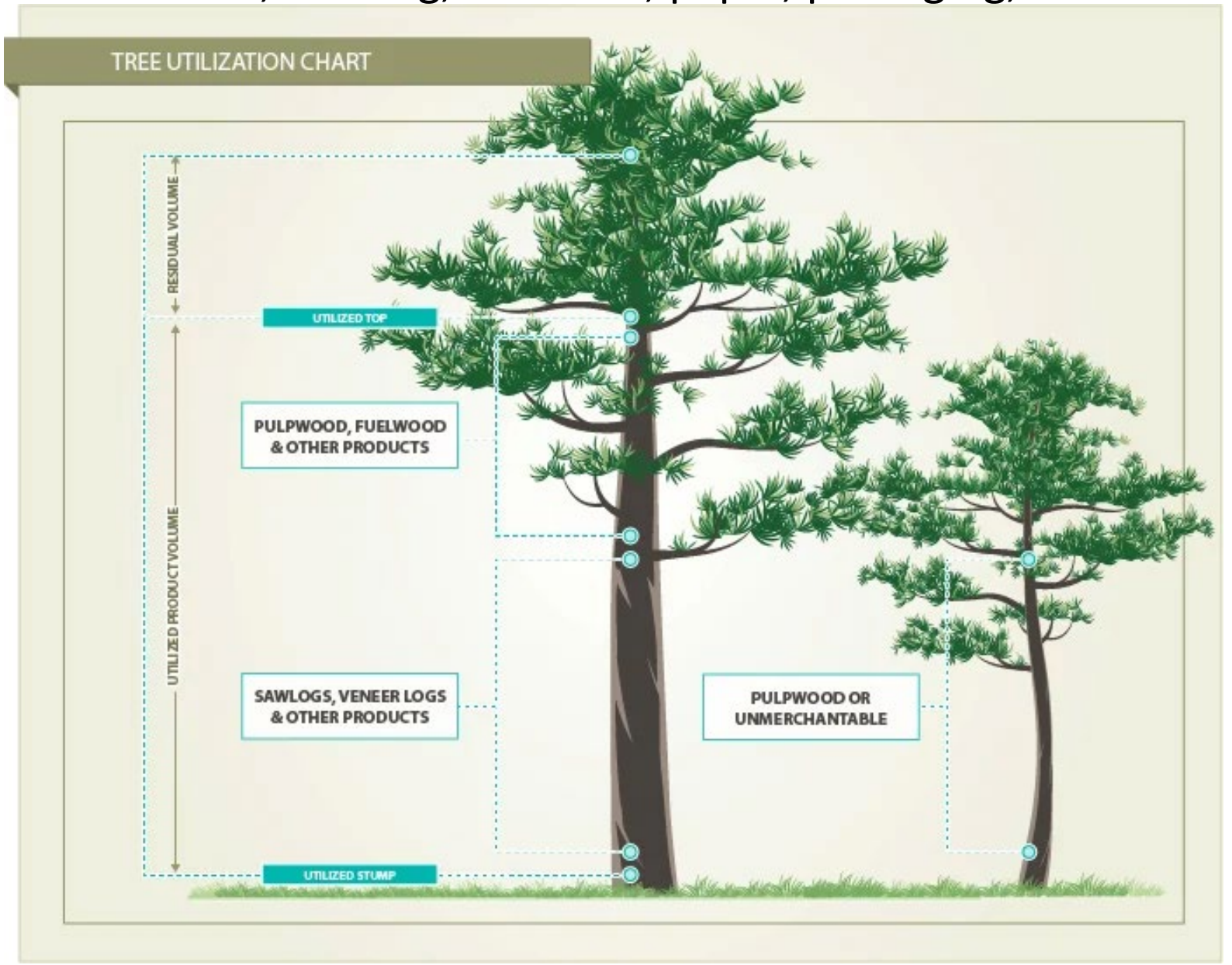


Most of the harvested timber does not end up as wood pellet fuel.

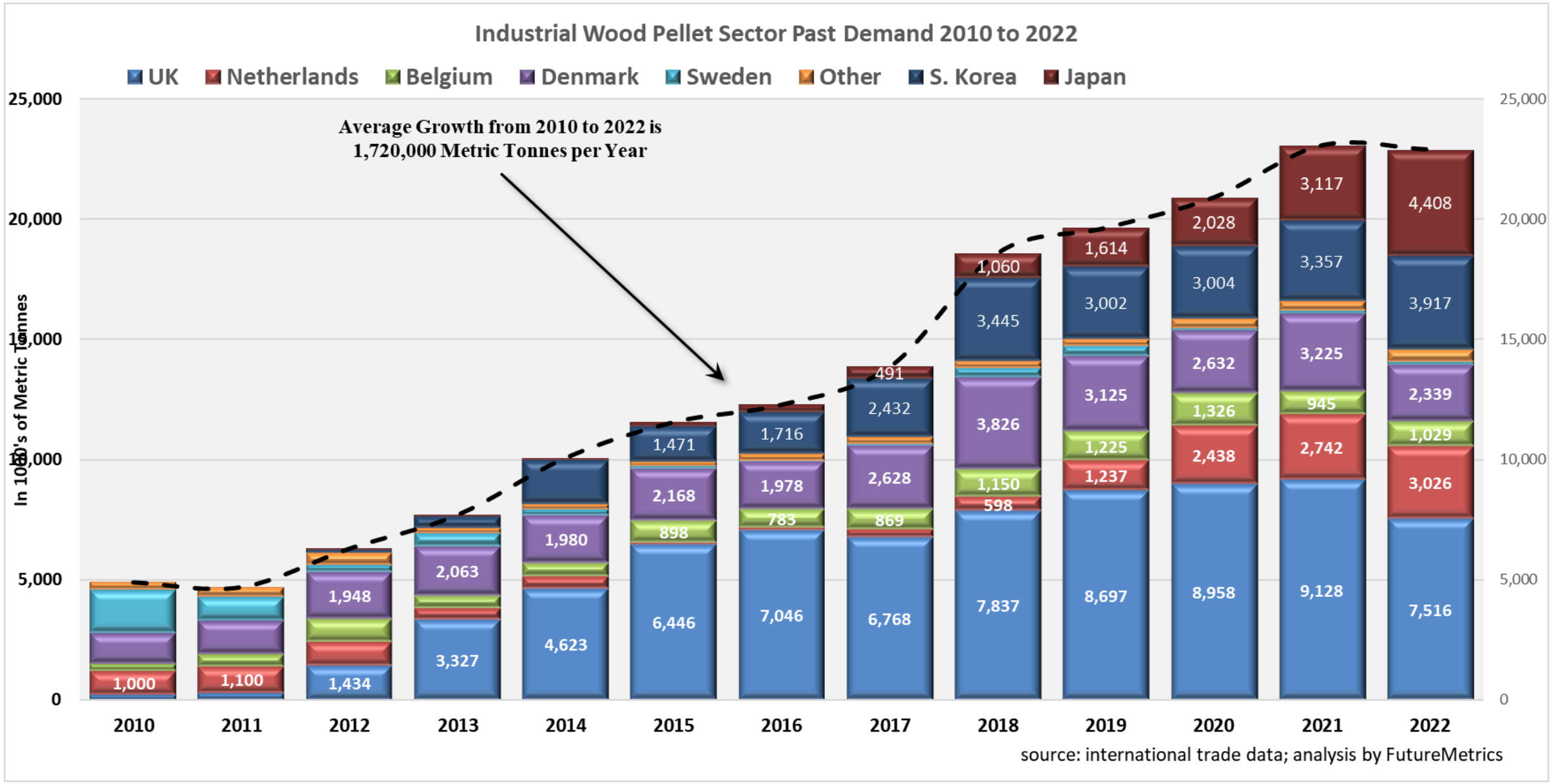
Much of the harvested timber from managed working forests becomes lumber, furniture, flooring, pallets, packaging, tissue, and paper.

The "sawmill residuals" (around the edge of the sawlog and sawdust) and the parts of the tree not suitable for traditional forest products manufacturing become feedstock for pellet manufacturing.

“Forest Residuals” are the parts of the harvested tree that are not suitable for primary industries such as lumber, flooring, furniture, paper, packaging, and tissue production.

