Biomass Power Options for Power Generation: Pellets, PKS, Chips…?

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Canadian Wood Pellet Industry Seminar & Networking Reception

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Embassy of Canada

FutureMetrics

Intelligent Analysis, Operations Expertise, and Strategic Leadership for the Pellet Sector

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www.FutureMetrics.com

- **Project evaluation and risk analysis for investors**
- **Operations optimization for new and existing pellet plants**
- **Market research and strategic guidance across the pellet supply chain**

Consultants to the World's Leading Companies in the Wood Pellet Sector

Selection of Current and Recent Clients of our Team

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draxbiomass

Highland

SEWALL

cosan

enviva

Hancock Natural Resource Group

HANCOCK LUMBER

DOOSAN

Seaonus
Diversified Port Holdings

CEFC
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Department of Conservation
Maine Forest Service
State of Maine

BTEC
Biomass Thermal Energy Council

Cate Street Capital

MESYS
MAINE ENERGY SYSTEMS

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

Trans Pacific Fibre

WEST OREGON WOOD PRODUCTS

NCIC

LAHMEYER INTERNATIONAL

FULGHUM FIBRES

VIRIDIS ENERGY INC.

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The *FutureMetrics* Coal-to-Pellets Team

RAMBOLL

- Global leader in providing engineering services to power stations
- Significant experience and in-house expertise in power plant modifications from coal to co-firing or full conversion to wood pellet fuel

Hancock Renewable Energy Group®

- Financing for new pellet manufacturing, new pellet transportation infrastructure, and power plant upgrades and modifications
- An investment and asset management subsidiary of Manulife Financial investing capital in timberland, agricultural land and renewable energy infrastructure (with a focus on biomass)

FutureMetrics
RESEARCH, ANALYTICS, EXPERT ADVICE

- Leading global consultant in the wood pellet sector
- Provides information, analysis, operations guidance and strategic advice to many of the world's leading companies in the wood pellet sector

Award Winning and Well-Respected FutureMetrics Team Members

Dr. William Strauss, President

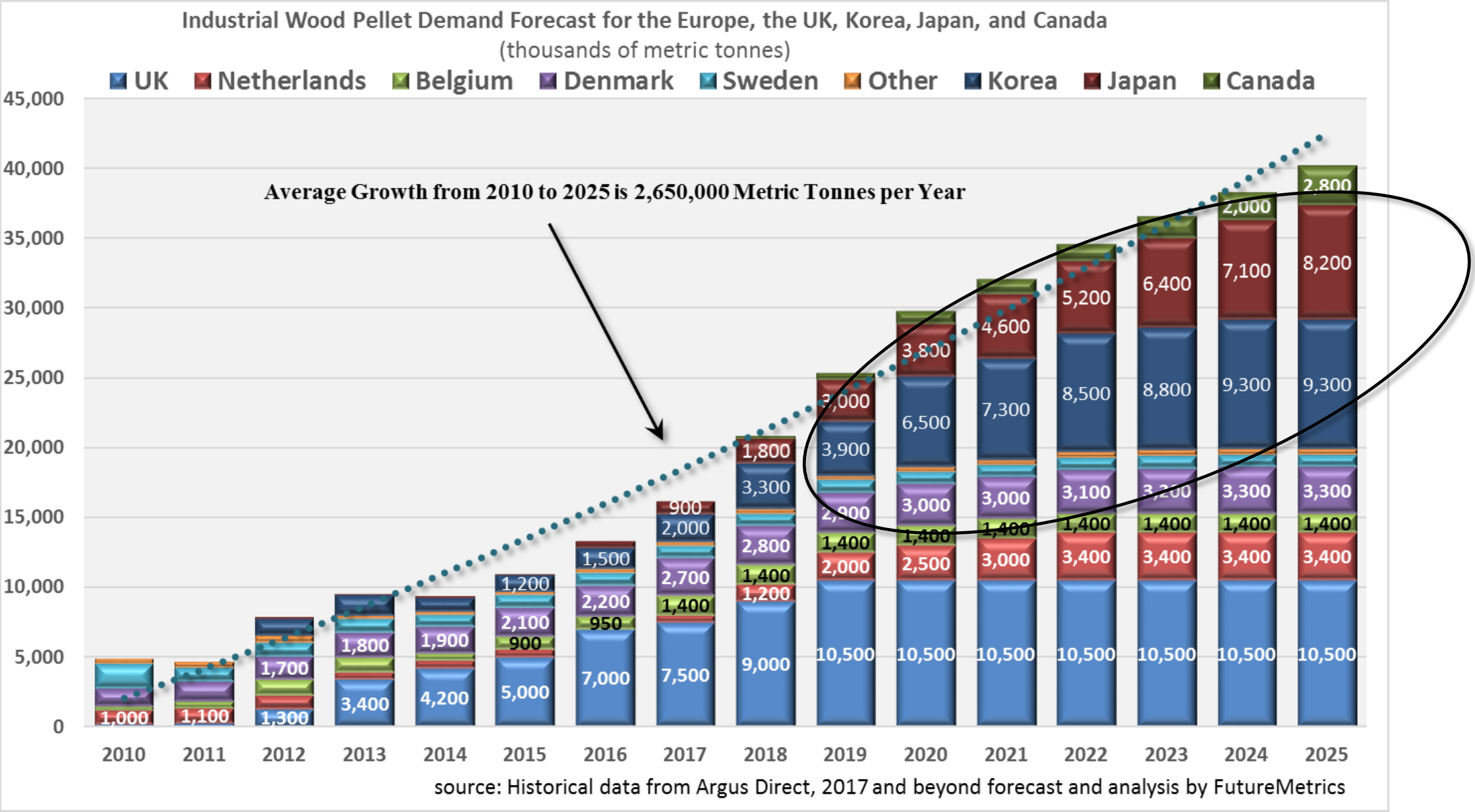
Named one of the most influential leaders in the biomass sector in 2016 and 2017 by Argus Media.

Recipient of the 2012 International Excellence in Bioenergy Award.

