Overview of Global Pellet Markets
and

Micro-Scale Pellet-Fueled Combined Heat and Power:
A new distributed power solution for the smart grid of the future

By William Strauss, PhD, FutureMetrics

The New Forest Economy- Biobased Power, Products, & Fuels
E2Tech Forum
March 24, 2017

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Holson

May, 2014
Deal Valued at $50.1 Million
NEW ENGLAND WOOD PELLET
Jaffrey, New Hampshire
HAS BEEN ACQUIRED BY
RENTECH
Denver, Colorado
FutureMetrics and its consulting partners initiated the acquisition process and provided early stage advice, analysis, and due diligence for Rentech

IOGEN CORPORATION

WEST OREGON WOOD PRODUCTS

NCIC

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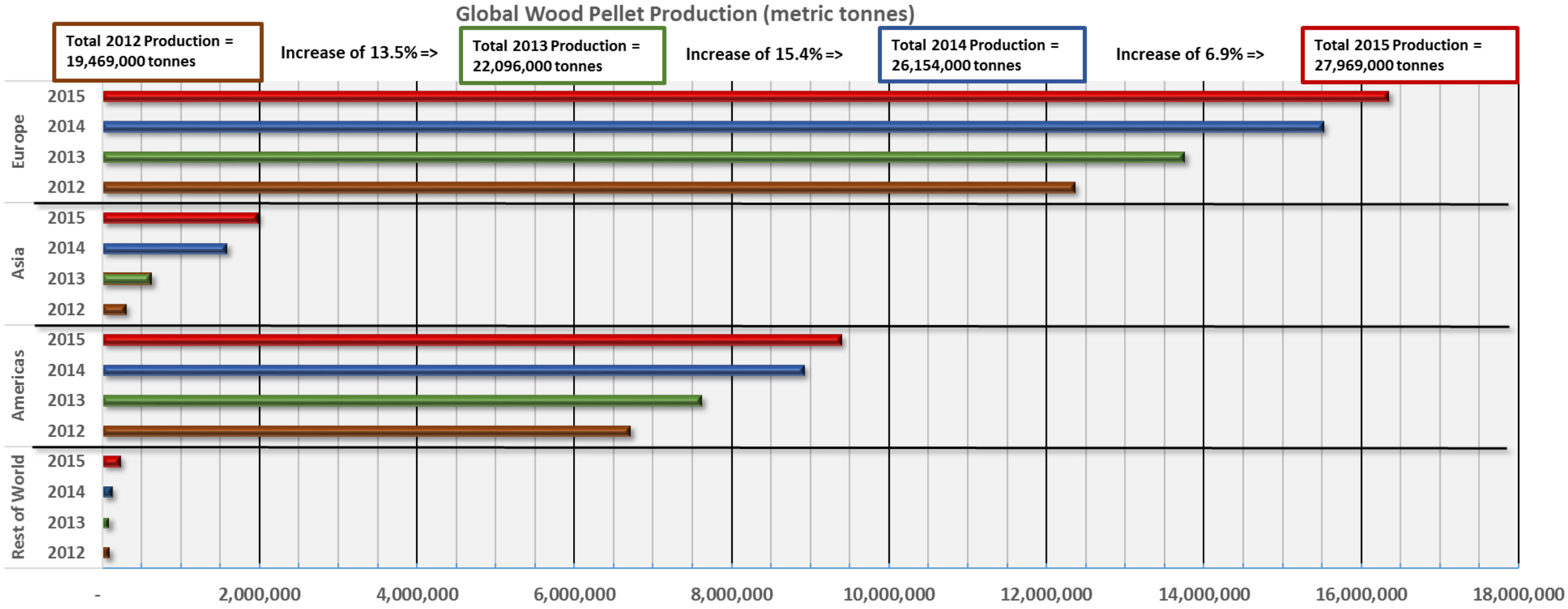
Overview of Global Pellet Markets

Putting this into perspective

Global wood pellet markets have had significant growth in the past decade. The wood pellet market has experienced growth rates over the last few years of about 10% annually from about 19.5 million metric tonnes in 2012 to about 28 million metric tonnes in 2015.

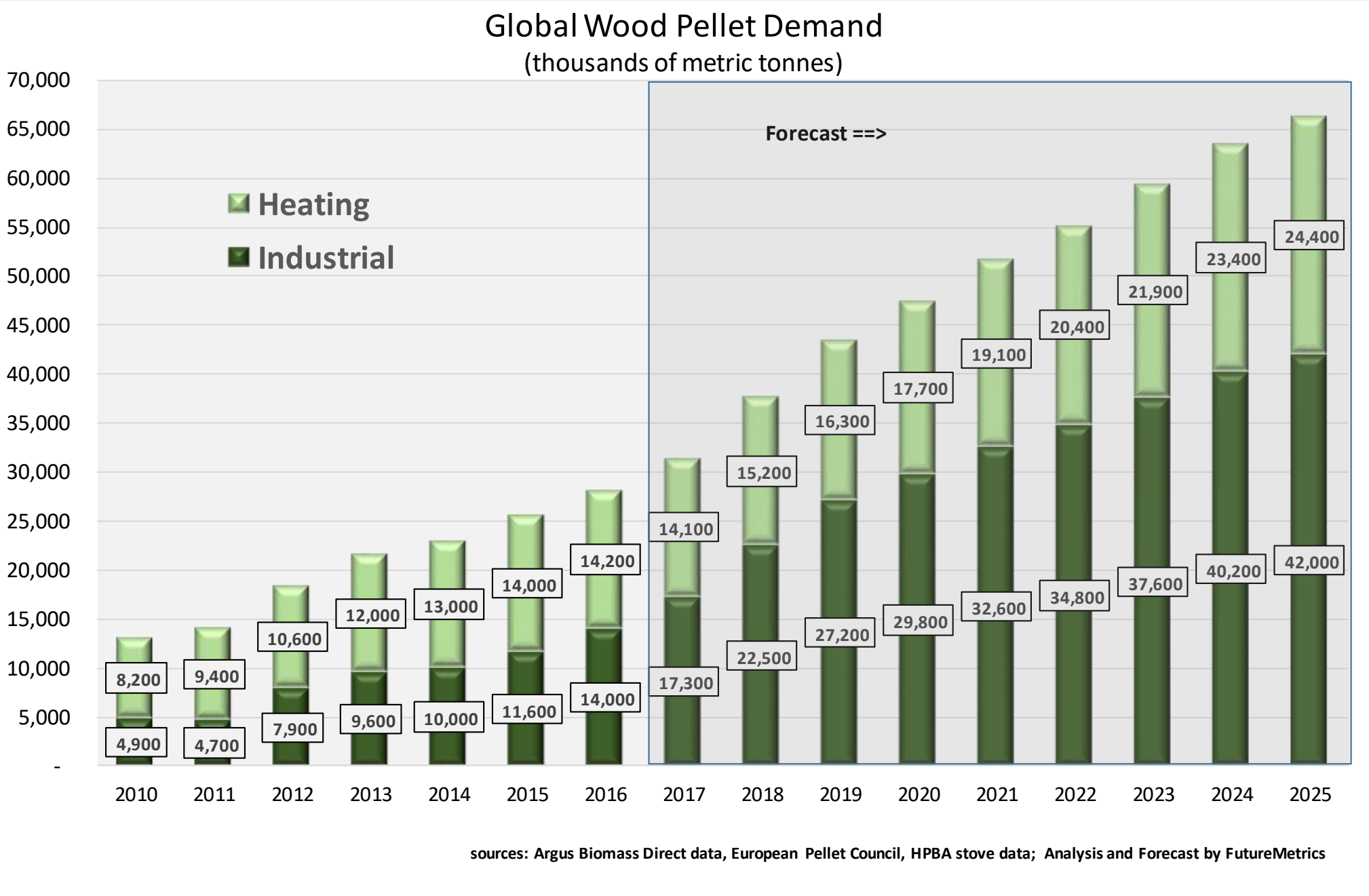


Source: Data from Food and Agriculture Organization of the United Nations, December, 2016, Analysis by FutureMetriics