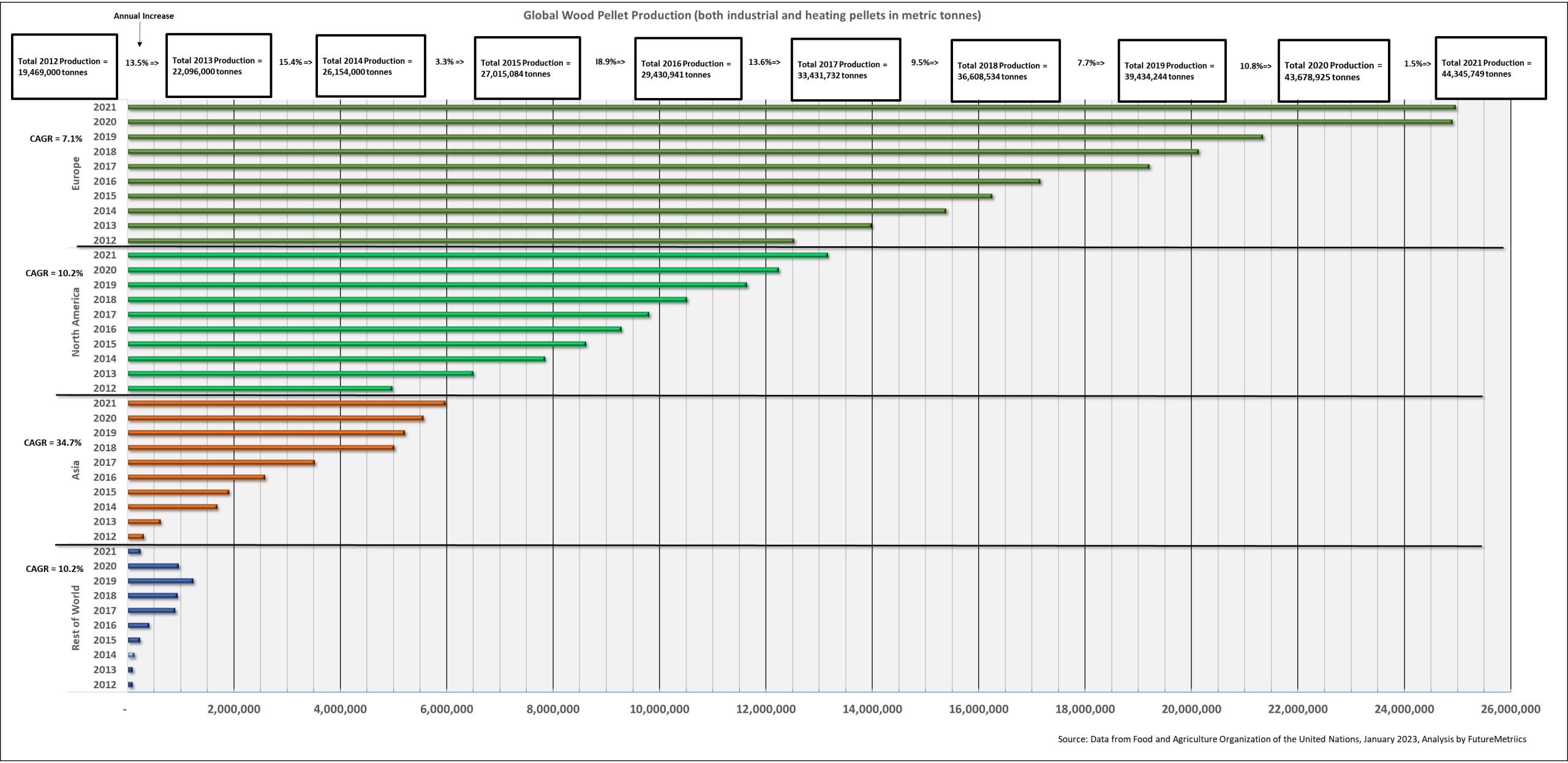


An Overview of the Markets for these Energy Pellets made from a Non-depleting Resource

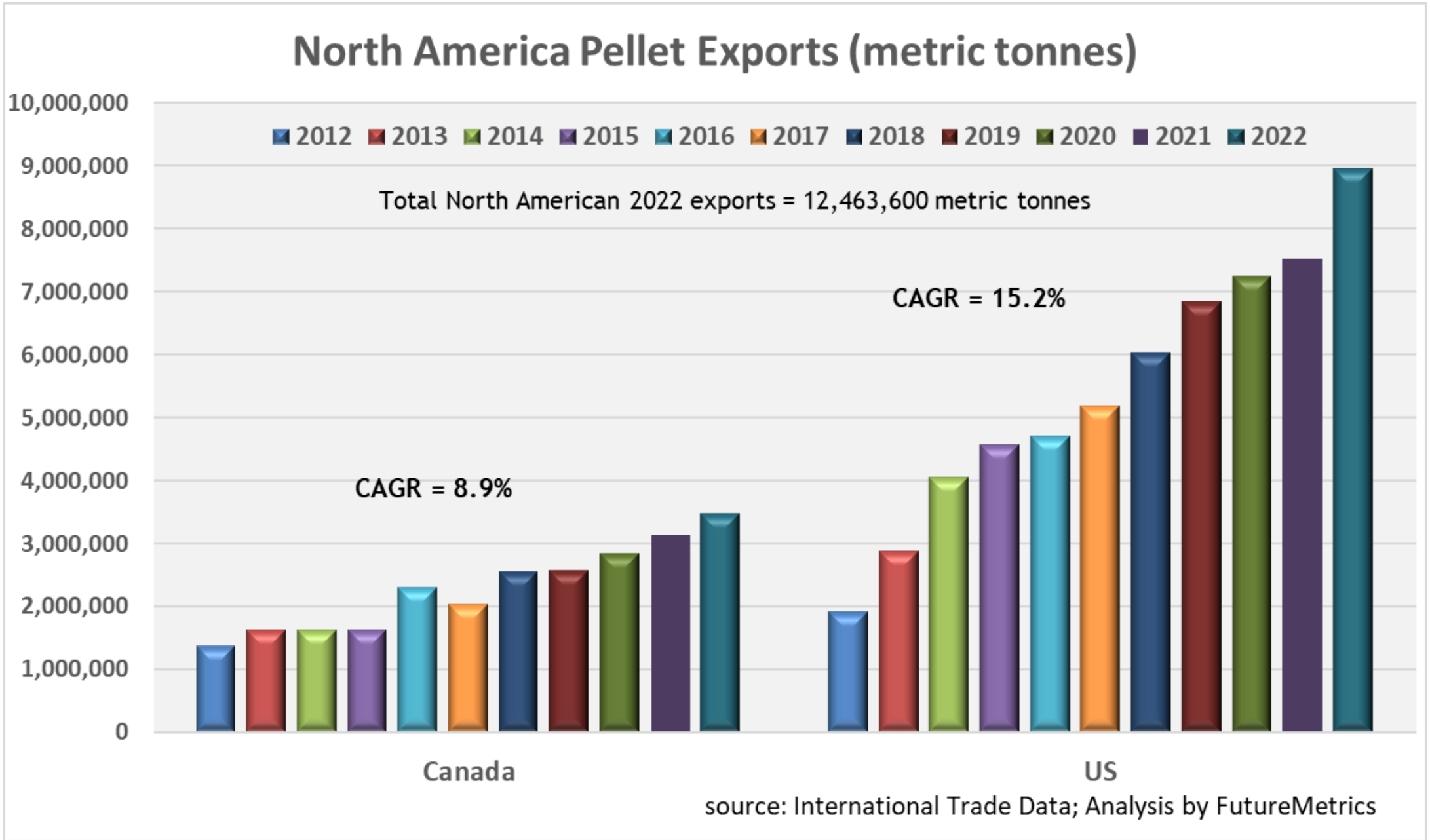

Industrial Wood Pellet Sector Past Demand 2010 to 2022
UK
Netherlands
Belgium
Denmark
Sweden
Other
S. Korea
Japan
Average Growth from 2010 to 2022 is
1,720,000 Metric Tonnes per Year
In 1000's of Metric Tonnes
25,000
20,000
15,000
10,000
5,000
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
1,000
1,100
1,434
1,948
3,327
2,063
4,623
1,980
6,446
898
2,168
1,471
7,046
783
1,978
1,716
6,768
869
2,628
2,432
491
7,837
598
1,150
3,826
3,445
1,060
8,697
1,237
1,225
3,125
3,002
1,614
8,958
2,438
1,326
2,632
3,004
2,028
9,128
2,742
945
3,225
3,357
3,117
7,516
3,026
1,029
2,339
3,917
4,408
source: international trade data; analysis by FutureMetrics