John Swaan, VP

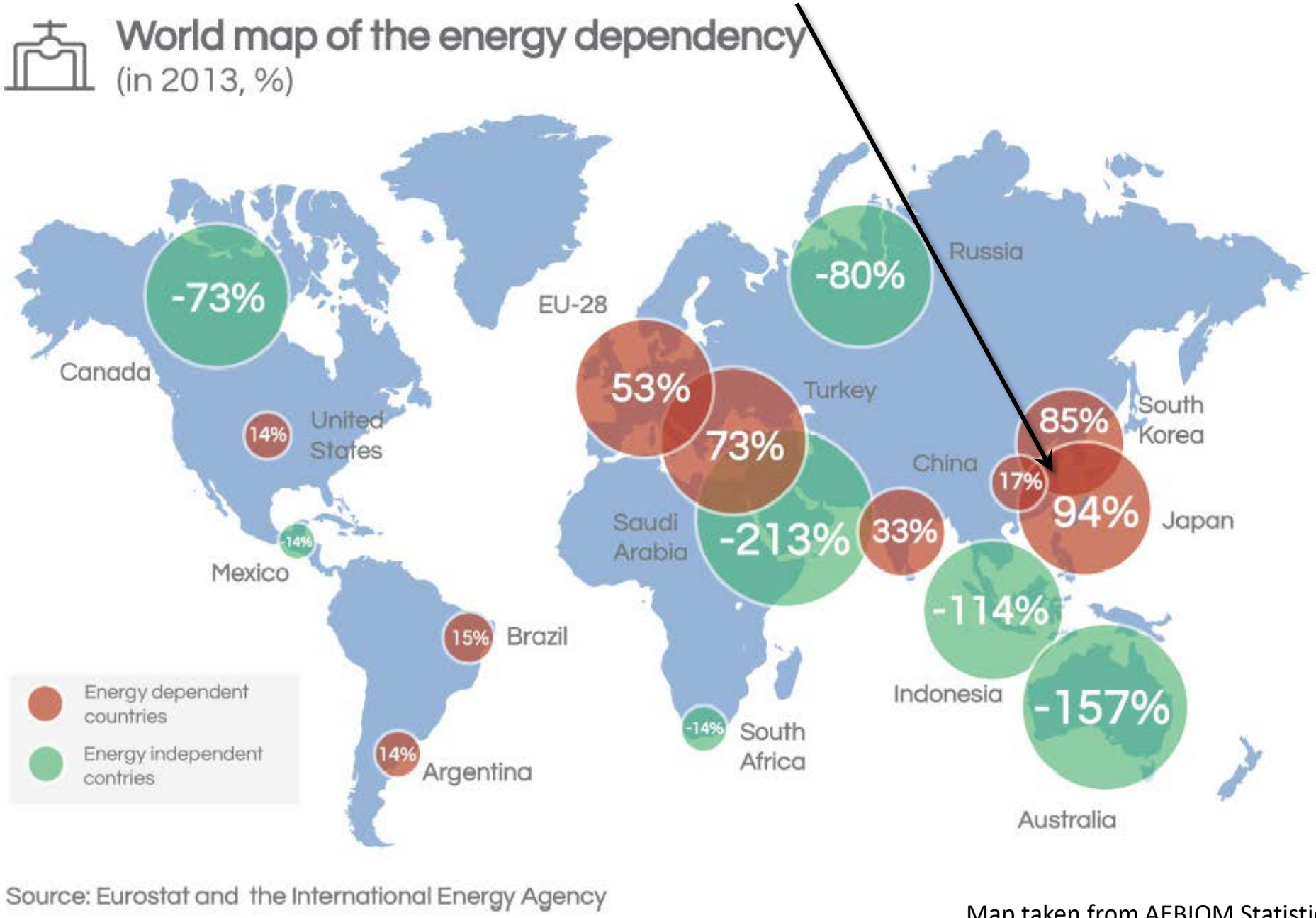
Recipient of the 2014 International Founders Award.

Founder of Pacific BioEnergy and producer of the first transatlantic shipment of wood pellets from North America to Europe (1998).



Growth from 2020 onward is primarily expected to be in Japan and S. Korea

Japan is the most energy dependent country; S. Korea is a close second.



Map taken from AEBIOM Statistical Report, 2016

Both Japan and S. Korea are major importers of coal.

For renewable low carbon thermal energy generation, biomass imports will be needed.

Wood Pellets, Palm Kernel Shell (PKS), or Chips?

A Primary Consideration for Biomass Fuels:
The cost per unit of energy delivered to the power station!

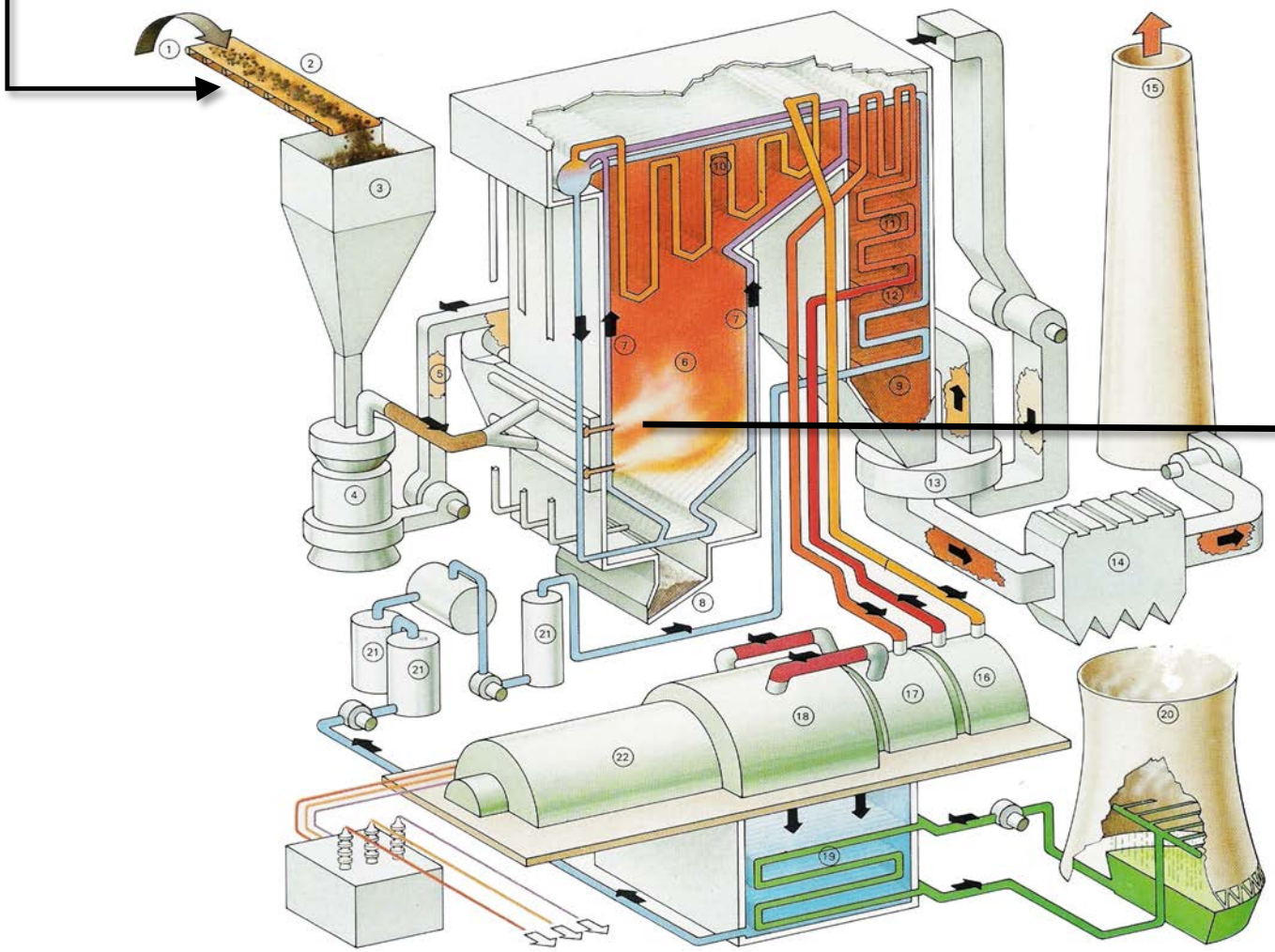
(There are other considerations which are highlighted later in this presentation)

