An Overview of Wood Energy In North America

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Wood-based Energy Goes Global
WoodEMA/Forest Products Society Conference

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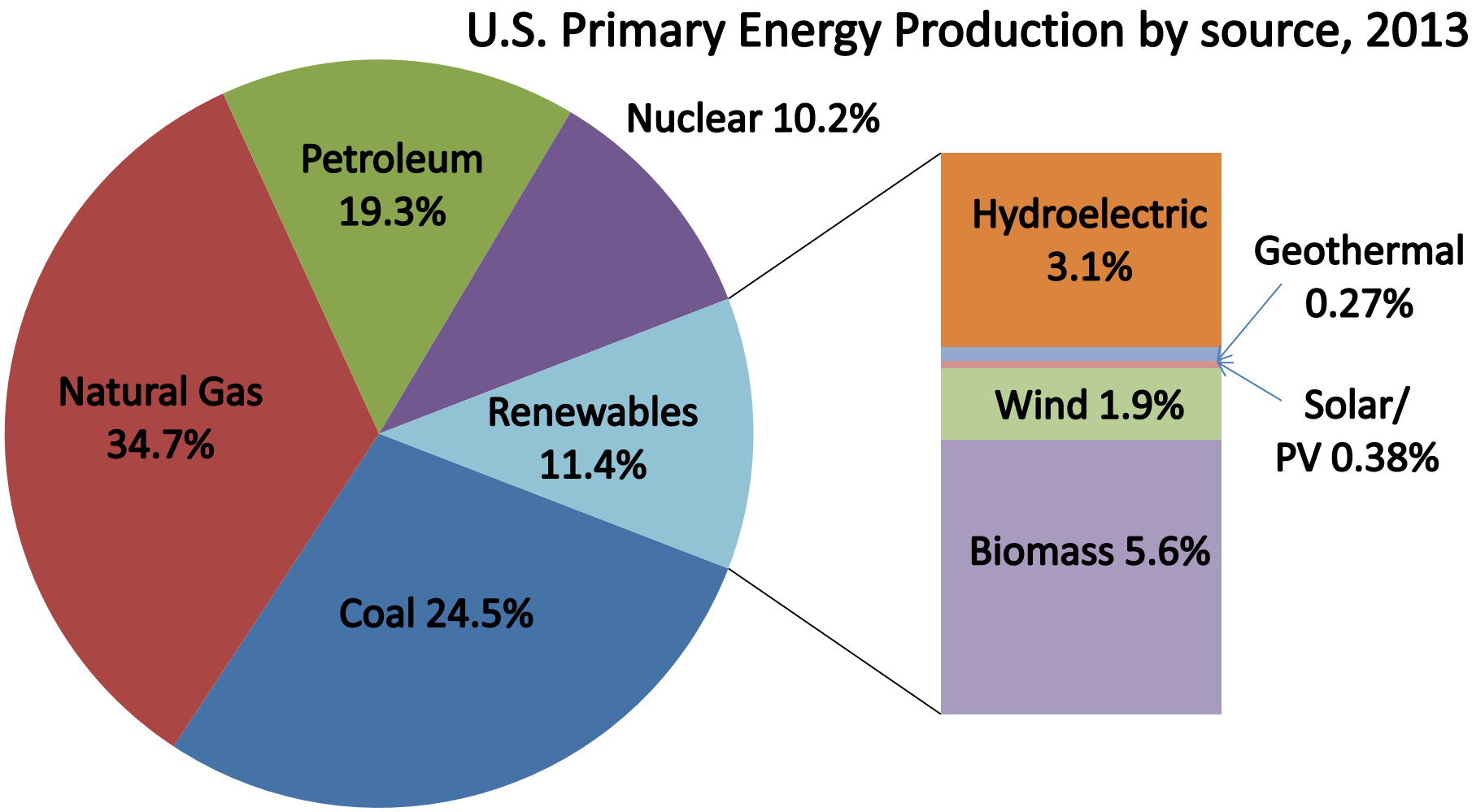
Presentation Outline

- Renewable Energy
- Wood-to-Energy
- Wood Biomass
- Energy Options
- Current Landscape
- Challenges & Issues