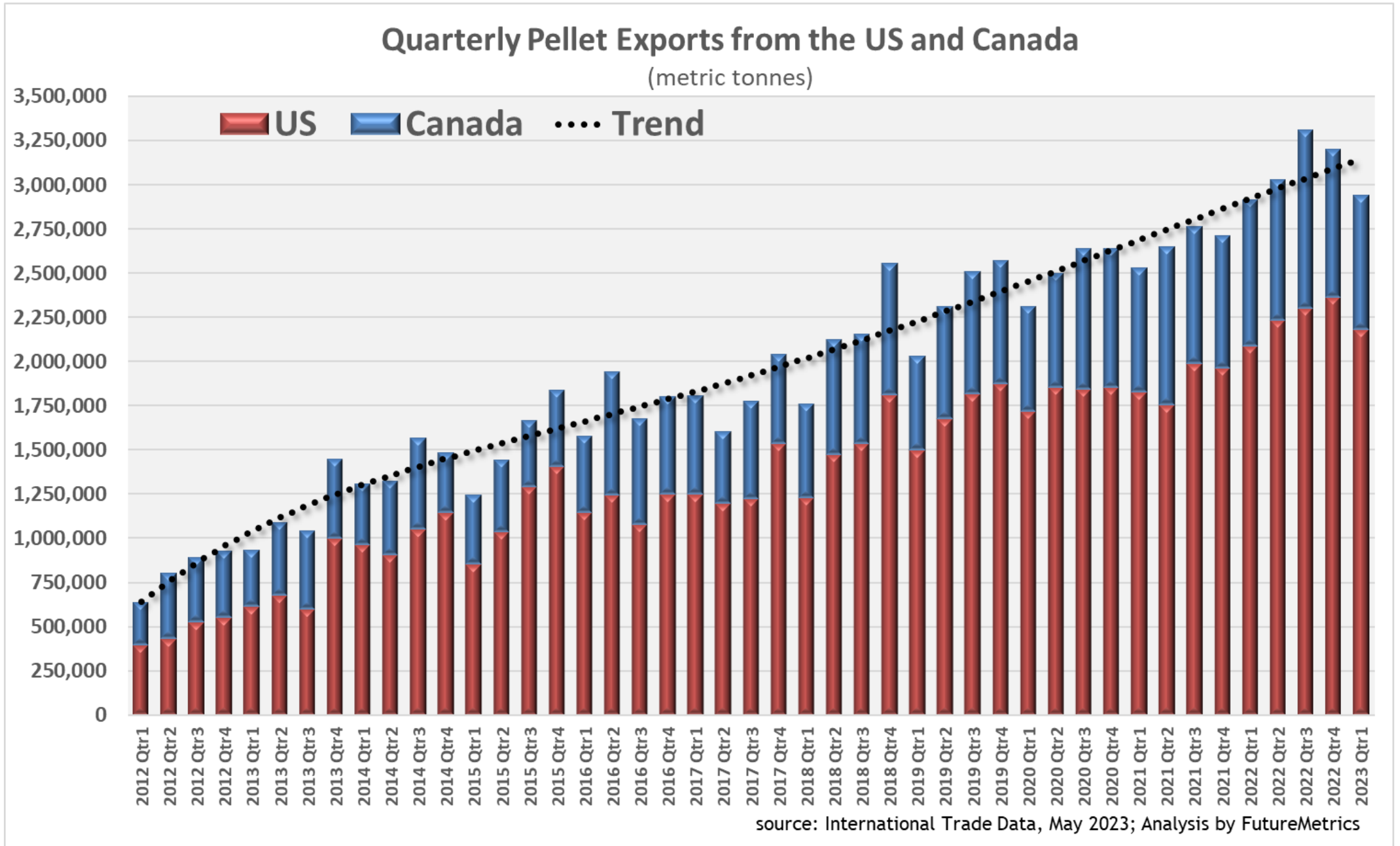
Total Pellet Production by Region (includes both heating and industrial pellets)

44.35 million metric tonnes in 2021



Source: Data from Food and Agriculture Organization of the United Nations, January 2023, Analysis by FutureMetriics


North America Pellet Exports (metric tonnes)
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Total North American 2022 exports = 12,463,600 metric tonnes
CAGR = 15.2%
CAGR = 8.9%
Canada
US
source: International Trade Data; Analysis by FutureMetrics


Quarterly Pellet Exports from the US and Canada
(metric tonnes)
US
Canada
Trend
3,500,000
3,250,000
3,000,000
2,750,000
2,500,000
2,250,000
2,000,000
1,750,000
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
0
2012 Qtr1
2012 Qtr2
2012 Qtr3
2012 Qtr4
2013 Qtr1
2013 Qtr2
2013 Qtr3
2013 Qtr4
2014 Qtr1
2014 Qtr2
2014 Qtr3
2014 Qtr4
2015 Qtr1
2015 Qtr2
2015 Qtr3
2015 Qtr4
2016 Qtr1
2016 Qtr2
2016 Qtr3
2016 Qtr4
2017 Qtr1
2017 Qtr2
2017 Qtr3
2017 Qtr4
2018 Qtr1
2018 Qtr2
2018 Qtr3
2018 Qtr4
2019 Qtr1
2019 Qtr2
2019 Qtr3
2019 Qtr4
2020 Qtr1
2020 Qtr2
2020 Qtr3
2020 Qtr4
2021 Qtr1
2021 Qtr2
2021 Qtr3
2021 Qtr4
2022 Qtr1
2022 Qtr2
2022 Qtr3
2022 Qtr4
2023 Qtr1
source: International Trade Data, May 2023; Analysis by FutureMetrics

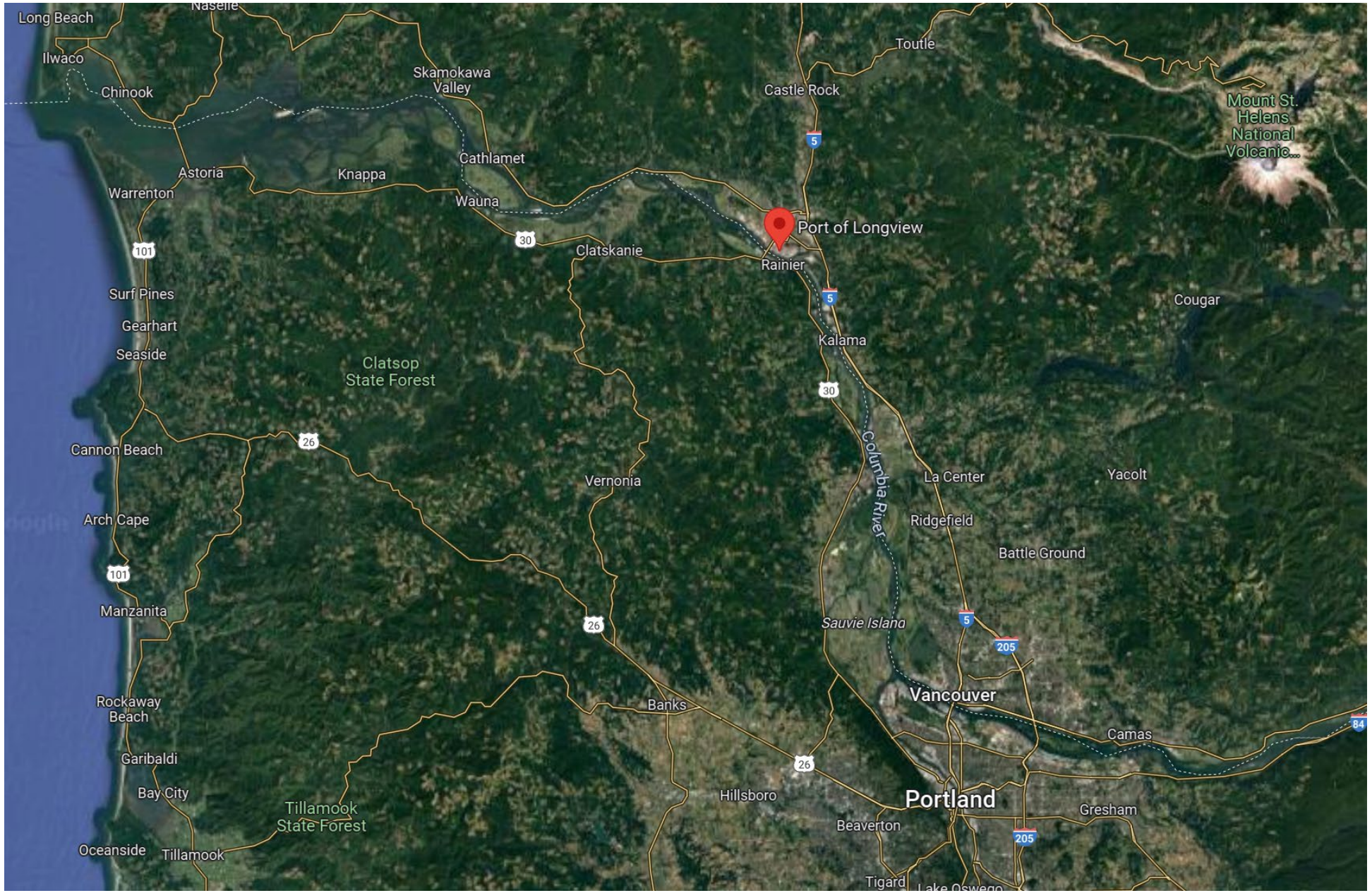
What about the Western US?

Insurance giant Allstate followed State Farm in halting home insurance policies for Californians.