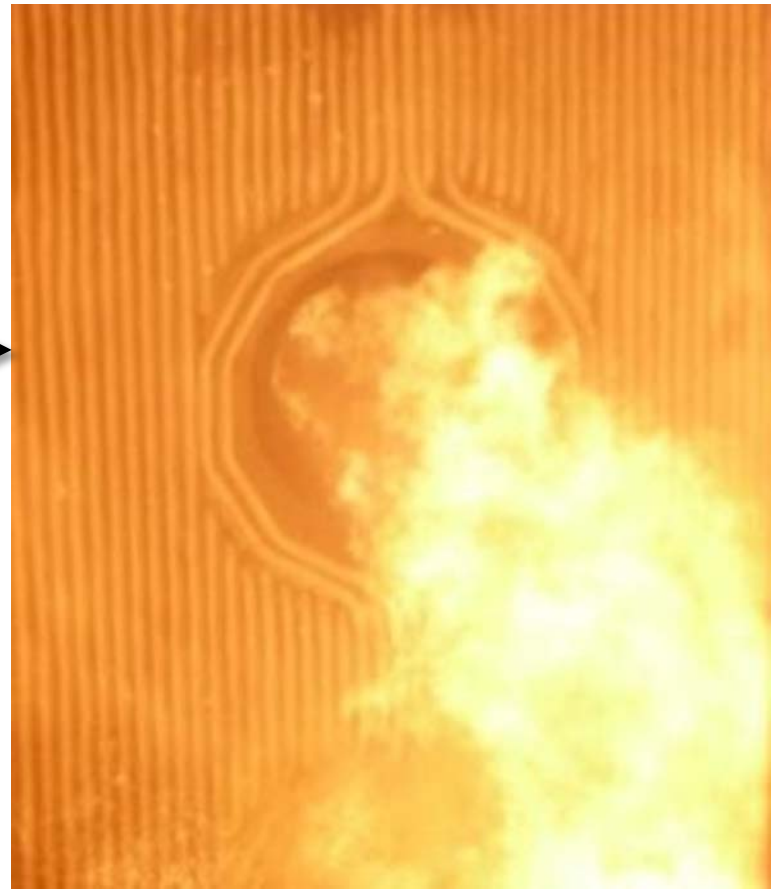
Optimizing the cost of the delivery of energy (gigajoules or GJ's) drives the selection of fuel.

Wood chips are 40% to 55% water! So transport cost per GJ are high.
When used as fuel, the high moisture content dramatically lowers efficiency.
The power plant needs a very large area and to store the lower energy density fuel.

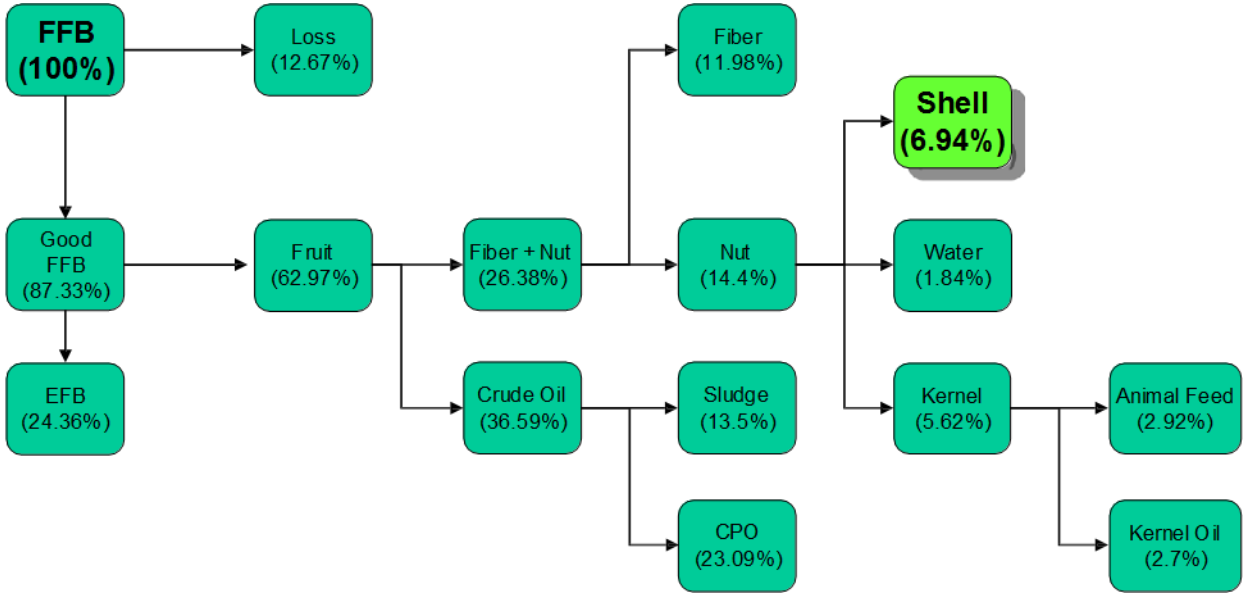
Dry energy-dense fuel is preferred: wood pellets or PKS.

Wood pellets are used in existing large power boilers that rely on pulverized coal. Wood pellets pulverize and can substitute for coal. If properly modified, there is no lost of output or reliability.





Palm Kernel Shell (PKS) – Are <u>not suitable for large-scale pulverized coal boilers</u> (they do not pulverize) but are used in smaller circulating fluidized bed (CFB) boilers.



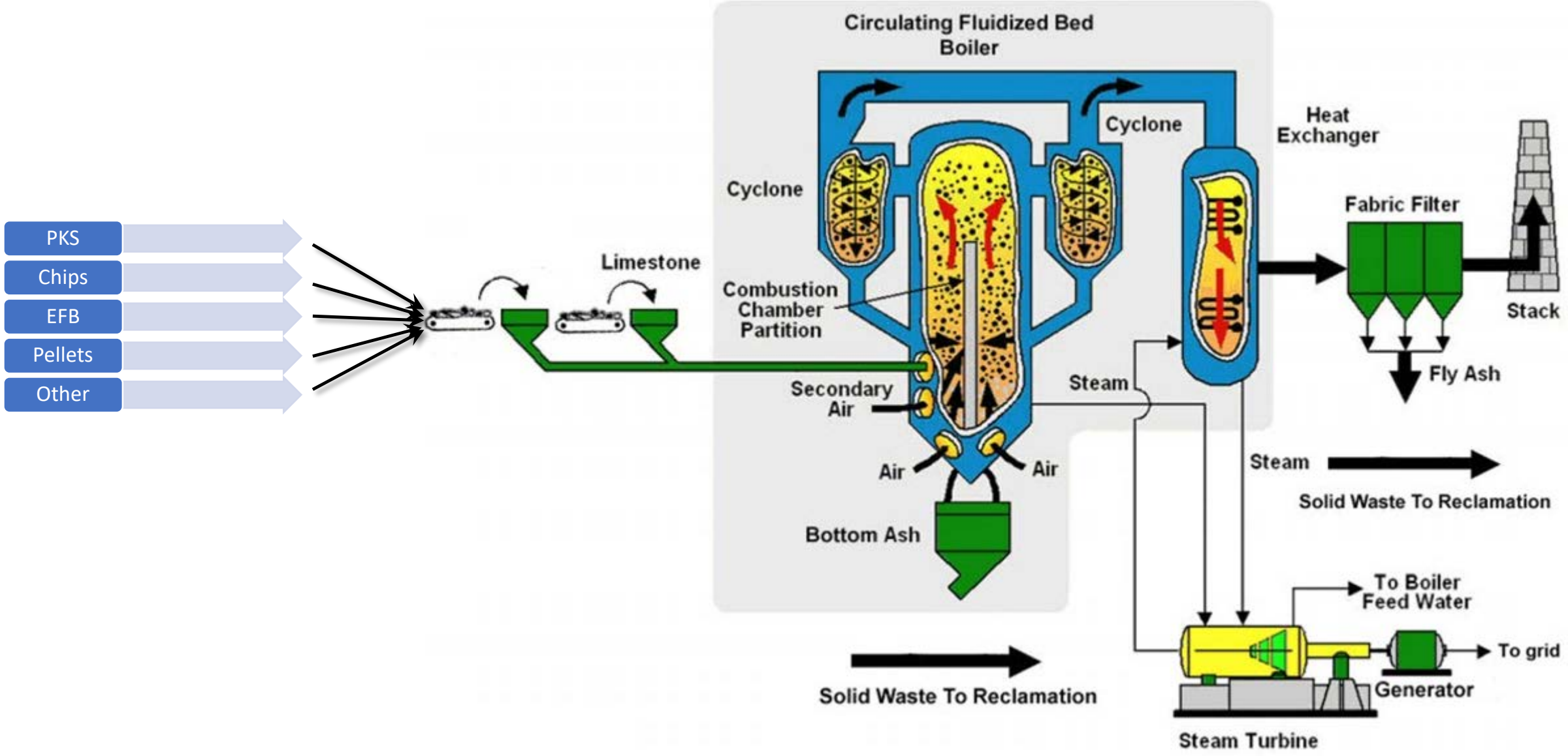
While the technology for producing PKS is well developed, <u>compared to the industrial wood pellet supply chain, **there are more risks in the PKS supply chain**</u>. <u>Long-term consistent offtake is challenging</u>.