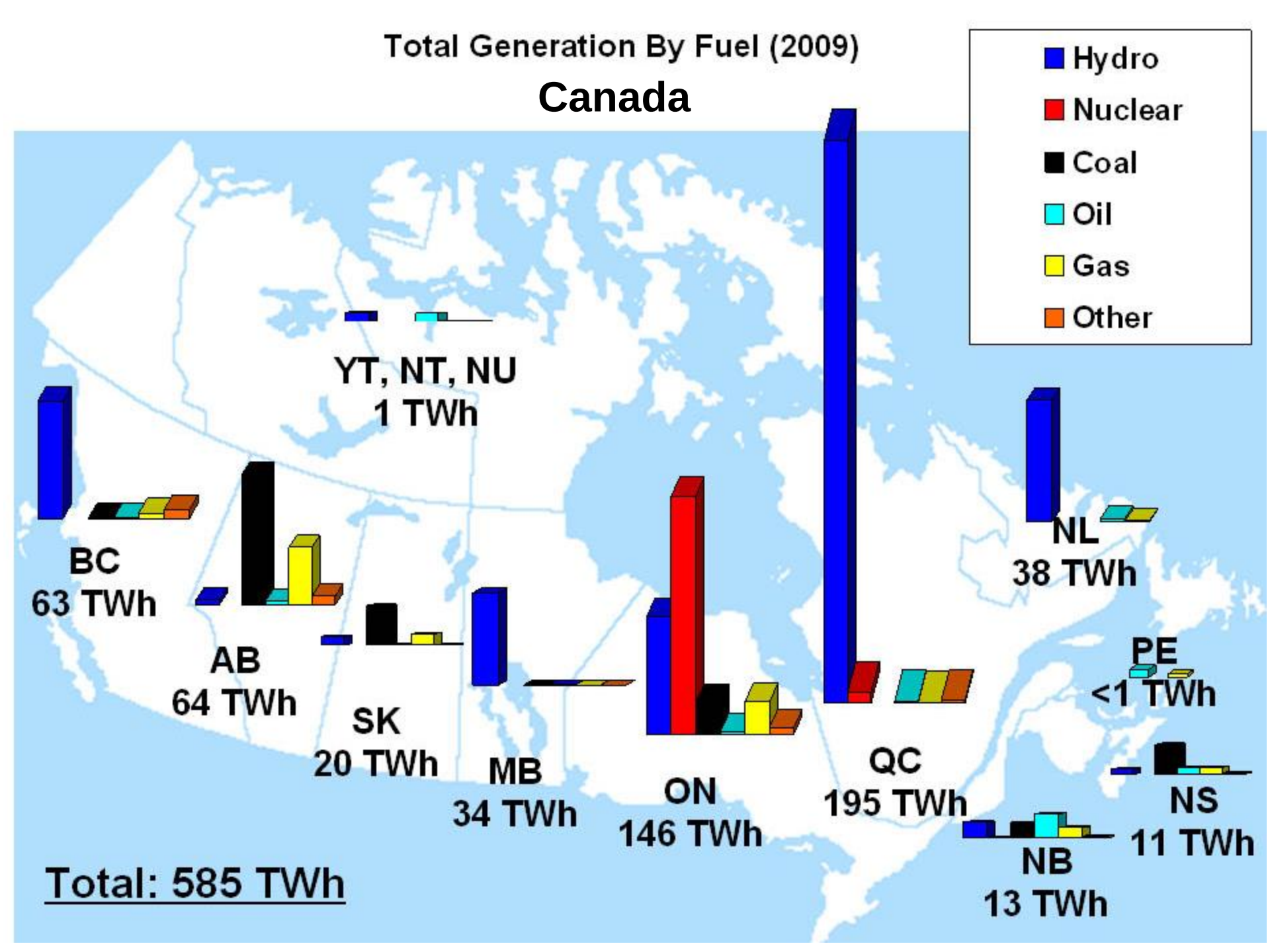
Where are we now in the U.S. ?