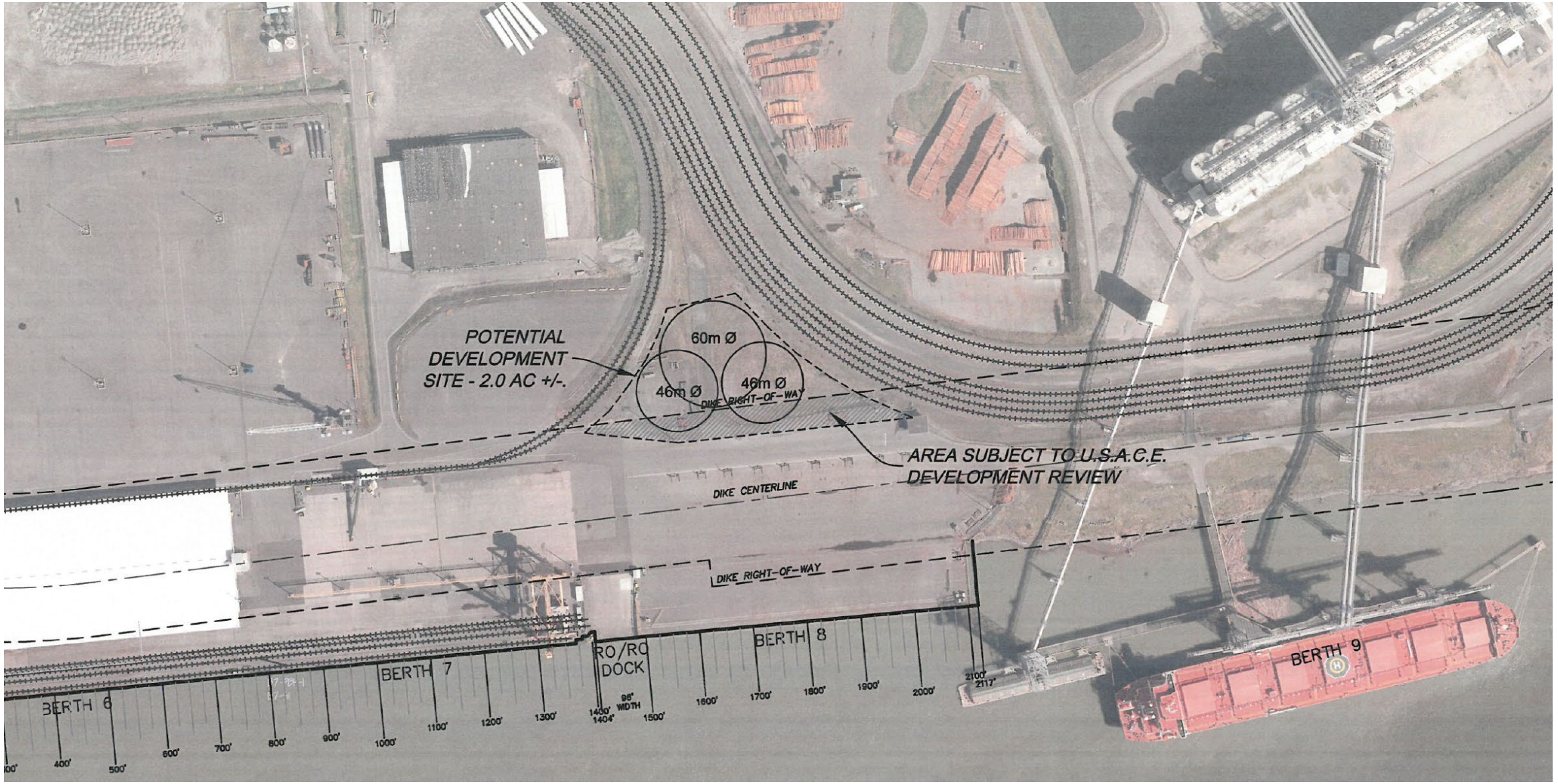
The moves come amid increasingly disastrous wildfires in the state.

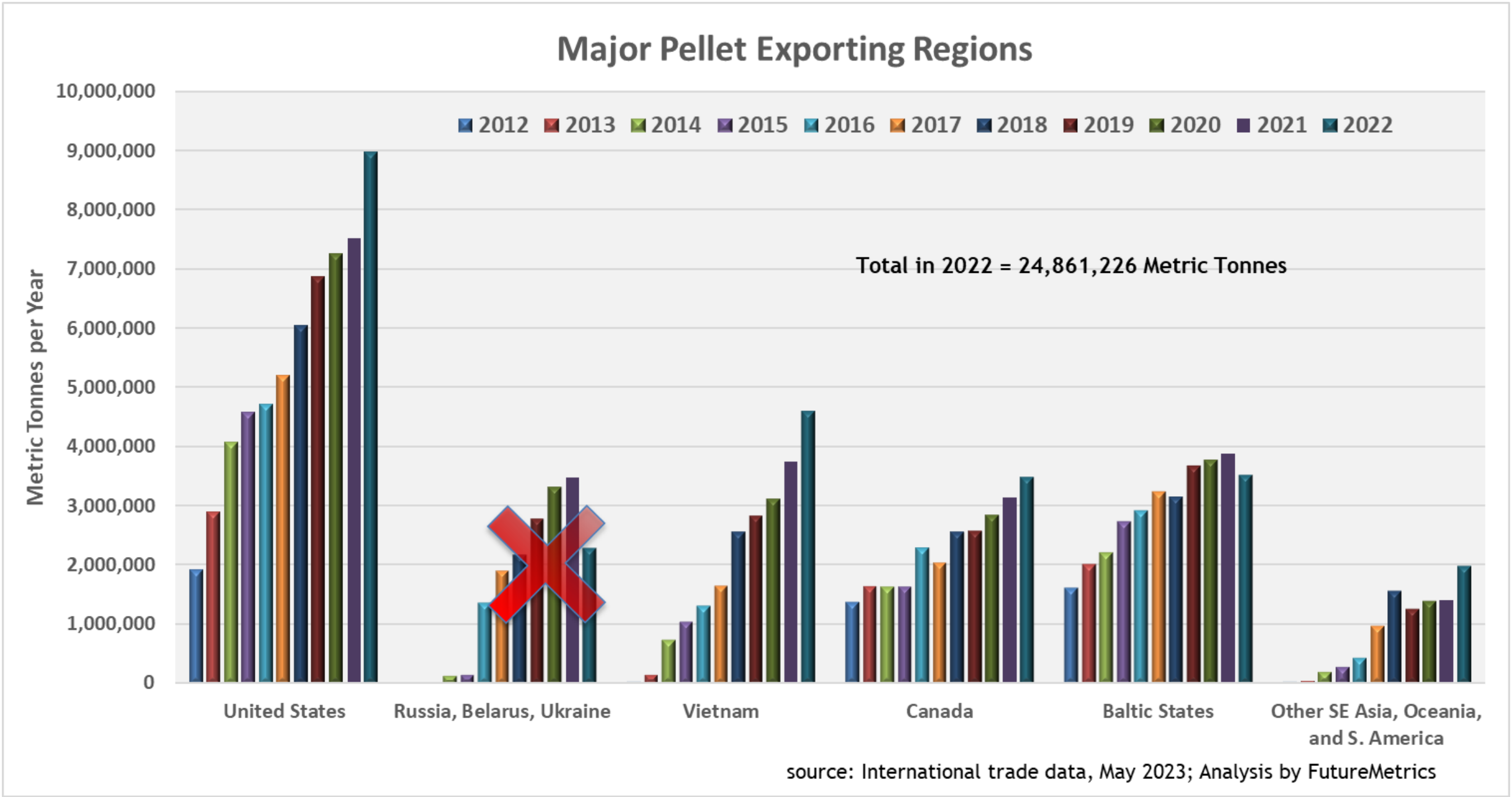
Will wood costs be subsidized by fire mitigation treatment contracts?

Drax announces a 450,000 t/yr new-built pellet plant in Longview, Washington, that includes the development of a new port facility at the same location, both expected to begin commissioning in 2025.