Supply risk is summarized by the following:

- Highly manual operations and logistics
- Multiple locations have to be aggregated
- Weather / crop Issues
- Uncertainty with consistency of suppliers
- Infrastructure challenges
- Port congestion
- Producer countries domestic biomass demand increasing

source: Chart, risk summary, and photos from Asia Resource Partners; CPO = crude palm oil

Many of the IPP projects in Japan built to benefit from the FIT are CFB systems.



Large existing utility power stations have to use a fuel that pulverizes into consistent fine particles.
They also need a reliable and robust supply chain

That will drive demand for wood pellets.

New-build smaller circulating fluidized bed (CFB) power plants can use a wide variety of biomass fuels.

That will drive demand for PKS and other biomass.

Major Drivers for Japan and S. Korea for Biomass Imports

Japan is guiding the power generation industry with three areas of policy:

(1) carbon reduction goals,
(2) "best energy mix for 2030" goal, and
(3) the Feed-in-Tariff (FIT) with a locked in 20-year known rate for power (¥21/kWh or about $180/MWh at current FX).

The only policy instrument that currently provides a monetary incentive is the FIT.

Explicit CO_2 goal and FIT only awarded if wood pellets are from certified sustainable sources.

S. Korea is guiding the power generation industry with a Renewable Portfolio Standard (RPS). The RPS program requires 13 largest power companies (with installed power capacity larger than 500 MW) to steadily increase their renewable energy mix in total power generation over the period from 2012-2024.

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
2.0%	2.5%	3.0%	3.0%	3.5%	4.0%	4.5%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%

The instrument that provides a monetary incentive are Renewable Energy Certificates (RECs) and fines for non-compliance.

CO_2 not explicit. Sustainability criteria in flux…

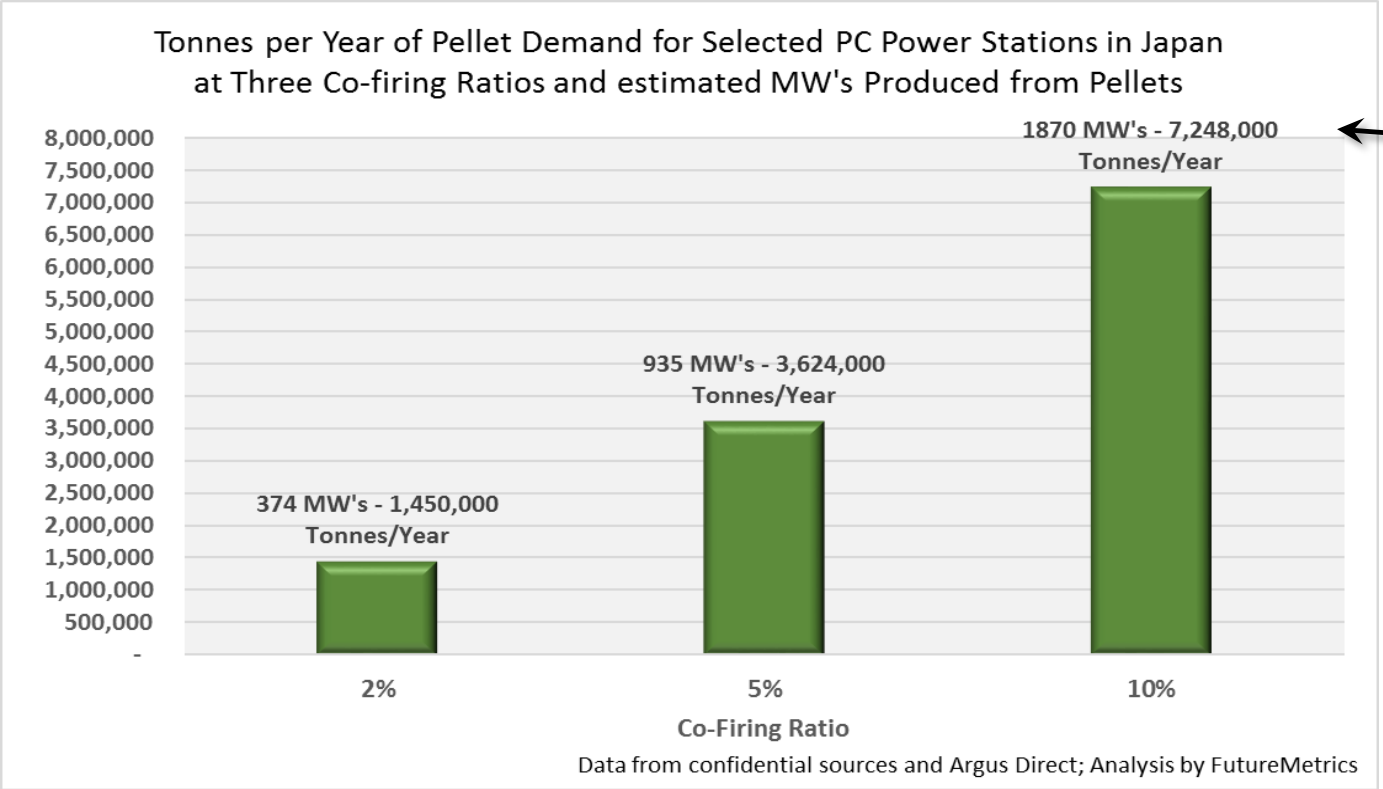
Japan

Carbon Emissions Targets - Japan has already implemented a target reduction of CO_2 emissions that will require all power companies to reduce CO_2 per kWh by 35% from 2013 levels by 2030. This will drive increased compliance challenges in large power stations and therefore increase the demand for wood pellets.

A few major utilities are already co-firing wood pellets at modest 1% to 3% ratios in pulverized coal (PC) stations.

<u>Major gencos can now benefit from the FIT</u>.

Only wood pellets can be co-fired in large PC power plants.



About the same output and demand as the Drax power station in the UK.

S. Korea

For power companies to meet their RPS targets they can:

(1) invest in renewable energy installations themselves and generate RECs (one REC per MWh), or

(2) purchase RECs on the market to meet their obligation.