There are Two Categories of Wood Pellets:

- For use in pellet stoves and pellet boilers for heat (premium heating pellets)

- For use as a substitute for coal in large utility power plants (industrial pellets)


Global Wood Pellet Demand
(thousands of metric tonnes)
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
Heating
Industrial
Forecast ==>
8,200
9,400
10,600
12,000
13,000
14,000
14,200
14,100
15,200
16,300
17,700
19,100
20,400
21,900
23,400
24,400
4,900
4,700
7,900
9,600
10,000
11,600
14,000
17,300
22,500
27,200
29,800
32,600
34,800
37,600
40,200
42,000
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
sources: Argus Biomass Direct data, European Pellet Council, HPBA stove data; Analysis and Forecast by FutureMetrics

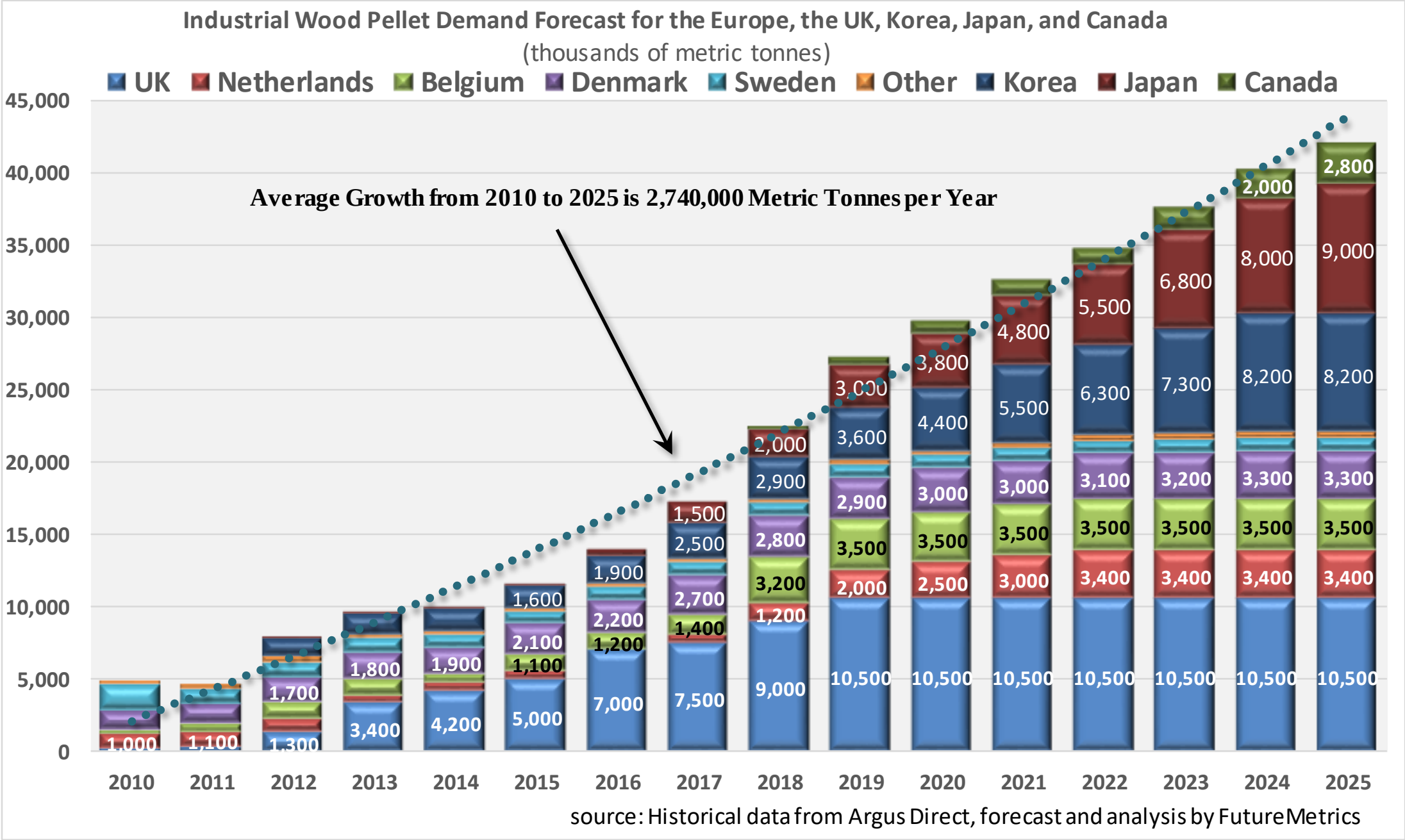
Industrial Wood Pellets

Why Wood Pellets are an Easy Substitute for Coal in Pulverized Coal (PC) Power Plants

- Wood pellets are upgraded solid fuel made from biomass.
- They are grindable.
- They are dry (~5% moisture content).
- They handle easily.
- They have an energy density of ~18 Gigajoules/tonne.

At low co-firing ratios (less than ~6% white wood pellets) no modifications are required.

At higher blend ratios modifications are needed but they are well understood and proven in large PC plants.