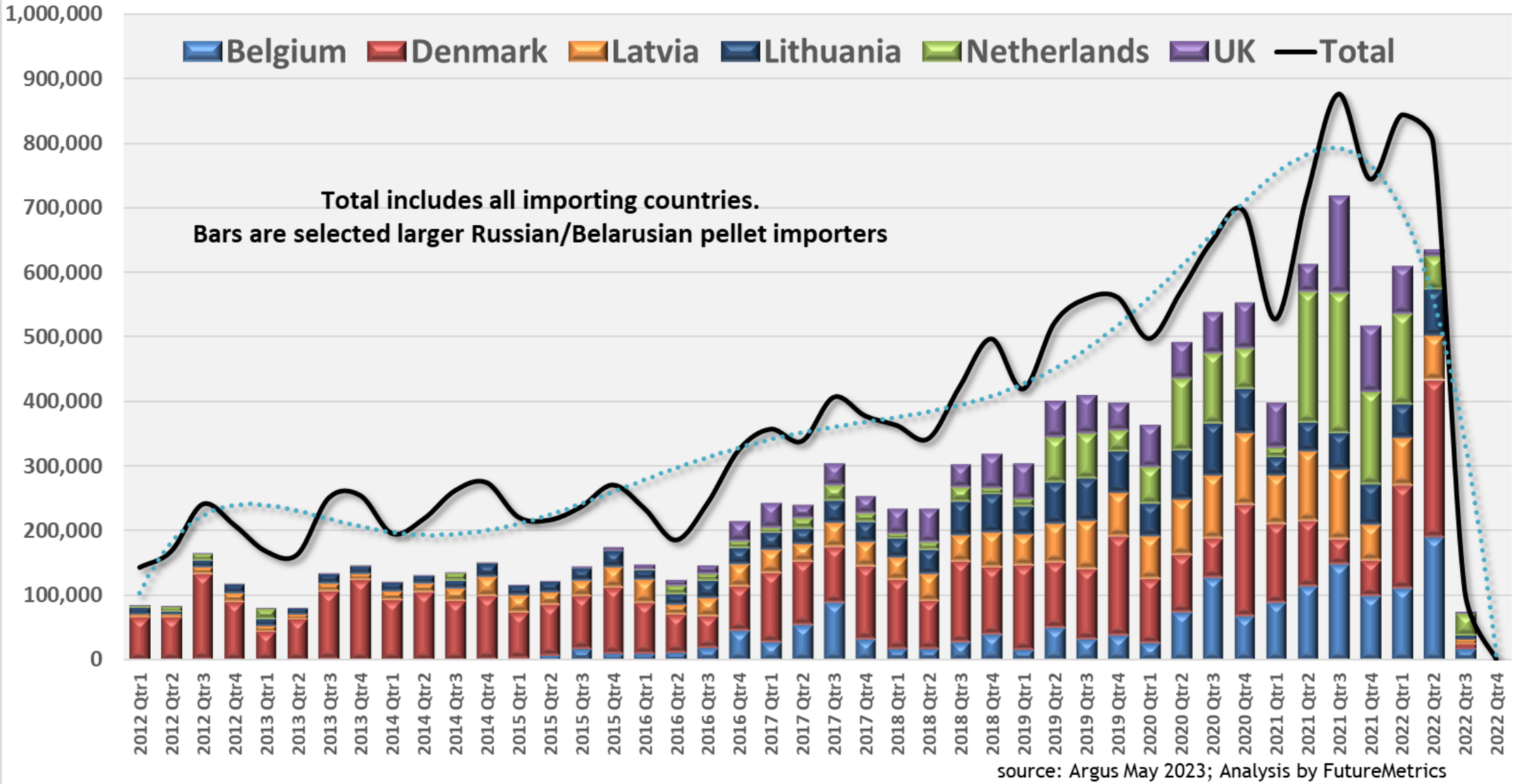
FutureMetrics does not know the exact location of the Drax project.
A few years ago we located a spot for one large or two smaller domes at the port of Longview for a client.



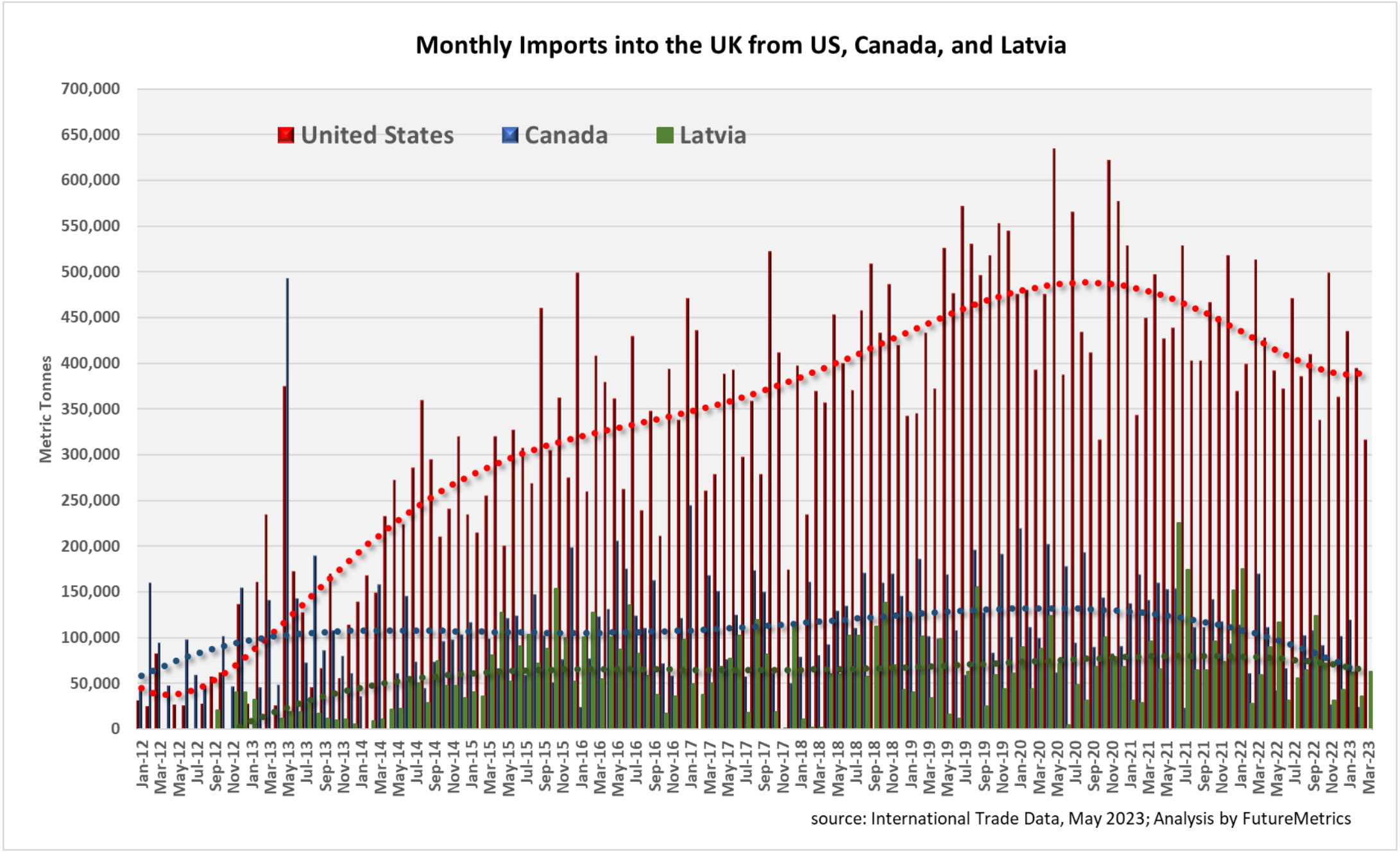

Major Pellet Exporting Regions
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Metric Tonnes per Year
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Total in 2022 = 24,861,226 Metric Tonnes
United States
Russia, Belarus, Ukraine
Vietnam
Canada
Baltic States
Other SE Asia, Oceania, and S. America
source: International trade data, May 2023; Analysis by FutureMetrics

Europe Imports of Russian and Belarusian Pellets

(quarterly in metric tonnes)