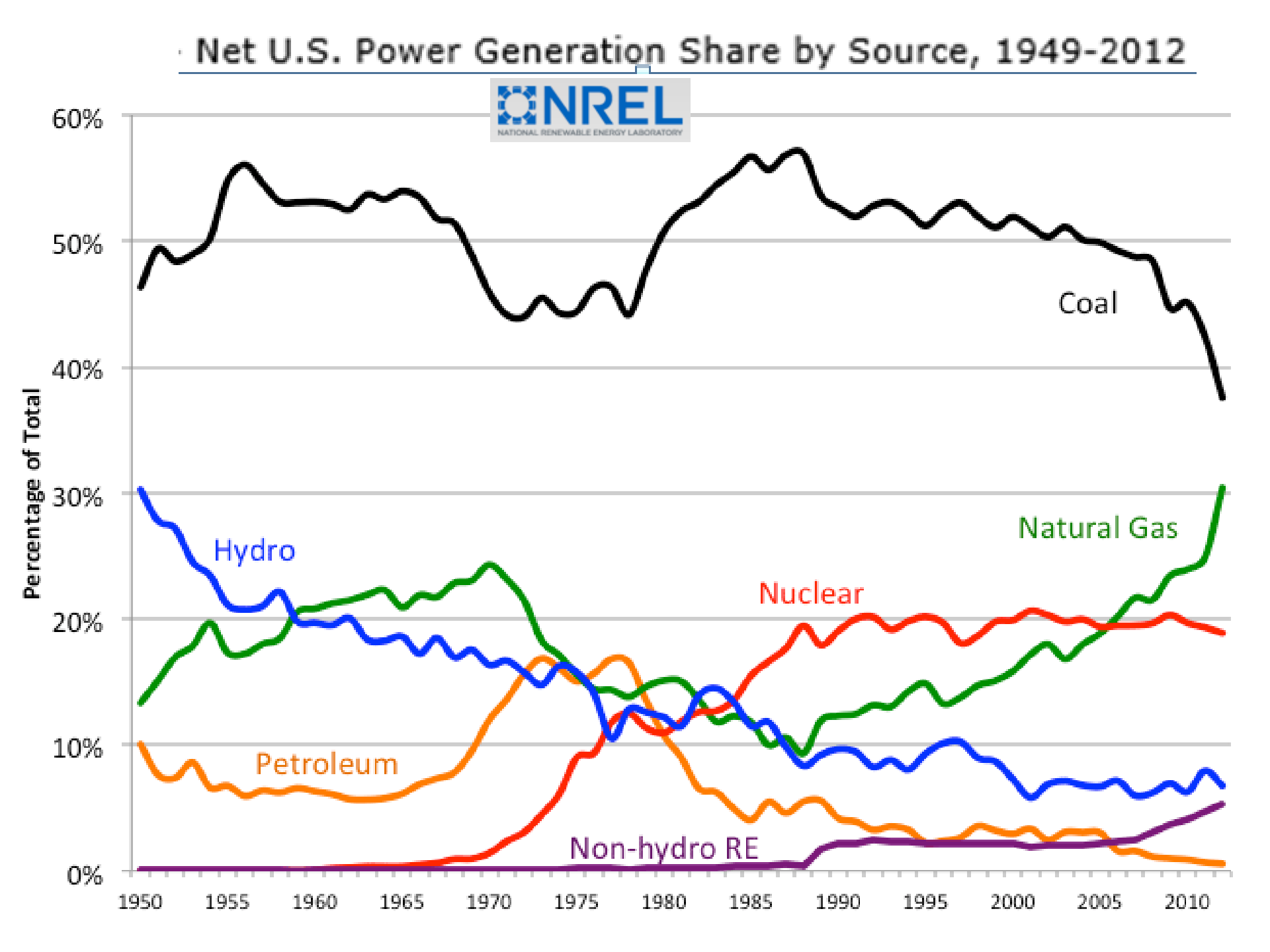
2013 Total Energy Production: 81.66 Quad BTU