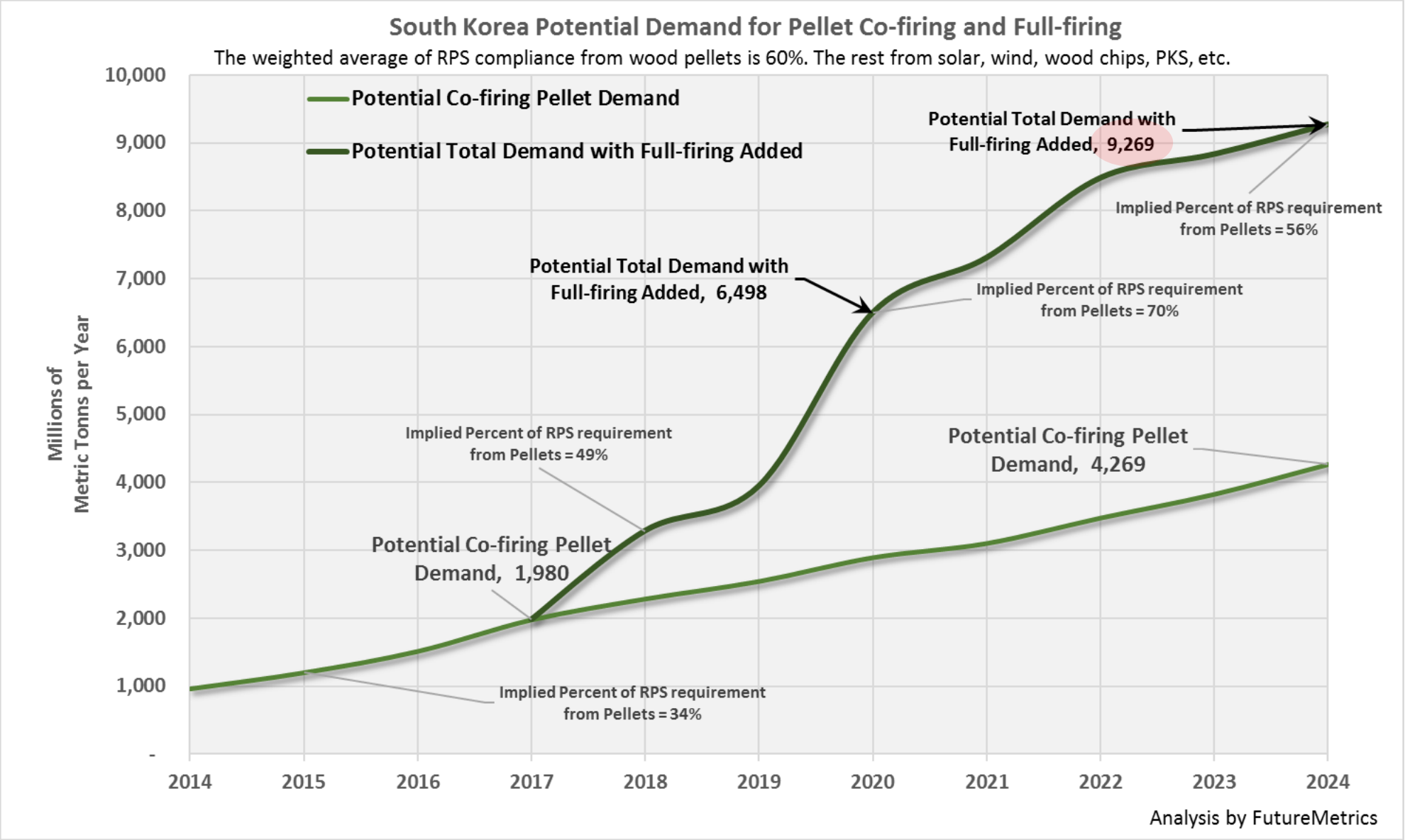
The power companies have to submit the total RECs either generated or purchased to the New and Renewable Energy Center (KNERC) on an annual basis.

If the power company fails to present required number of RECs, KNERC applies a financial fine. The <u>penalty equals to 150% of the average market price of the REC</u> for that year.

S. Korean REC Markets				1130	Won/$
	2015	2016		2015	2016
Volume (REC)	268,071	285,407	% change		
Highest price (won/REC)	₩120,000	₩180,000	50.0%	$ 106.19	$ 164.78
Average price (won/R C)	₩96,213	₩167,834	74.4%	$ 85.14	$ 150.23
Lowest price (won/REC)	₩70,000	₩86,000	22.9%	$ 61.95	$ 82.39

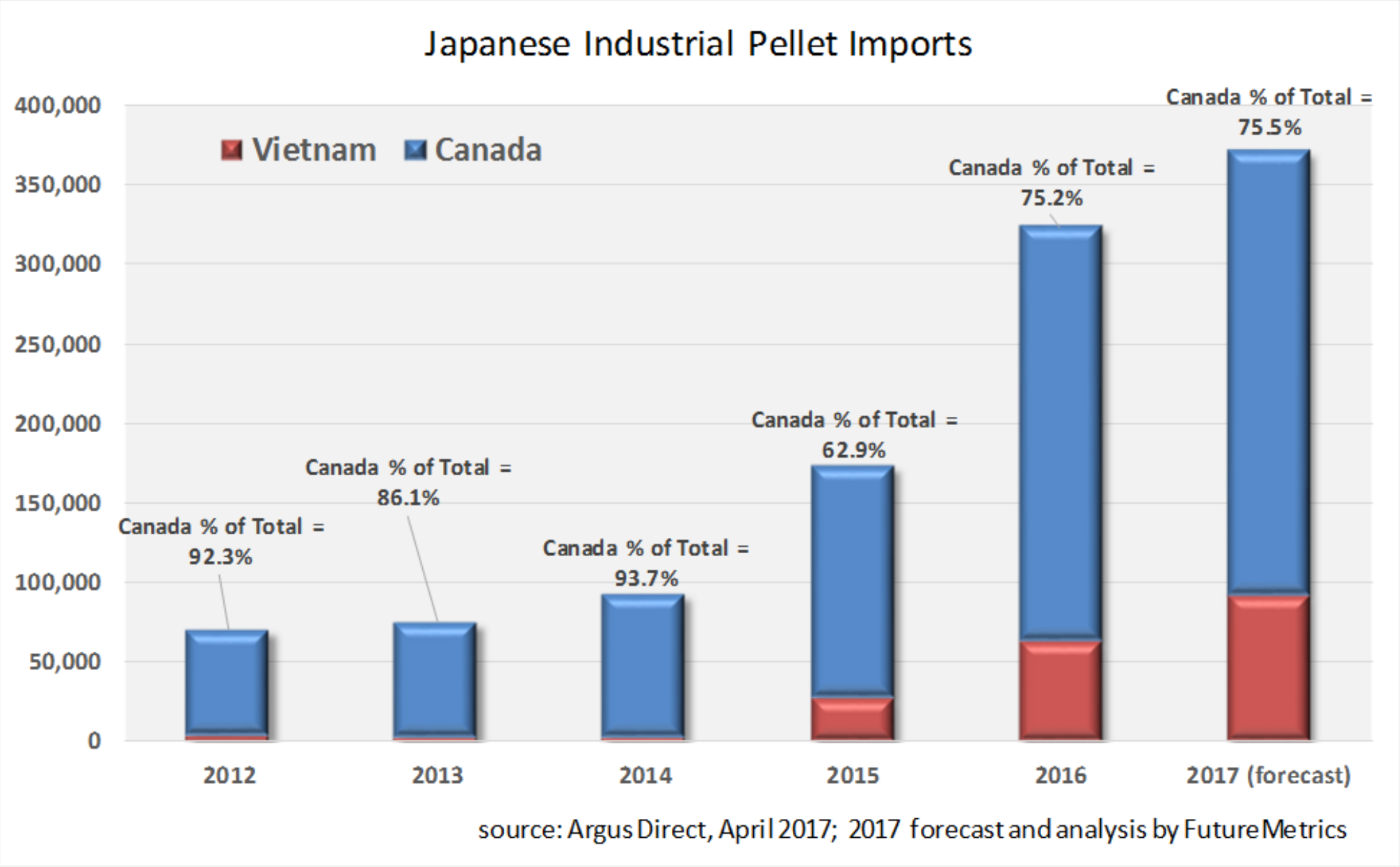
Data provided by Argus

The non-compliance fine, based on 2016 average REC price, is equivalent to $225/MWh!