source: Argus May 2023; Analysis by FutureMetrics


Monthly Imports into the UK from US, Canada, and Latvia
United States
Canada
Latvia
Metric Tonnes
700,000
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
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Mar-17
May-17
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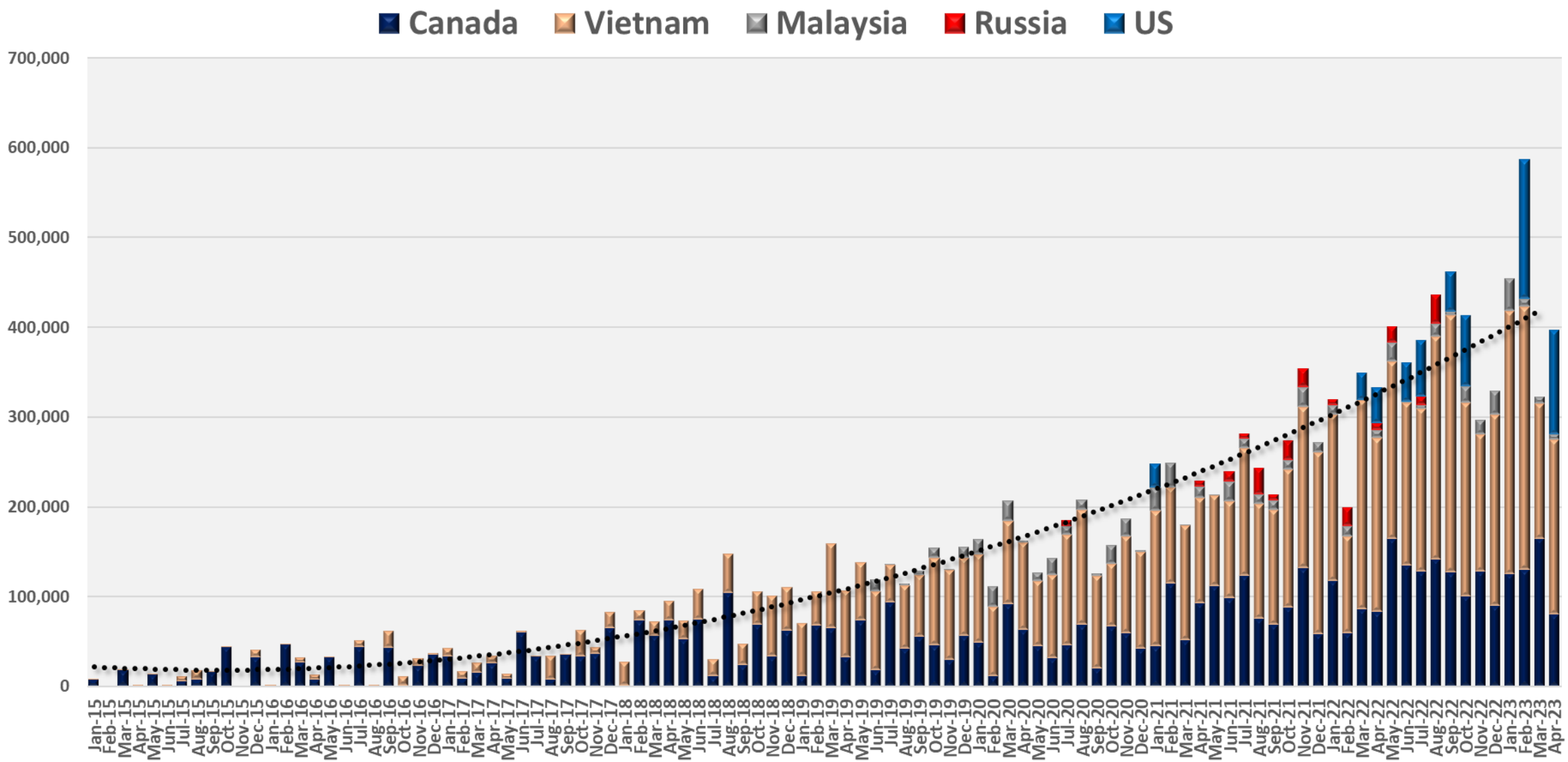
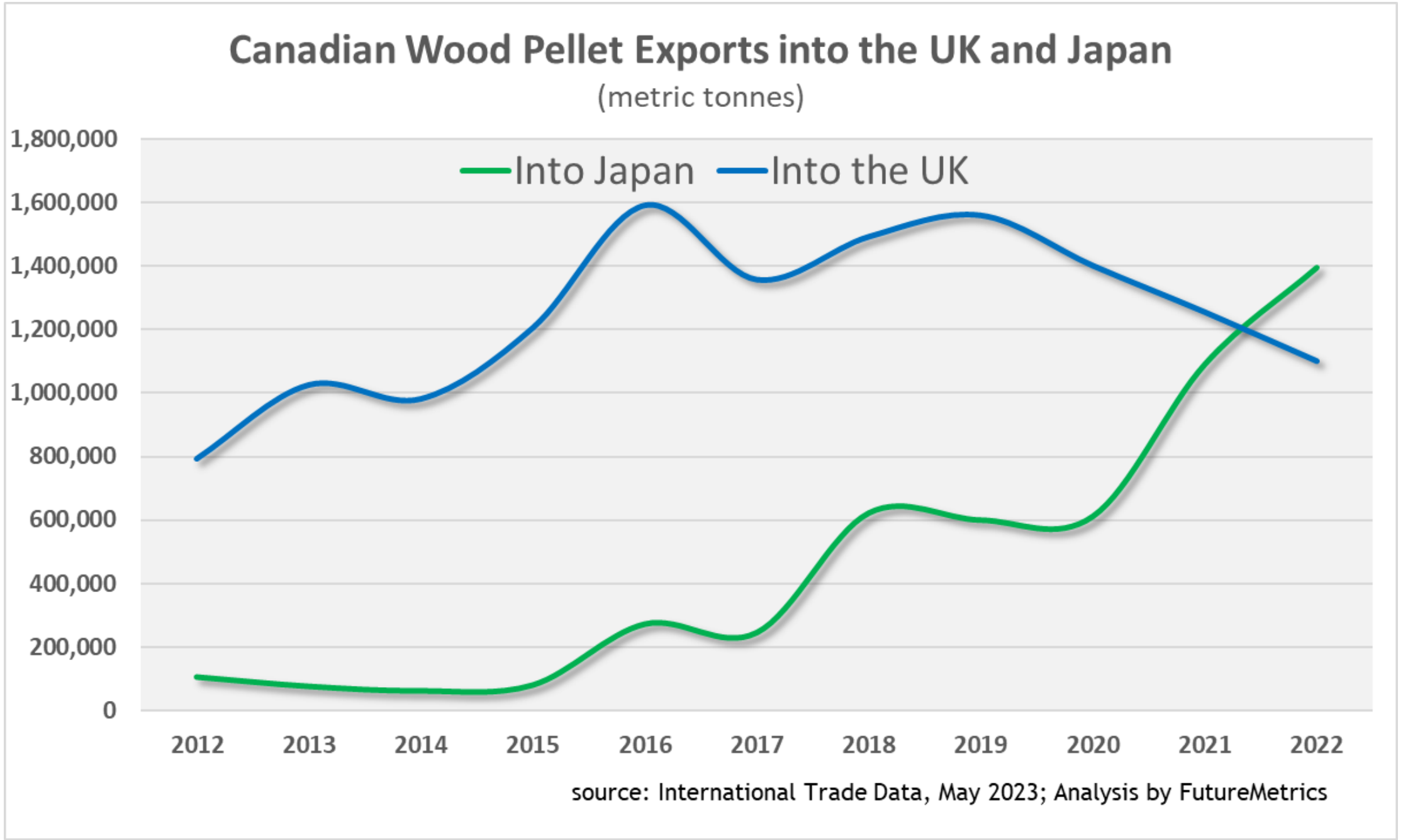
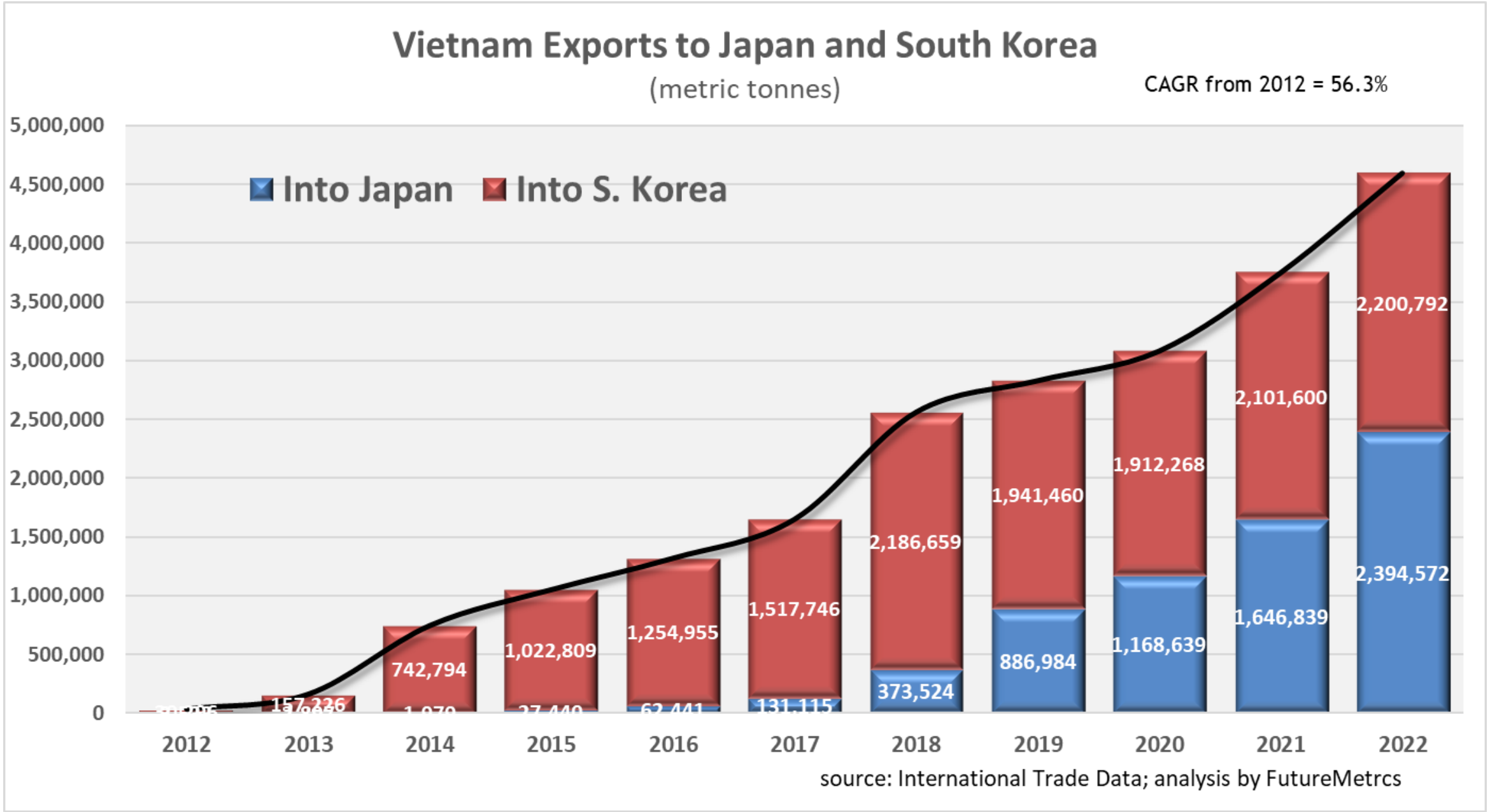
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
source: International Trade Data, May 2023; Analysis by FutureMetrics