2013 Renewable Energy Production: 9.30 Quad BTU



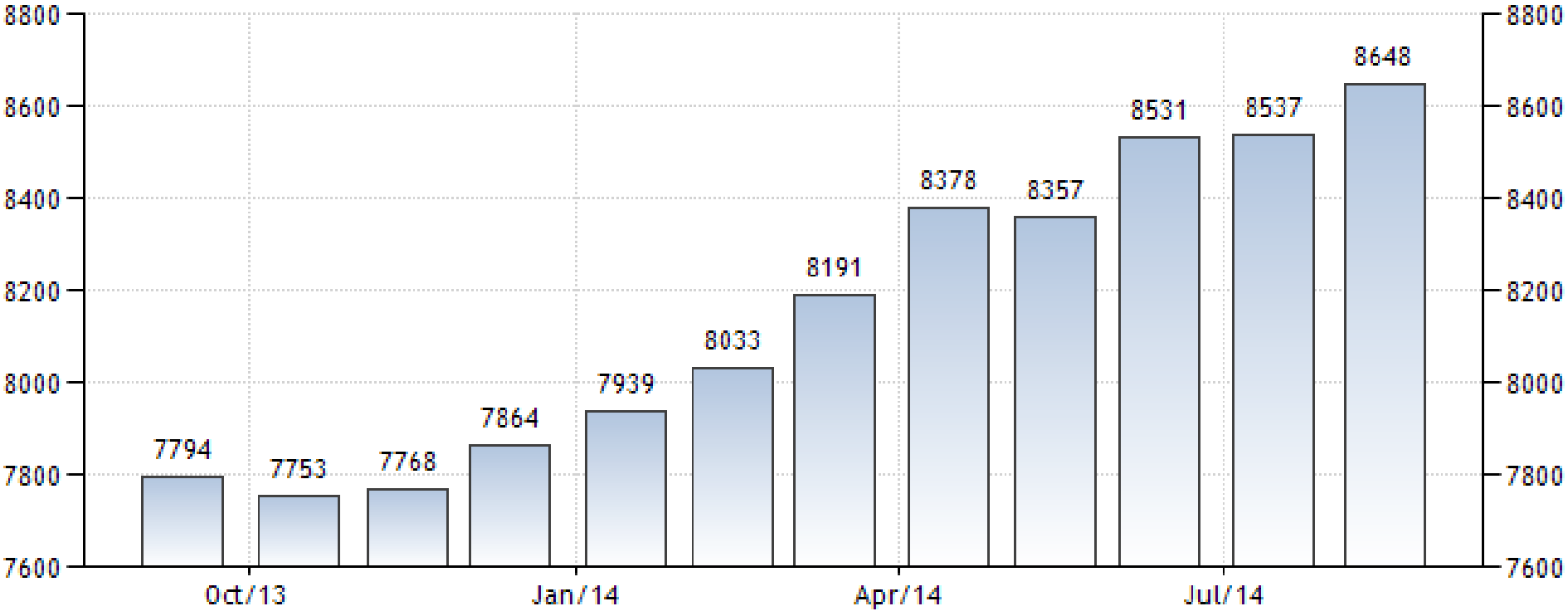
Source: U.S. Energy Information Administration


Total Generation By Fuel (2009)
Canada
Hydro
Nuclear
Coal
Oil
Gas
Other
YT, NT, NU
1 TWh
BC
63 TWh
AB
64 TWh
SK
20 TWh
MB
34 TWh
ON
146 TWh
QC
195 TWh
NL
38 TWh
PE
<1 TWh
NS
11 TWh
NB
13 TWh
Total: 585 TWh


Net U.S. Power Generation Share by Source, 1949-2012
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
60%
50%
40%
30%
20%
10%
0%
Percentage of Total
Coal
Hydro
Natural Gas
Nuclear
Petroleum
Non-hydro RE
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010


Natural Gas Price
3.61 USD/mmbtu
15 Nov '13
Natural Gas Price (USD/mmbtu)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Jun 6
2008
Jul 31
2009
Sep 24
2010
Nov 18
2011
Jan 11
2013
InfoMine.com

U.S. Crude Oil Production



SOURCE: WWW.TRADINGECONOMICS.COM | U.S. ENERGY INFORMATION ADMINISTRATION

Where Does Wood Fit into the Picture?