Industrial Wood Pellet Demand Forecast for the Europe, the UK, Korea, Japan, and Canada
(thousands of metric tonnes)
UK
Netherlands
Belgium
Denmark
Sweden
Other
Korea
Japan
Canada
Average Growth from 2010 to 2025 is 2,740,000 Metric Tonnes per Year
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
1,000
1,100
1,300
1,700
3,400
1,800
4,200
1,900
5,000
1,100
2,100
1,600
7,000
1,200
2,200
1,900
7,500
1,400
2,700
2,500
1,500
9,000
1,200
3,200
2,800
2,900
2,000
10,500
2,000
3,500
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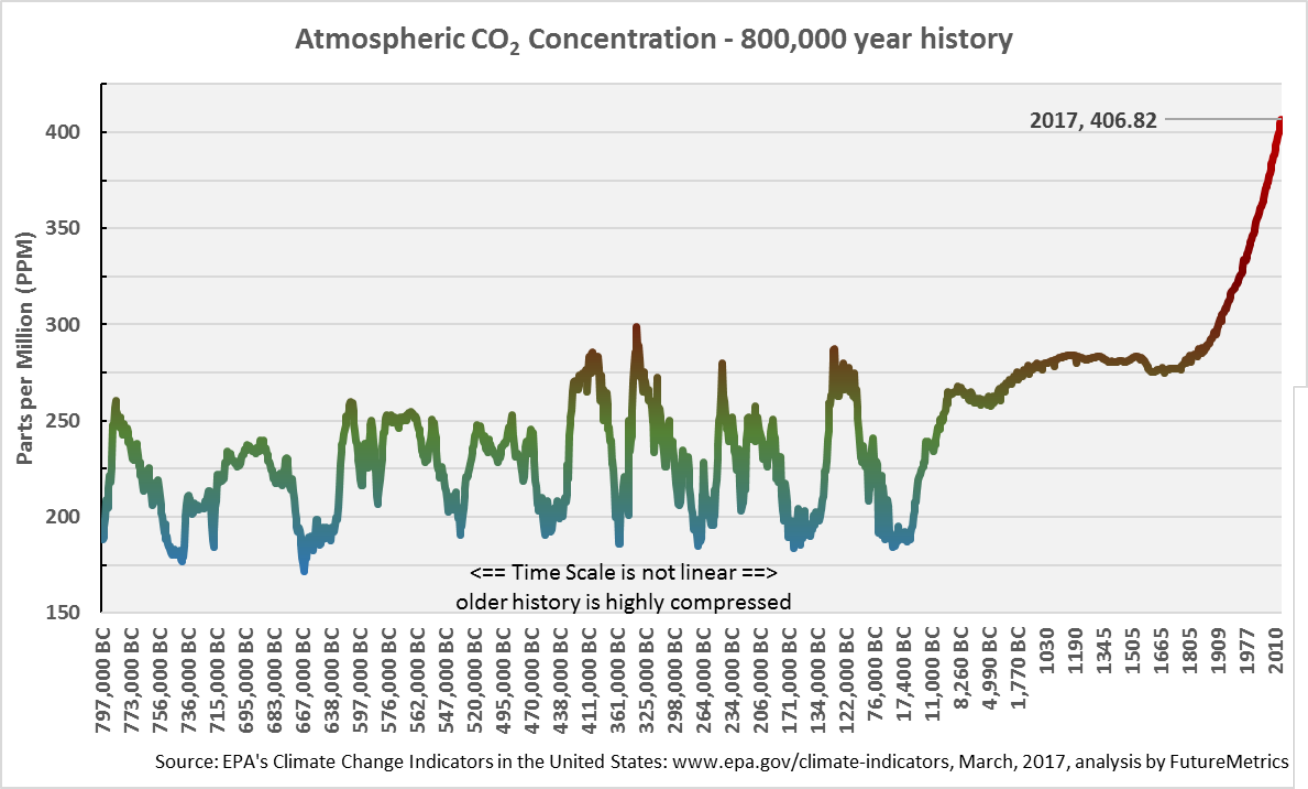
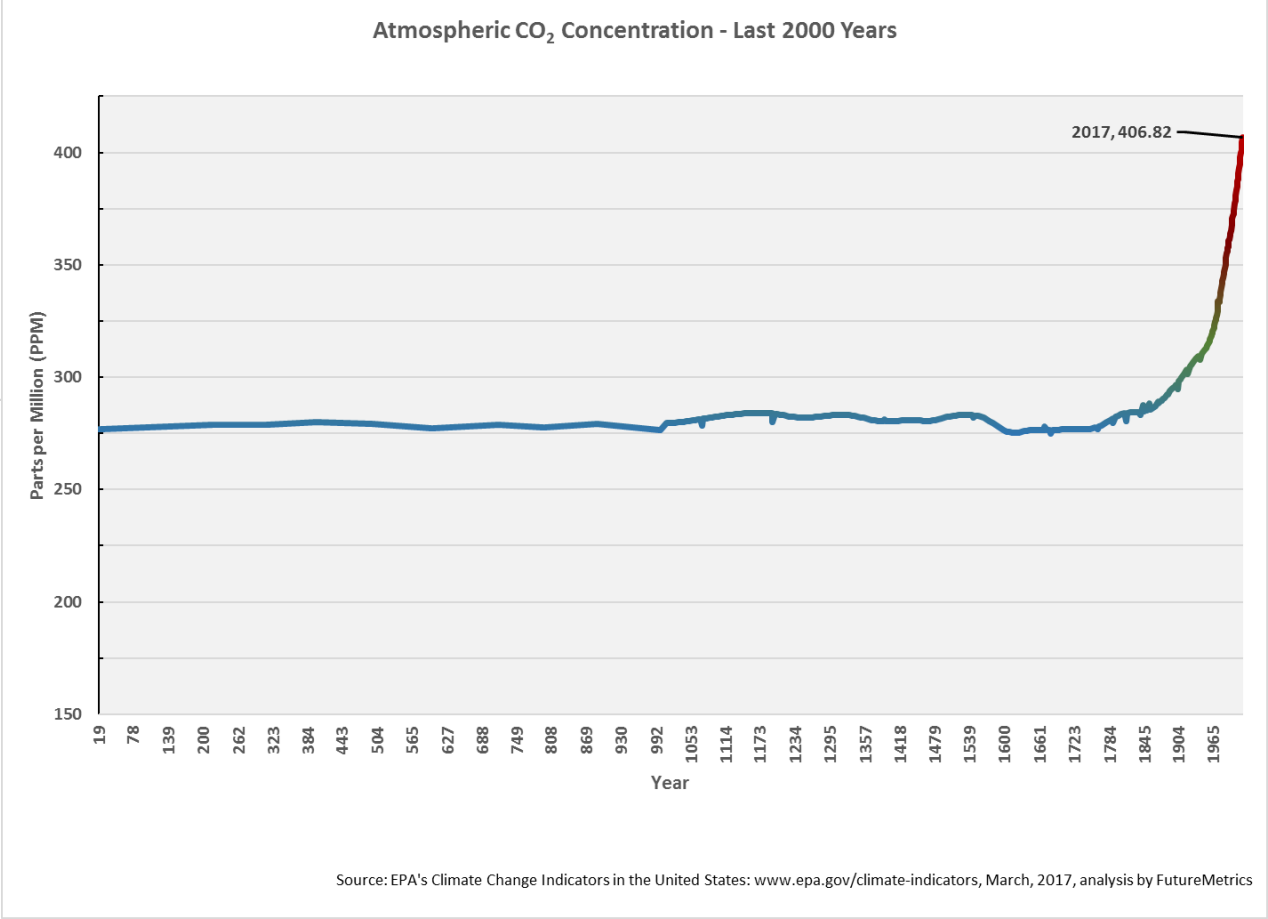
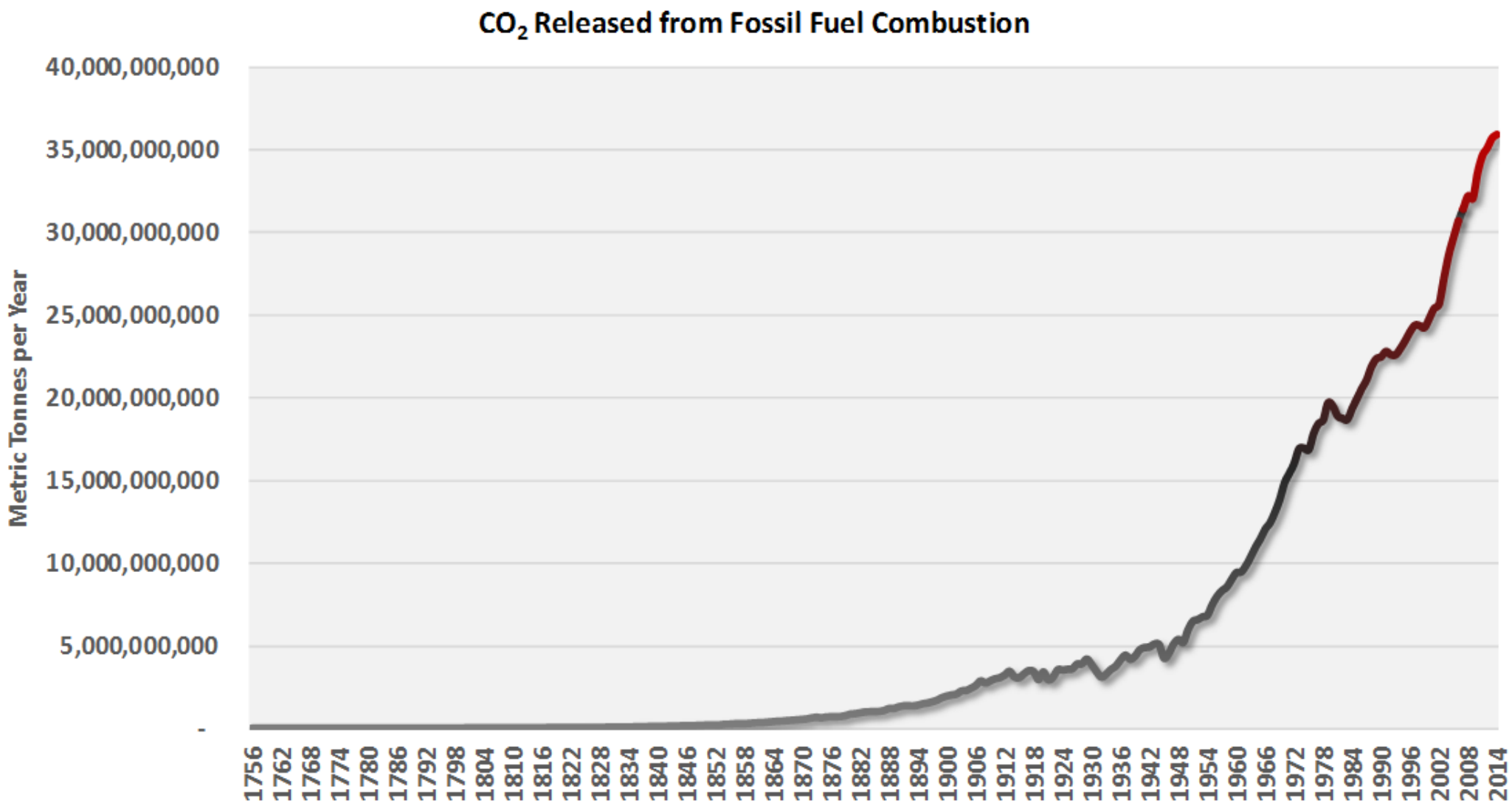
3,500
3,100
6,300
5,500
10,500
3,400
3,500
3,200
7,300
6,800
10,500
3,400
3,500
3,300
8,200
8,000
2,000
10,500
3,400
3,500
3,300
8,200
9,000
2,800
source: Historical data from Argus Direct, forecast and analysis by FutureMetrics