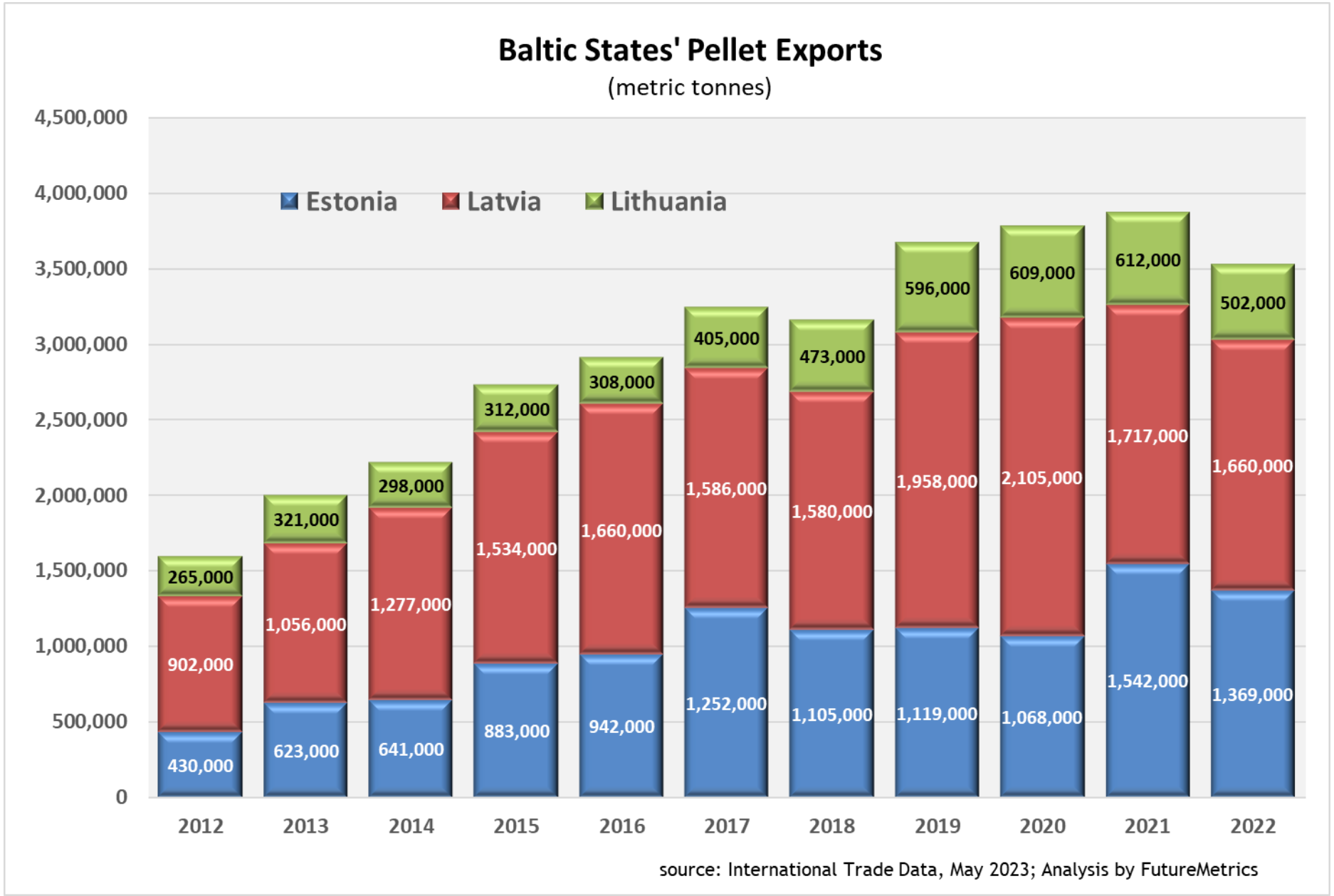
Monthly Imports (metric tonnes) into Japan

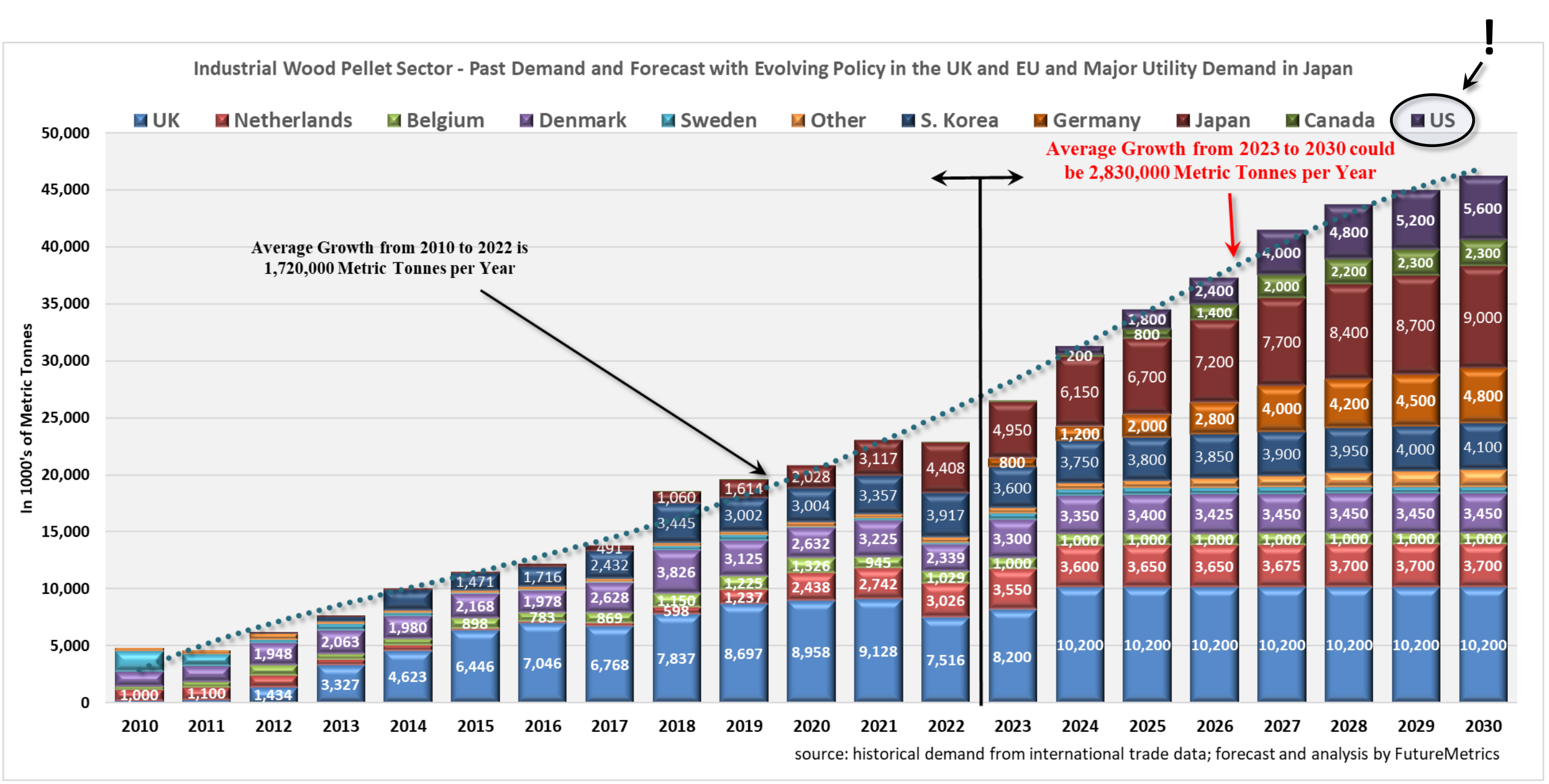


source: International Trade Data, June 2023; Analysis by FutureMetrics


Canadian Wood Pellet Exports into the UK and Japan
(metric tonnes)
Into Japan
Into the UK
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
source: International Trade Data, May 2023; Analysis by FutureMetrics