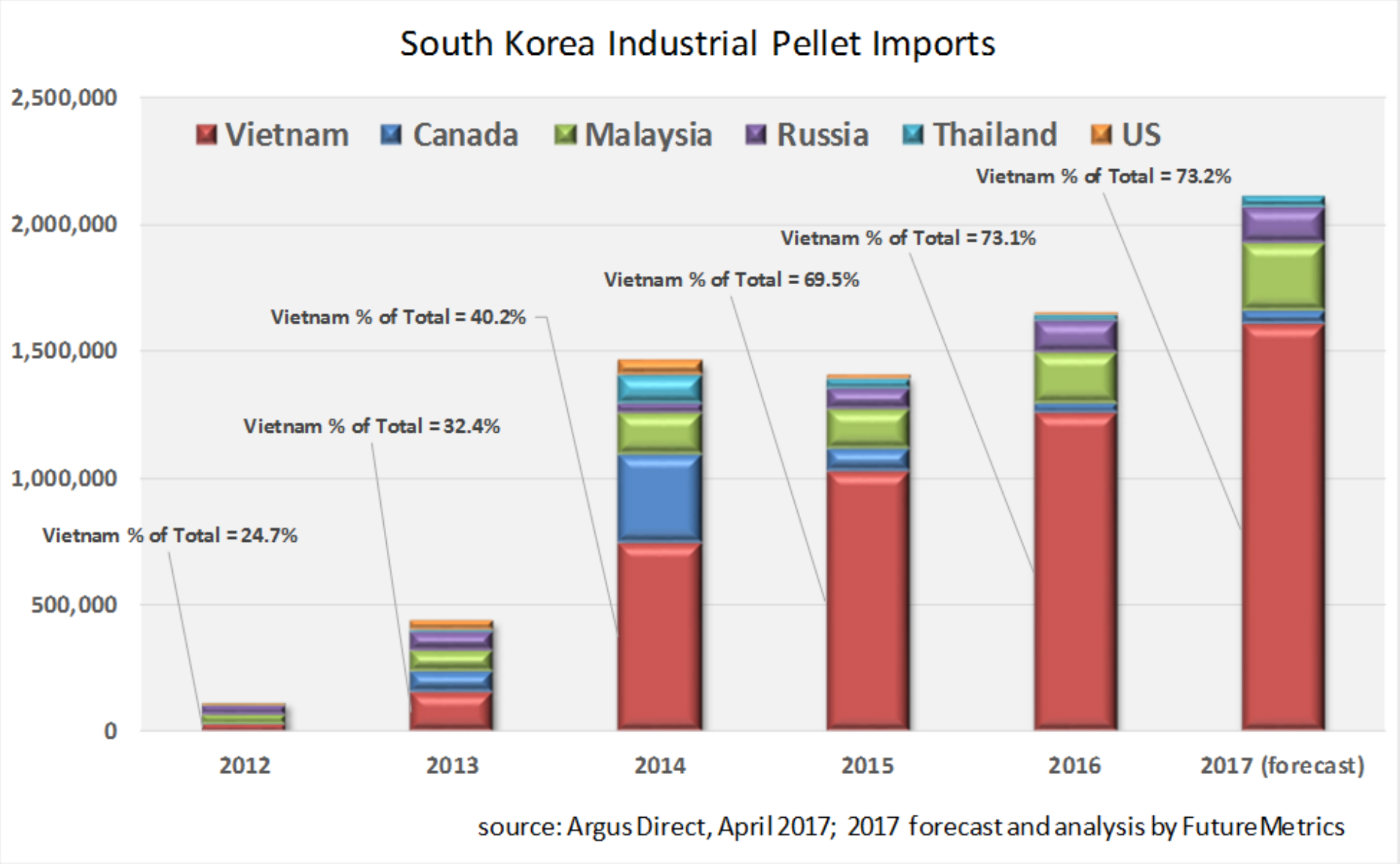


Some industry participants are now projecting total South Korean woody biomass demand of around 7mn-8mn t/yr by 2020, an upward revision from 5mn-6mn t previously. This growth is based on conversion projects and the addition of at least two large dedicated biomass power projects in South Korea in the coming years. Previously announced planned projects by state-controlled utilities Koen and Korea Midland Power (Komipo), as well as a joint project by construction company Hanyang and state-controlled nuclear power producer KNHP, could together create demand for 3.6mn t/yr of wood pellets when they start full operations by 2020, according to *Argus* calculations. (**source: Argus Direct, April 17, 2017**)