What is driving the industrial wood pellet markets?

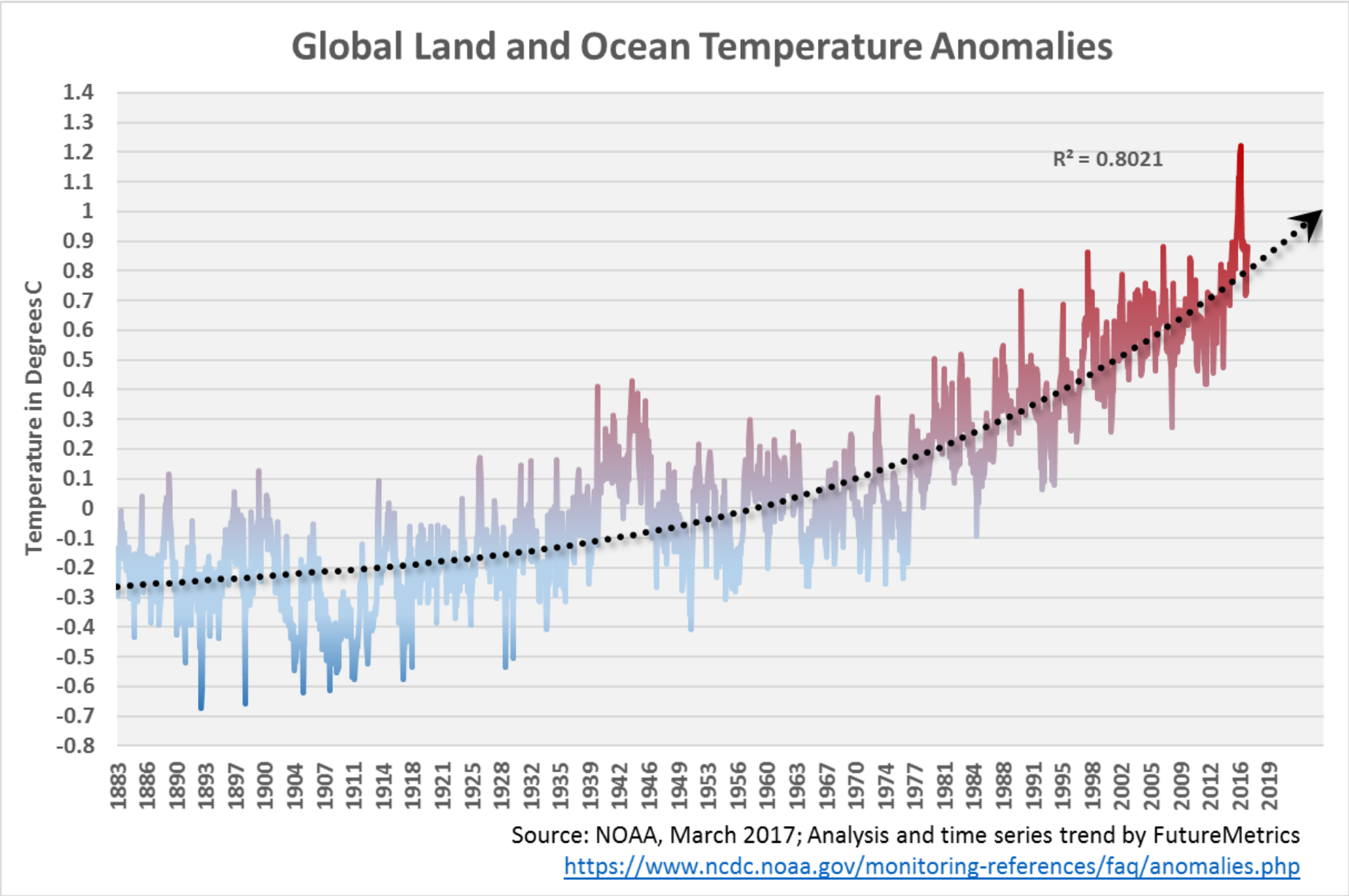


This is what is driving policy in every other developed country in the world except the US.