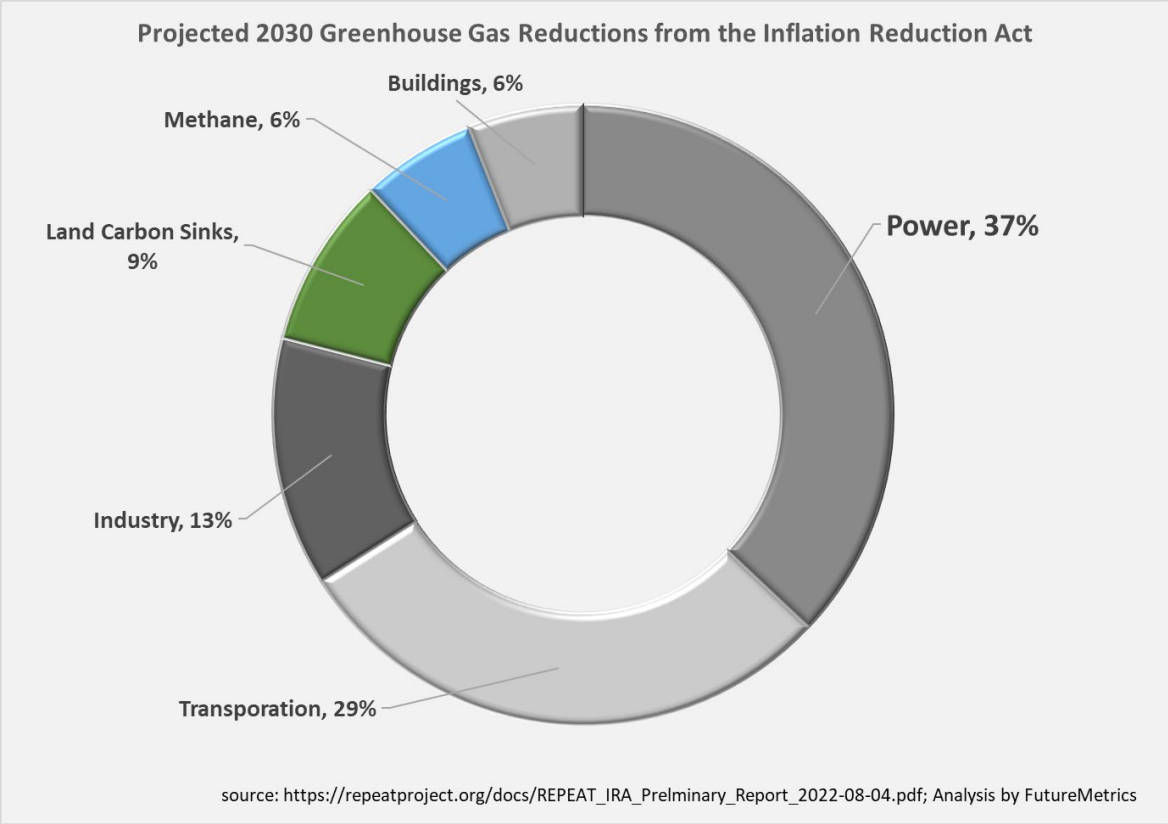

Vietnam Exports to Japan and South Korea
(metric tonnes)
CAGR from 2012 = 56.3%
Into Japan
Into S. Korea
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
157,226
742,794
1,022,809
1,254,955
1,517,746
2,186,659
1,941,460
1,912,268
2,101,600
2,200,792
373,524
886,984
1,168,639
1,646,839
2,394,572
source: International Trade Data; analysis by FutureMetrcs


Baltic States' Pellet Exports
(metric tonnes)
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Estonia
Latvia
Lithuania
265,000
902,000
430,000
321,000
1,056,000
623,000
298,000
1,277,000
641,000
312,000
1,534,000
883,000
308,000
1,660,000
942,000
405,000
1,586,000
1,252,000
473,000
1,580,000
1,105,000
596,000
1,958,000
1,119,000
609,000
2,105,000
1,068,000
612,000
1,717,000
1,542,000
502,000
1,660,000
1,369,000
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
source: International Trade Data, May 2023; Analysis by FutureMetrics


Industrial Wood Pellet Sector - Past Demand and Forecast with Evolving Policy in the UK and EU and Major Utility Demand in Japan
UK
Netherlands
Belgium
Denmark
Sweden
Other
S. Korea
Germany
Japan
Canada
US
In 1000's of Metric Tonnes
Average Growth from 2010 to 2022 is 1,720,000 Metric Tonnes per Year
Average Growth from 2023 to 2030 could be 2,830,000 Metric Tonnes per Year
source: historical demand from international trade data; forecast and analysis by FutureMetrics

The “Inflation Reduction Act” (IRA) will support the build out of Bioenergy Carbon Capture and Storage (BECCS) in the US.

The lowest cost and most efficient pathway to carbon negative is to replace coal with pellets in existing pulverized coal power stations and add CCS.



A selection of “new” coal fueled power stations

Station Name	Capacity (MW)	Age (Years)	
Arizona - Springerville Generating Station - Unit 4	458	13	
Arkansas - John W. Turk Jr. Power Plant - Unit 1	609	10	
Arkansas - Plum Point Energy Station - Unit 1	720	12	
Colorado - Comanche Generating Station - Unit 3	857	12	
Illinois - Dallman Station - Unit 4	230	13	
Illinois - Prairie State Energy Campus - Unit 1	883	10	
Illinois - Prairie State Energy Campus - Unit 2	883	10	
Iowa - Walter Scott Jr. Energy Center - Unit 4	923	15	
Kentucky - Spurlock power station - Unit 4	329	13	
Kentucky - Trimble County Generating Station - Unit 2	834	11	
Missouri - Iatan Generating Station - Unit 2	914	12	
Missouri - John Twitty Energy Center - Unit 2	300	11	
Nebraska - Nebraska City Station - Unit 2	738	13	
Nebraska - Whelan Energy Center - Unit 2	248	11	
North Carolina - James E. Rogers Energy Complex - Unit 6	910	10	
South Carolina - Cross Generating Station - Unit 3	591	15	
South Carolina - Cross Generating Station - Unit 4	652	14	
Texas - J. K. Spruce Station - Unit 2	878	12	
Texas - Oak Grove Plant - Unit 1	917	12	
Texas - Oak Grove Plant - Unit 2	879	11	
Texas - Sandy Creek Plant - Unit 1	1008	9	
Virginia - Virginia City Hybrid Energy Center -	668	10	
West Virginia - Longview Plant - Unit 1	808	11	
Wisconsin - Elm Road Generating Station - Unit 1	701	12	
Wisconsin - Elm Road Generating Station - Unit 2	701	11	
Wisconsin - Weston Power Plant - Unit 4	595	14	
Wyoming - Dry Fork Station - Unit 1	484	11	
TOTAL ==>	**18,717**	**11.8**	**<== Average Age**

BECCS by Drax will be one of the largest carbon removal projects in the U.S

It will permanently remove 2 million tons of carbon from the atmosphere while also generating 2 terawatt hours of 24/7 renewable power. And this is just the beginning. Drax is developing a pipeline of BECCS projects in the U.S. that will be available as early as 2025.

BECCS is the most scalable and affordable carbon removal technology available and can be deployed quickly — playing a key role in achieving a clean energy grid by 2035. BECCS offers high-integrity, permanent carbon removals that can complement your business strategy to decarbonize directly and enable you to meet your net zero goals. Now is your chance. Capture the opportunity and go further, faster with BECCS by Drax.

From Drax website: https://www.drax.com/us/wp-content/uploads/sites/10/2022/09/BS5038_Drax_Carbon_Removals_Brochure_Online-Final-Version.pdf

Replacing Coal with a Non-Depleting Carbon Beneficial Solid Fuel is a Pragmatic and Rational Component of a Decarbonization Strategy

Thank you! - William Strauss

WilliamStrauss@FutureMetrics.com

My dog Fezziwig helping at the local ski shop…