Japan Pellet Imports are Primarily from Canada

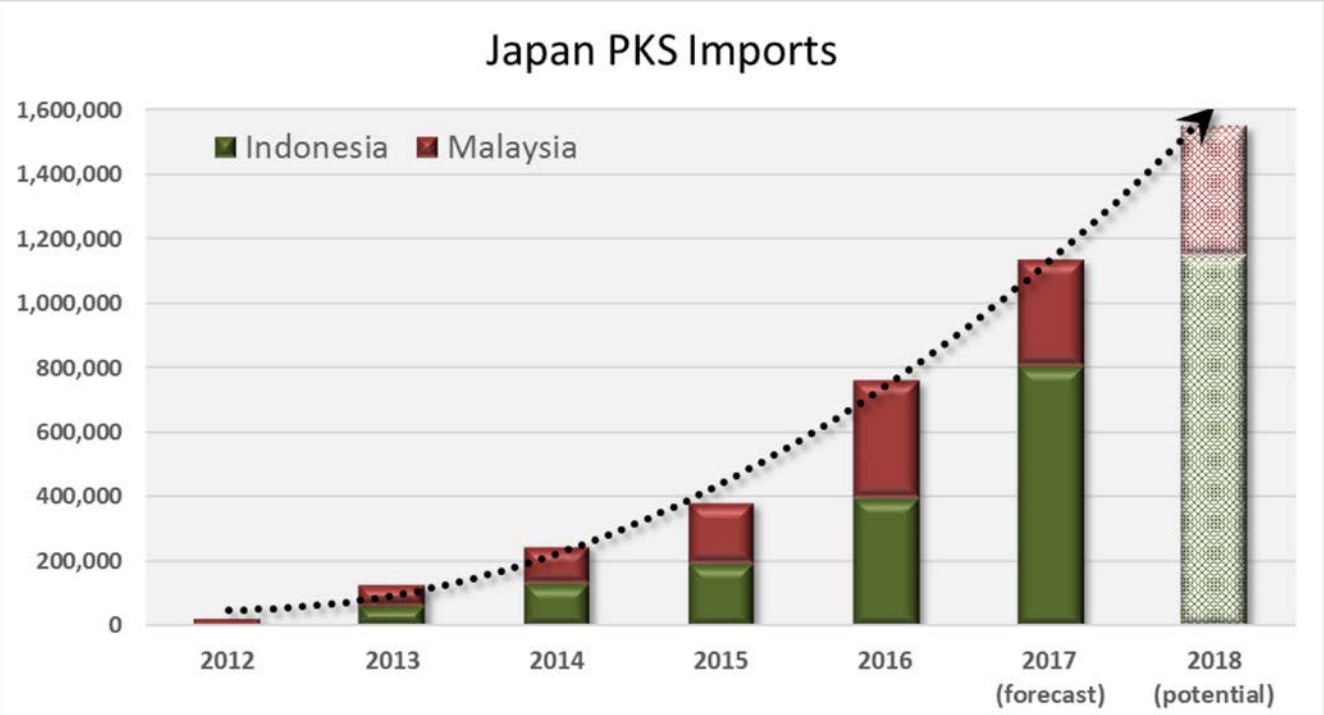


South Korean Pellet Imports are Primarily from Vietnam

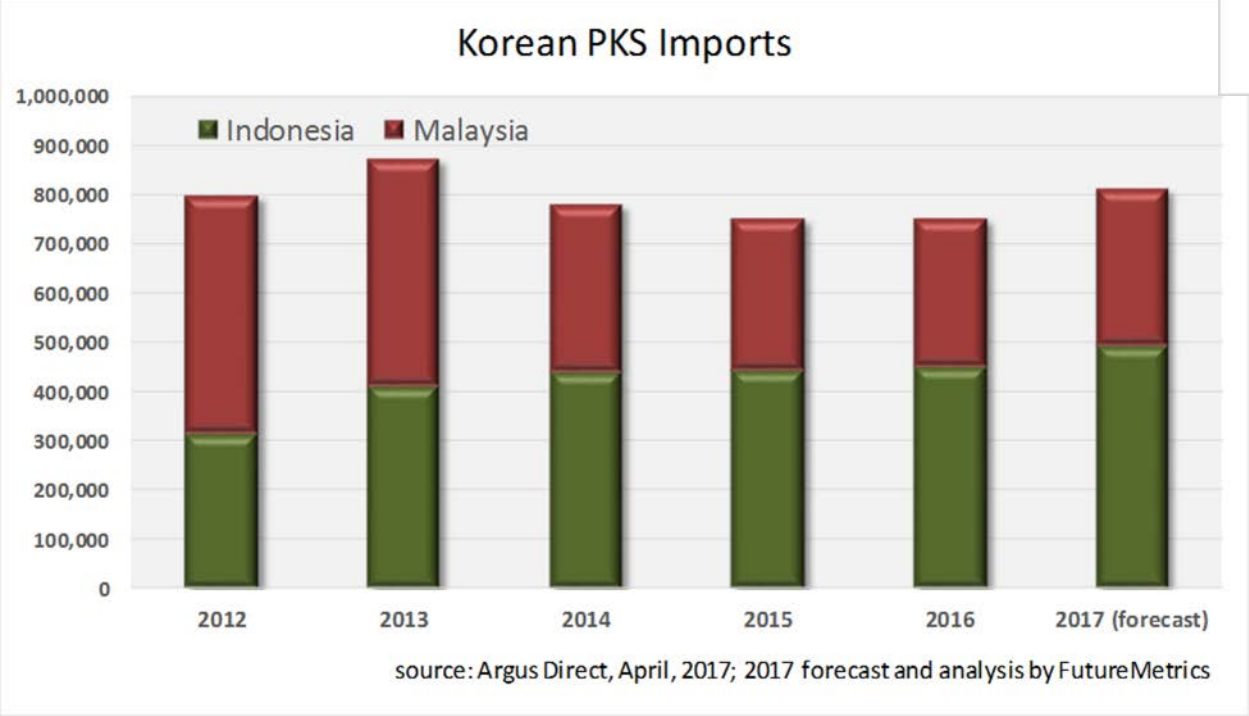


Japan FIT has resulted in many small independent power producers (IPPs) building small power stations using CFB boilers which can combust many forms of biomass. Thus PKS imports have surged.

S. Korean RPS has impacted the large gencos who have to use a pulverizable fuel in their large PC boilers. Thus PKS is not supported by the RPS.



source: Argus Direct, April, 2017; 2017 forecast and analysis by FutureMetrics



source: Argus Direct, April, 2017; 2017 forecast and analysis by FutureMetrics

Future growth in demand for biomass will be dominated by <u>wood pellets</u>.

The certification of sustainability will become critical.

Key characteristics that will determine pellet sourcing

- ✓ Cost of Wood / Cost to Produce Pellets
  - Health of other nearby forest products sectors: sawmilling (plus), pulp and paper (minus), furniture industry (plus).
  - Good infrastructure for harvest and extraction (logging, trucking, aggregation)
  - Growth rate (10 year rotation versus 50 year rotation)
- ✓ **Sustainability**
  - No depletion of the forest or the carbon stock held in the forest (Japan ✔ , S. Korea**?**)
    - Growth rate is greater than or equal to the harvest rate
    - Other factors contributing the continuous health of forests and their habitants
  - **Rule of law and lack of corruption to provide underpinning to the sustainability certification and the long-term security of offtake agreements** (Japan engages in long-term offtake; S. Korea does not, *and may not!*)
- ✓ Logistics
  - Mill-to-port distance and quality of roads and rail
  - Size and "busyness" of the terminal
  - Shipping distance

What about so-called “black” pellets?

Two types:

- Torrefied
- Steam Exploded

<u>Advantages</u>:

- Higher energy density which lowers transport cost per GJ.
- Steam exploded pellets are water resistant.
- ~~Drop in coal replacement~~ (not true – next slide)

<u>Disadvantage</u>:

- To date, delivered cost per GJ has not provided an advantage over white pellets (including accounting for lower transport and the avoided dry storage costs)

The PC power station still has to be modified to safely and efficiently use black or white pellets