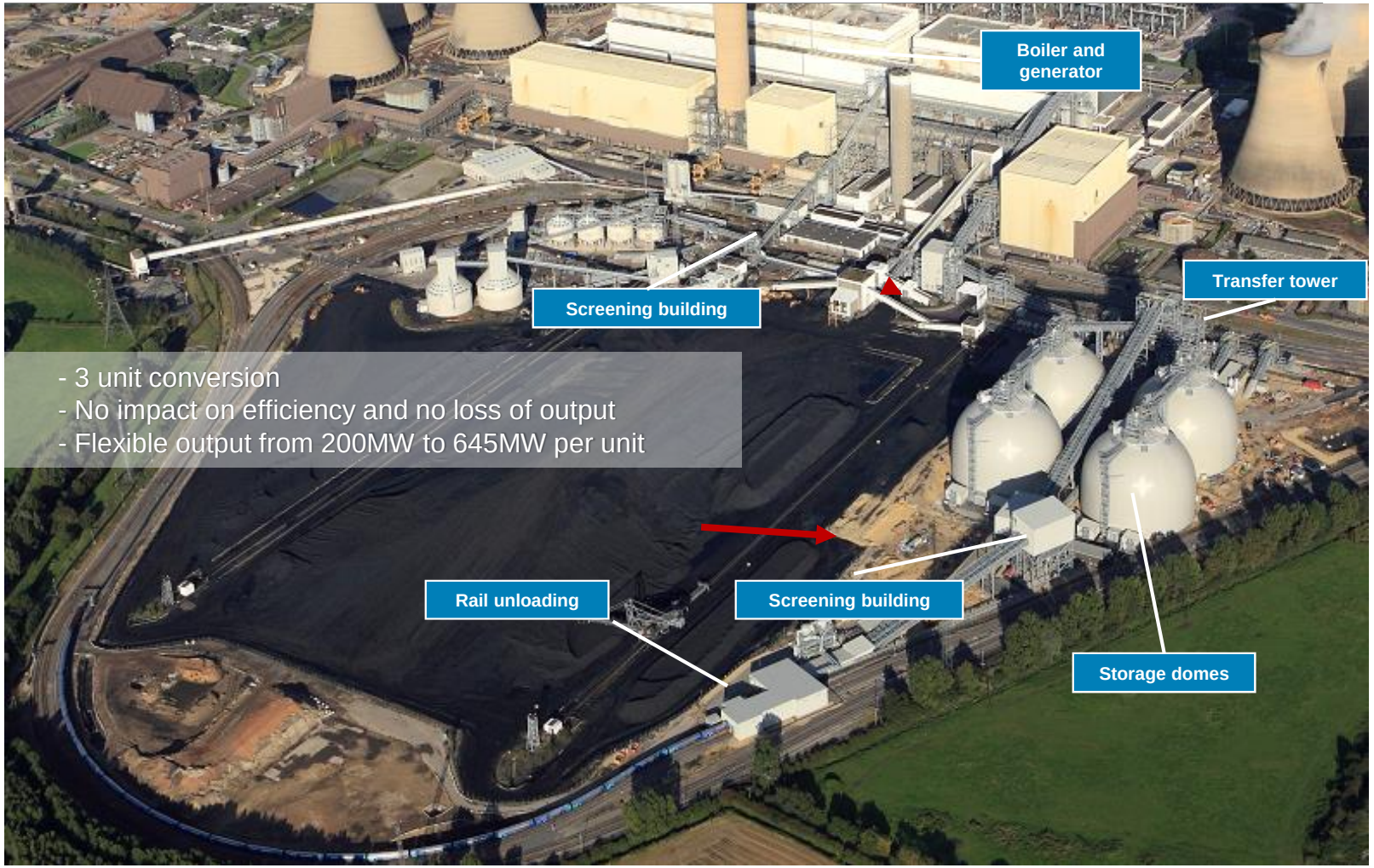


source: TA, Marland, G and Andres, RJ 2013. Global, Regional, and National Fossil-Fuel CO2 Emissions, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., USA doi 10.3334/CDIAC/00001_V2013, Augest 2016, Analysis by FutureMetrics



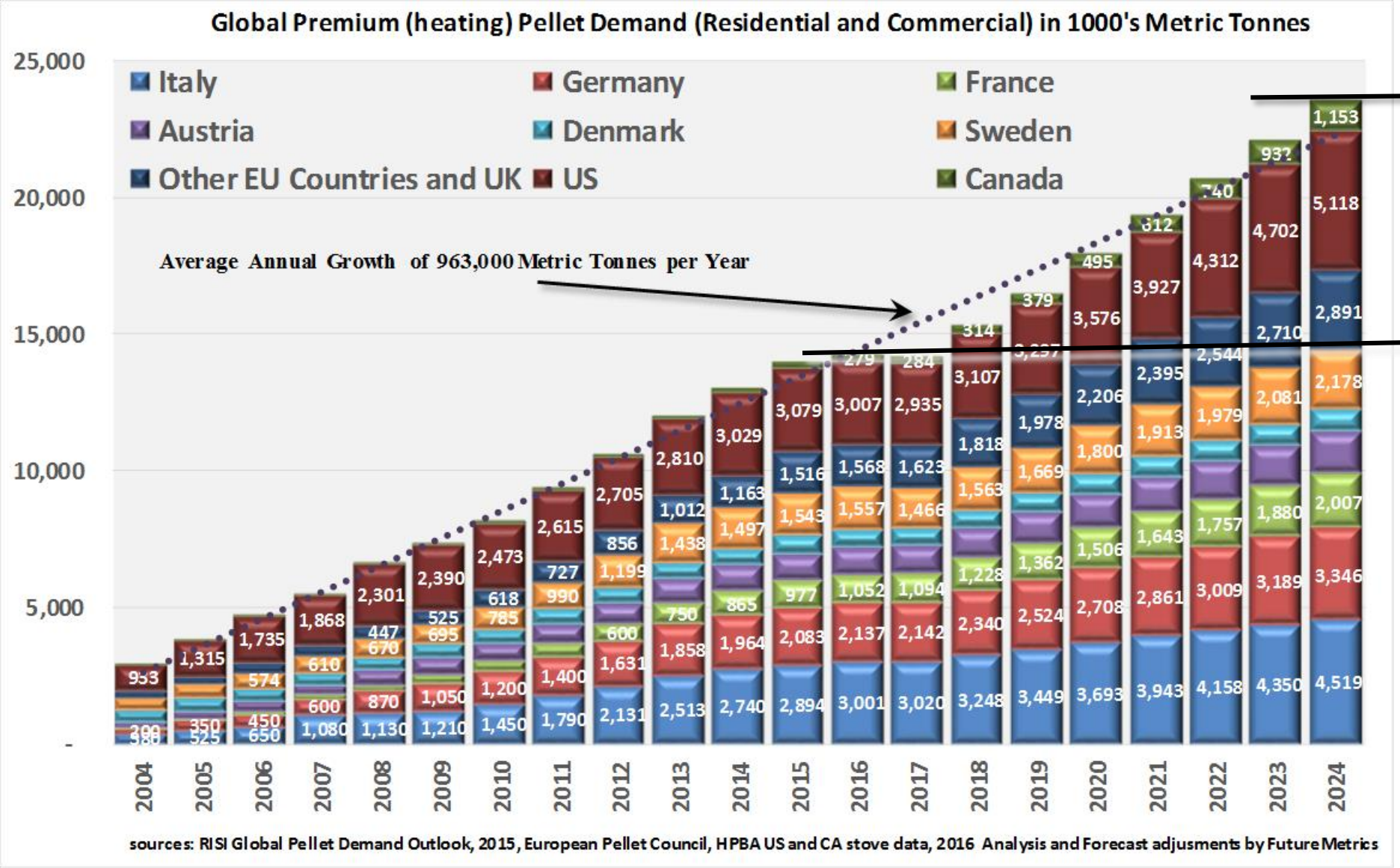
https://www.ncdc.noaa.gov/monitoring-references/faq/anomalies.php

Drax Power Station in the UK – Six 645 MW lines: three running on 100% wood pellet fuel



7.5 million metric tonnes per year of industrial wood pellets

Heating Pellets Markets



About 9 million tonnes per year increase

Micro-Scale Pellet-Fueled Combined Heat and Power:

A new distributed power solution for the smart grid of the future

The New Combined Heat and Power System

The new micro-CHP system is built upon the foundation of the reliable and highly efficient OkoFEN pellet boilers. There are more than 60,000 OkoFEN pellet boilers installed in 17 countries. In the US, thousands of systems produced in Maine by Maine Energy Systems are heating homes, businesses, municipal buildings, schools, and other buildings.