Drivers & Issues

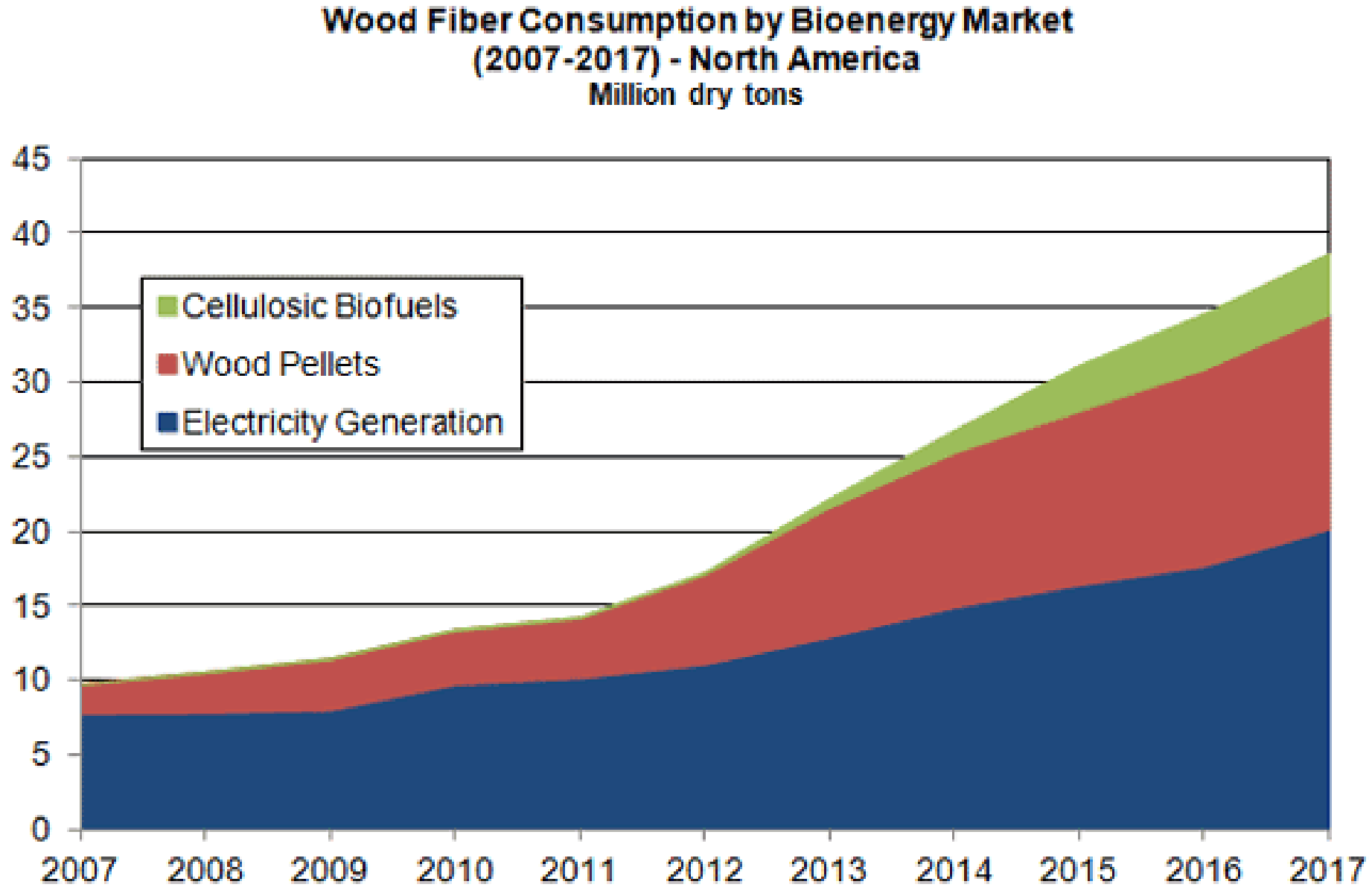
- Biomass industry drivers: subsidies, natural gas prices, sustainable harvest levels, wood fiber prices, and transportation costs.
- Harvesting, collecting and transporting cellulosic post-harvest biomass residues can be difficult and expensive.
- High transportation costs means cellulosic post-harvest biomass plants must source feedstock near plant-typically 75 miles (although up to 150 miles has been reported).

Pre-Summary

- Biomass demand currently driven by wood-burning power companies---Pellets.
- Demand for wood→electricity could also change the landscape (beyond CHP).
- Wood-based fuels not economically viable.

Wood Energy in North America

- Wood is the most commonly used biomass fuel for heat and power.
- About 84% of the wood and wood waste fuel used in the U.S. is consumed by industry, electric power producers, and commercial businesses.
- Most of this is used at wood product manufacturing facilities in cogeneration.