Mill Primary Air Temp Reduction
for safety

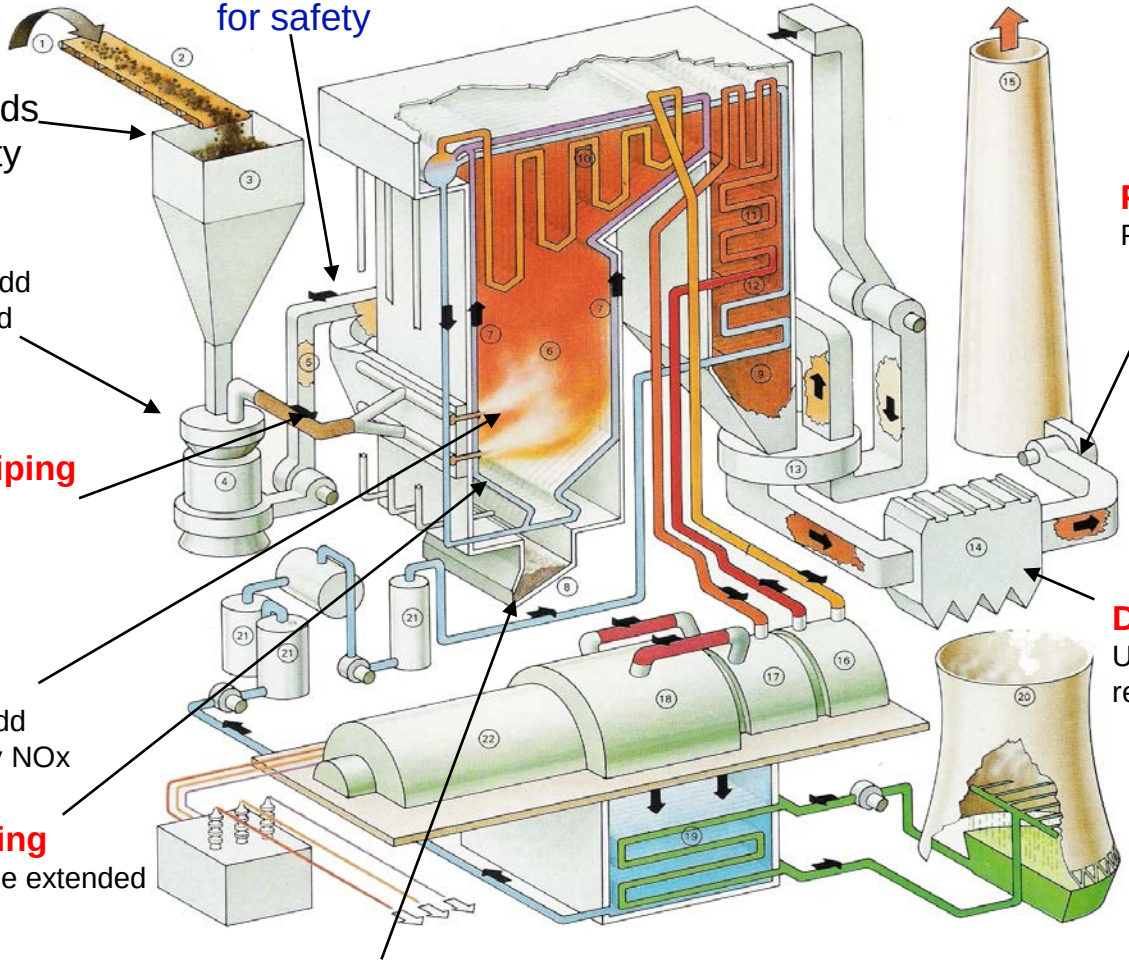
Fuel Handling
Bunker/feeder mods for safety & density

Milling Plant
Replace or modify & add dynamic classifiers and fire & explosion suppression

Pulverized Fuel Piping
Replace or modify for correct velocity

Combustion System
Replace or modify & add over-fire air for primary NOx control

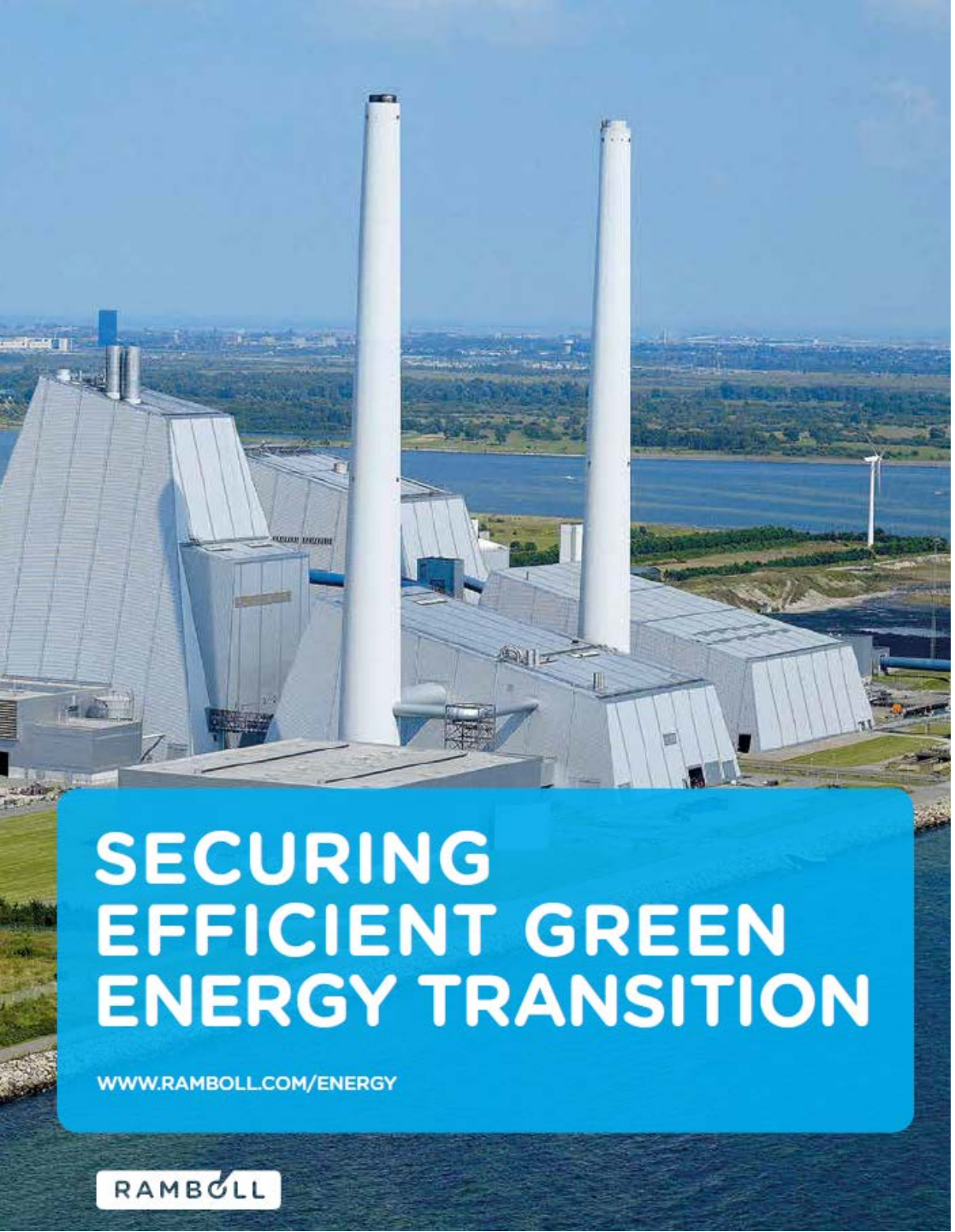
Furnace Cleaning
Usually needs to be extended



Fans
PA, ID, mass flow uprate

Dust Collection
Upgrade & refurbish

Ash systems
Fire & safety



FutureMetrics works with Ramboll on optimized power plant mods and conversions.

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About 16,000,000 metric tonnes of white pellets will be consumed in power plants in 2017.

To date, for **black** pellets as replacement fuel in PC power stations:

0,000 tonnes/year of torrefied pellets and about 7,500 tonnes/year of steam exploded pellets from Norway in one super-peaking station in Canada that runs only a few days per year.

Reliable and cost effective thermal treatment processes have been elusive… We will hear more later in this session.

Conclusion

Demand for wood pellets in Japan and S. Korea will increase significantly and rapidly.

Carbon reduction targets in Japan and RPS in S. Korea means that…

Existing PC power stations will be using sustainably sourced, and reliably produced and delivered wood pellet fuel.

Thank you

William Strauss, President,
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