These fully automatic pellet boilers have proven their reliability and efficiency.

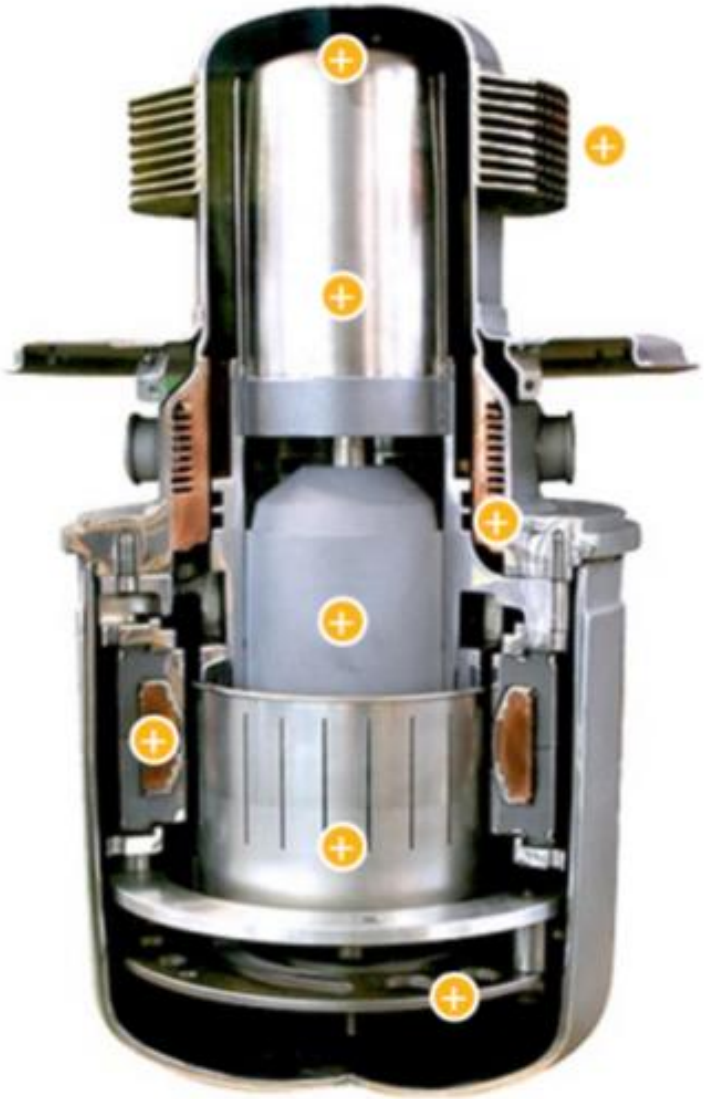
Now, in addition to heat, the pellet-fueled micro-CHP boiler also generates electricity.

After several years of R&D and field testing, the micro-CHP systems are being deployed in Europe and are several months from full approval for sale in the US.

The micro-CHP boiler produces up to 60 kilowatts of heat (about 205,000 BTU/hour) and up to 5 kilowatts of electricity. So, while the building is being heated by pellets, the CHP unit is also generating electricity.

The entire system sits on a space that is about 40 inches by 36 inches (100cm x 90cm).

The Generating Unit



How the Stirling engine and generator work[3].

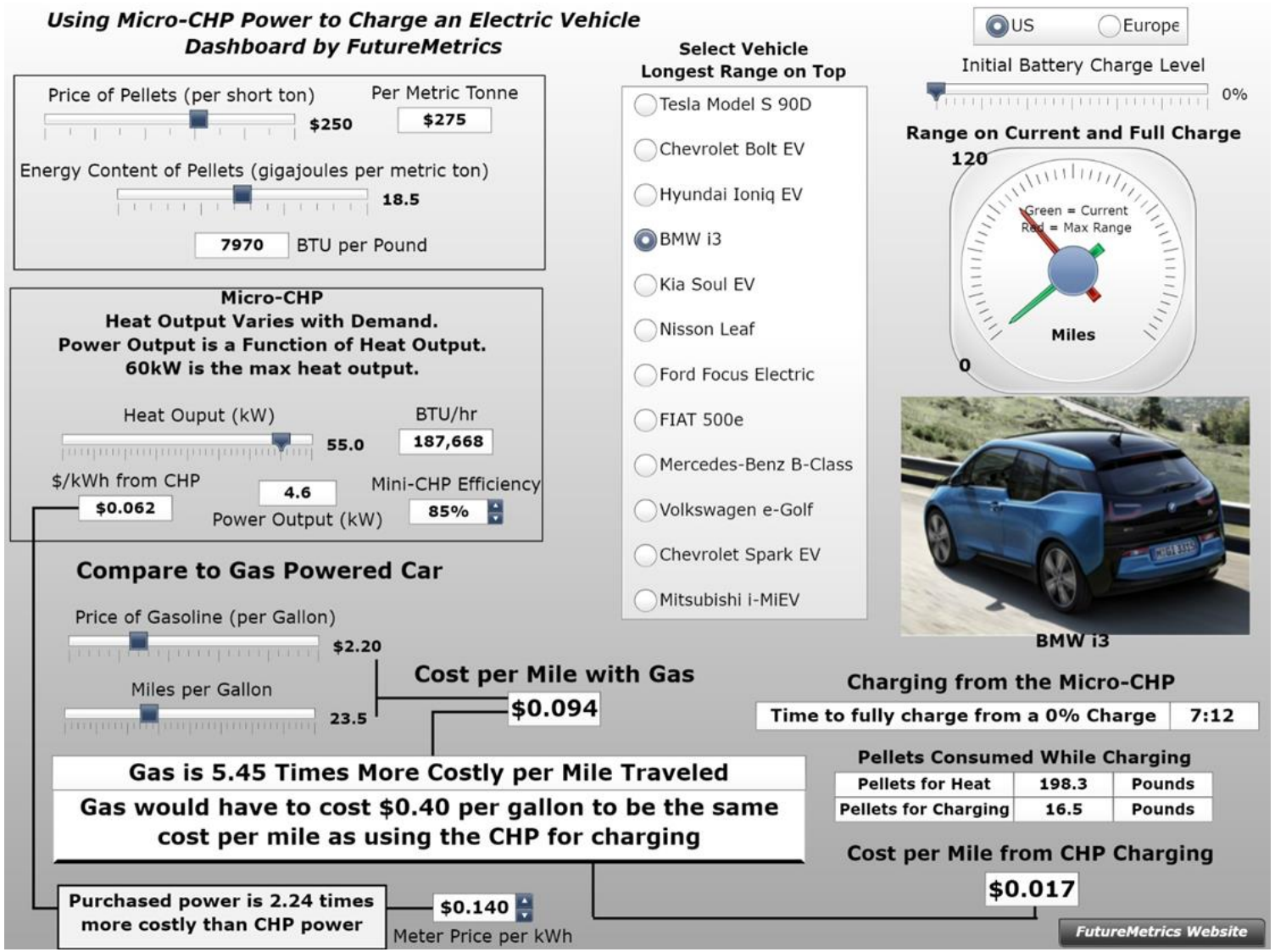
1. The head of the Stirling engine is heated with the flame of the wood pellet fuel. The heat is then transferred to the working fluid of the Stirling engine (helium). The heating leads to a pressure increase.

2. With the heat supply and the cooling of the Stirling engine from return water in the heating loop, a temperature and pressure difference is generated. Through this temperature difference, the helium in the Stirling engine expands and contracts in a cycle and the piston is set in motion moving up and down 60 times per second.

3. This movement is converted by the linear generator inside the Stirling engine into 60 cycle AC electricity.

Putting the Value of Micro-Scale Pellet-Fueled CHP in Perspective

Dashboard is free to play with at www.FutureMetrics.com



With the default inputs for the dashboard and comparing a gasoline fueled car with the BMW i3 EV, it is 5.45 times costlier in the US to drive the same distance in a combustion engine car running on gas than it is with the EV charged by the micro-CHP.

Or to put in another way, gas would have to cost about $0.40/gallon for the two costs per mile to be equivalent.

A Vision of How Micro-CHP will be Part of the Smart Grid and Invigorate the Market for Wood Pellets

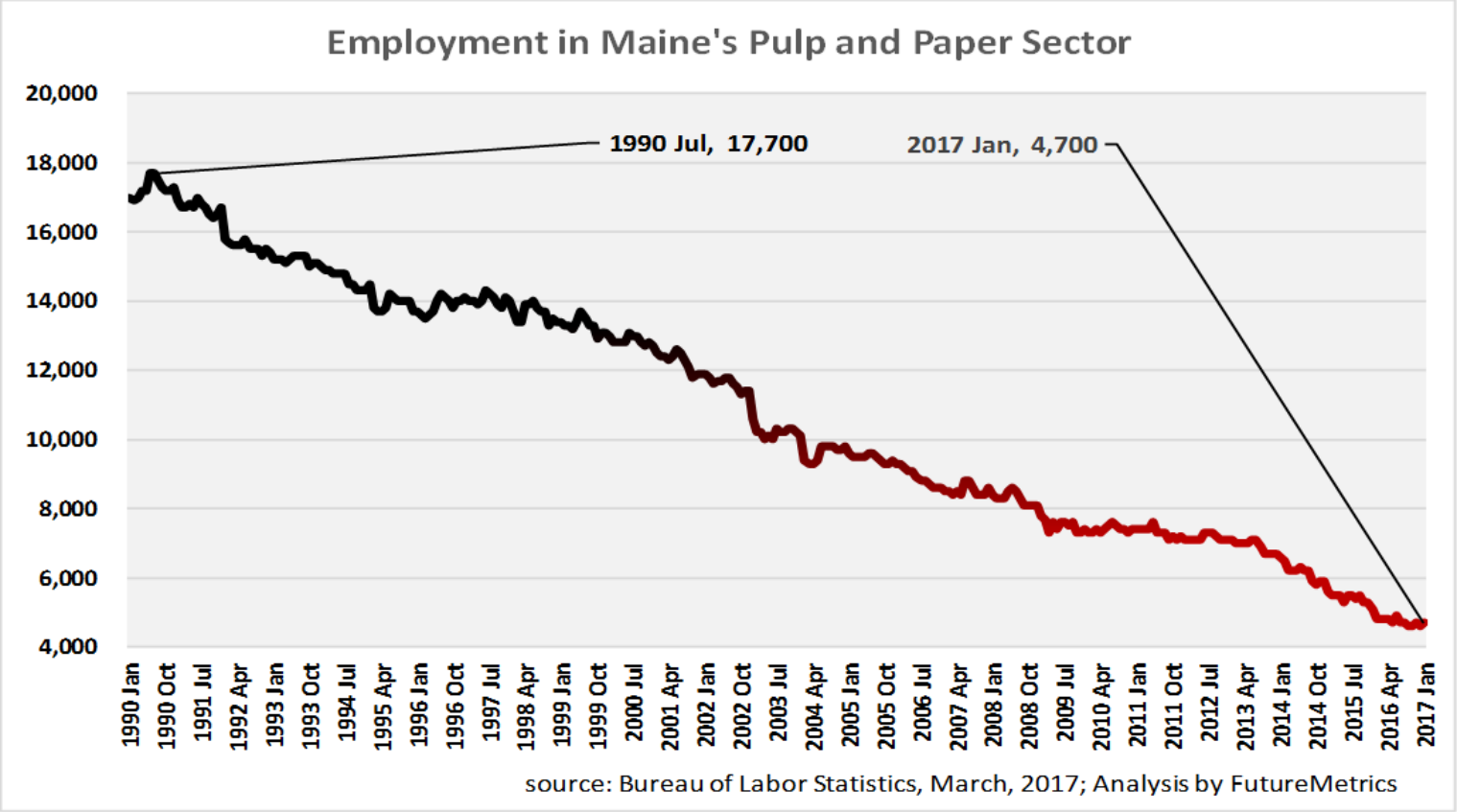
Based on EIA and US census data, Maine has the lowest proportion of homes and business connected to natural gas (5.8%).

Because natural gas infrastructure does not reach most of Maine's small towns and rural areas, Maine has the highest dependency on heating oil and propane of any state in the US. Maine also has the highest proportion of people living in rural areas (61.3%) than any other state.

Most of Maine's occupied buildings will never connect to a natural gas pipeline.

Furthermore, Maine has suffered major losses in the pulp and paper sector over the last few years.

"It's no secret that Maine has lost pulp mills in recent years. Bucksport, East Millinocket, Lincoln, Old Town, and Madison are now gone. The storied Androscoggin Mill in Jay is now a shadow of its former self (as measured by wood use), with Verso having moved beyond its "Skinny Andro" plan to something even leaner. Across these mills, Maine has lost somewhere around 3 million tons of pulpwood (and mill chip) markets since 2014. Put another way, the market has shrunk by 275 loads per day, every day. That doesn't count the biomass markets lost at these mills."*



*From an article by Eric Kingsley, Innovative Natural Resource Solutions, in The Northern Logger and Timber Processor Magazine, February 2017

If we assume that 20% of the estimated 262,000 occupied buildings in Maine not on natural gas are large enough to have a demand of 205,000 BTU/hour or more, and that they install the OkeFEN/MESys pellet-fueled CHP systems over the next several years, there would be about 52,400 micro-CHP systems providing heat and power in Maine.

If the average output of electricity per unit over the heating season is 2.5 kW's, **the average output from all of those systems would be about 131 megawatts. At peak power output during the cold winter months when the micro-CHP is outputting 5 kW's, the 52,400 units would be generating 262 MW's.**

The aggregated distributed power production would make the top ten list of power plant capacities in Maine; and during the cold winter months, the top five (the top four if Wyman is excluded).

Plant	Primary energy source	Operating company	Net summer capacity (MW)
William F Wyman	Petroleum	FPL Energy Wyman LLC	811
Westbrook Energy Center Power Plant	Natural gas	Westbrook Energy Center	506
Maine Independence Station	Natural gas	Casco Bay Energy Co LLC	490
Bucksport Generation LLC	Natural gas	Verso Bucksport LLC	274
Rumford Power, Inc	Natural gas	Rumford Power	254
Oakfield Wind Project	Wind	First Wind O&M, LLC	148
Androscoggin Energy Center	Natural gas	Verso Paper Androscoggin LLC	137
Kibby Wind Power Project	Wind	TransCanada Maine Wind Development Inc	132
Great Lakes Hydro America - ME	Hydroelectric	Great Lakes Hydro America LLC	132
Somerset Plant	Wood	Sappi Fine Paper North America-Somerset	115

Source: U.S. Energy Information Administration, Form EIA-860, "Annual Electric Generator Report." January, 2017

Most of those MW's would replace power generated from natural gas transported to Maine from far away with fuel made in Maine.

And all the heat that the micro-CHP systems produce would replace heat produced from heating oil and propane with heat produced from pellet fuel made in Maine.

Each unit would use about 30 tons of wood pellets per year .

Aggregate demand under this scenario would be about 1.56 million tons per year.

1.56 million tons per year may sound inconceivable for Maine which only has current pellet production capacity of about 300,000 tons per year.

But that 3 million tons per year of wood chips that pulp mills in Maine have been taking in for generations, but are no longer using (and never will again), could produce about 1.65 million tons per year of wood pellets; enough to fulfill this vision for the future.

Furthermore, many of the jobs that have been lost would return.

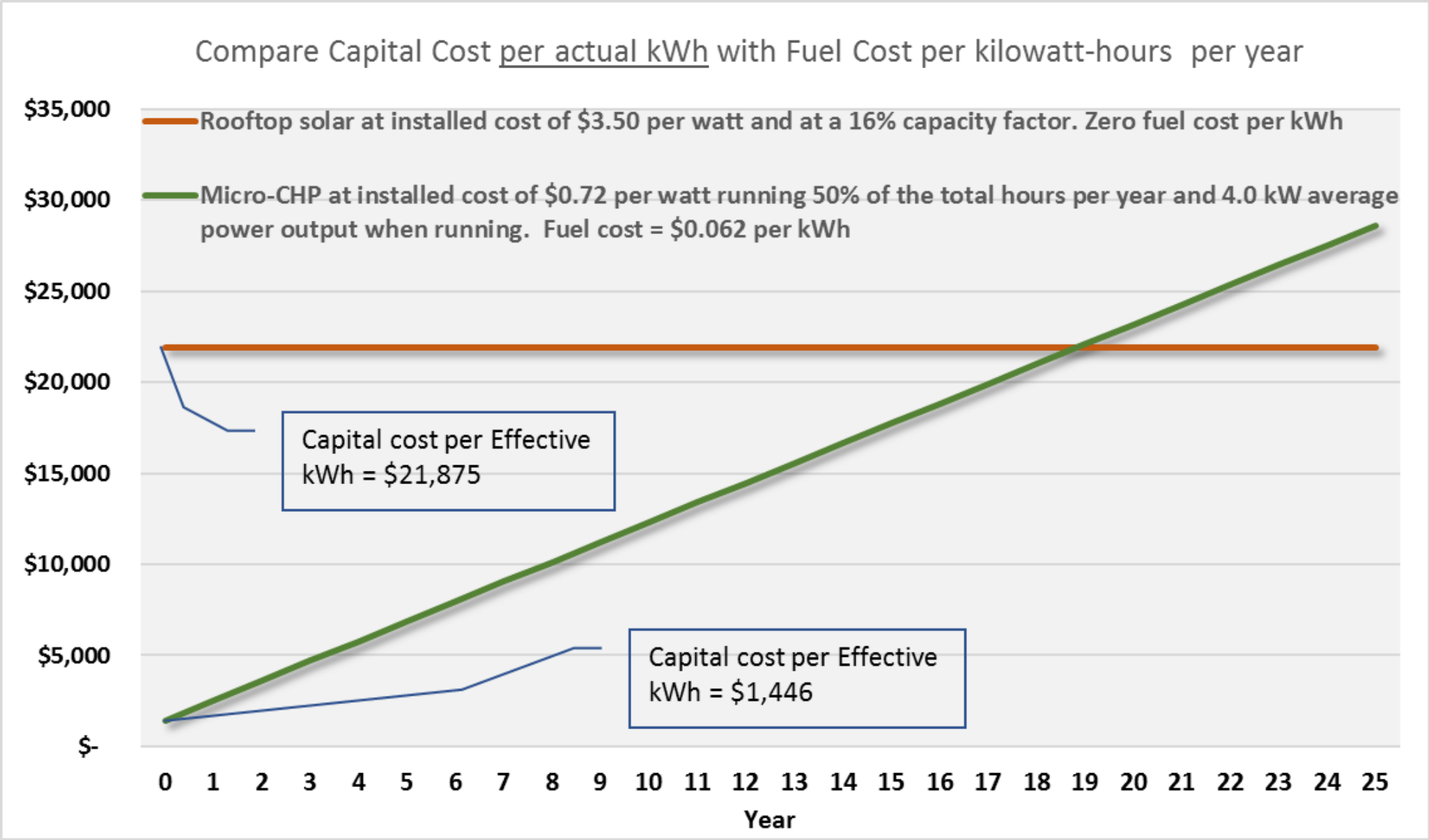

Compare Capital Cost per actual kWh with Fuel Cost per kilowatt-hours per year
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$-
Rooftop solar at installed cost of $3.50 per watt and at a 16% capacity factor. Zero fuel cost per kWh
Micro-CHP at installed cost of $0.72 per watt running 50% of the total hours per year and 4.0 kW average power output when running. Fuel cost = $0.062 per kWh
Capital cost per Effective kWh = $21,875
Capital cost per Effective kWh = $1,446
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year

TABLE 1: SOLAR PV CAPACITY FACTORS BY STATE AND AREA, 2015 EIA DATA					
State/Area	Number of Plants	Installed Capacity MW	Average MW Per Plant	Generation GWh	Capacity Factor
California	289	4,395	15.3	10,826	28.1
Arizona	48	1,078	22.5	2,550	27.0
Nevada	11	238	21.6	557	26.7
New Mexico	33	261	7.9	590	25.8
Colorado	20	118	5.9	235	22.7
Texas	12	187	15.6	354	21.7
North Carolina	148	669	4.5	1,162	19.8
New York	13	53	4.1	84	18.2
Indiana	24	94	3.9	149	18.1
Maryland	17	67	3.9	101	17.2
Vermont	14	28	2.0	41	16.9
Ohio	12	38	3.2	56	16.7
New Jersey	116	409	3.5	597	16.7
Maine	115	295	2.6	416	16.1
Pennsylvania	19	47	2.5	64	15.5
Other States	56	288	5.1	488	19.3

This transition cannot happen overnight.

But there is nothing in this strategy that is not possible.

- The technology exists,
- The sustainable wood supply exists,
- The economics for producing heat and power from pellet fuel makes sense, and
- Maine needs a way to revitalize its forest products industry.

Over the next decade, Maine could achieve this vision.

Some analysts predict that all new cars will be electric vehicles by 2035 .

Perhaps well before that, for those of us that live in the parts of the world that have cold winters and well-managed and underutilized working forests, micro-CHP fueled by low carbon renewable locally produced pellet fuel will be supplying some of the electricity that will drive us to work.

Thank you!

Bill Strauss