Wood Fiber Consumption by Bioenergy Market
(2007-2017) - North America
Million dry tons
45
40
35
30
25
20
15
10
5
0
Cellulosic Biofuels
Wood Pellets
Electricity Generation
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

Source-RISI

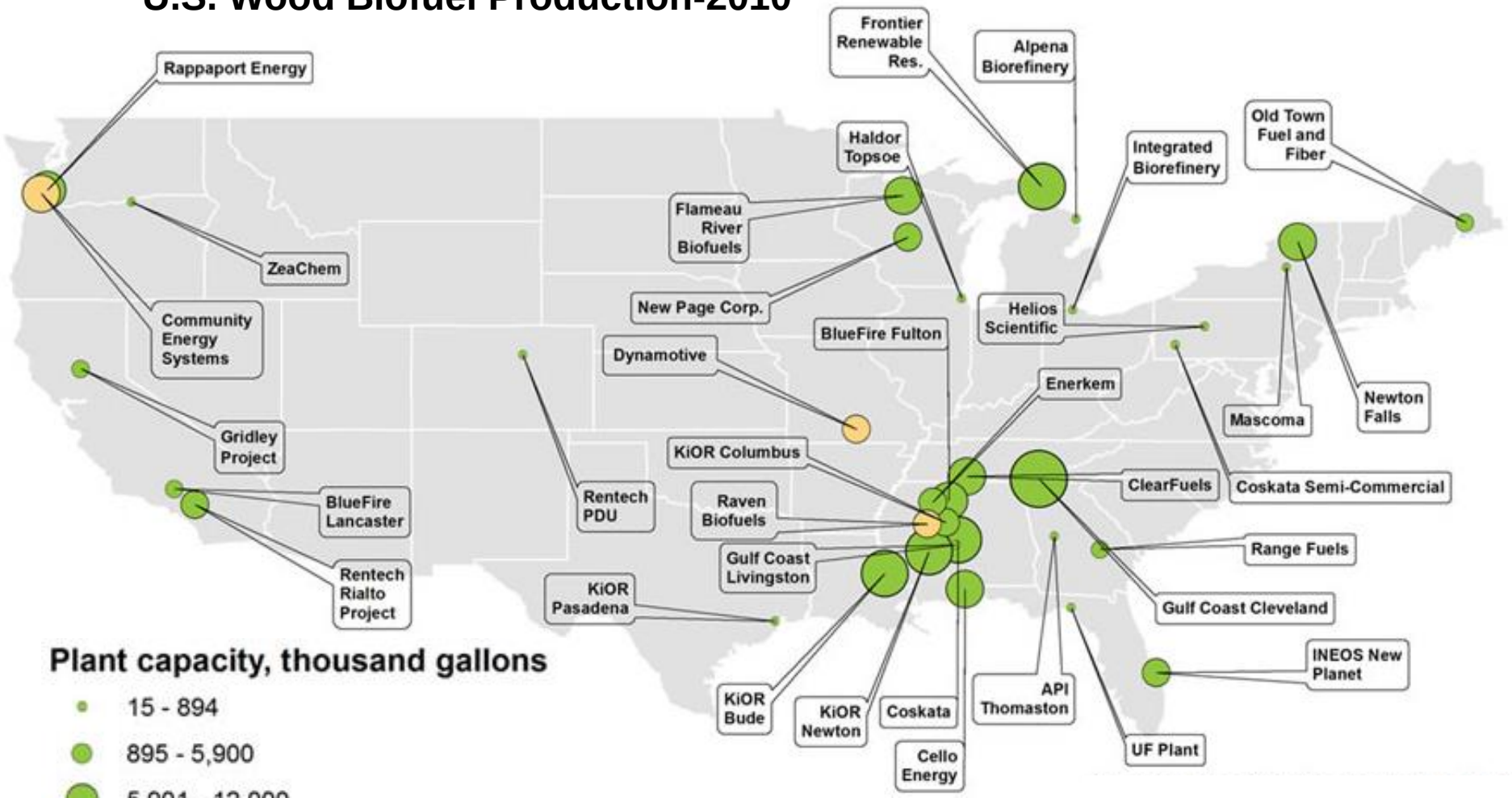
North American Wood Biomass Projects

Announcements-2007 to Present – October 2014
Wood Demand (000 green tons/year)

Wood Energy	36,944
Wood Pellets	45,475
Liquid Biofuels	2,185
Total	84,604

Source-RISI

U.S. Wood Biofuel Production-2010



*Primarily ethanol, butanol, diesel, gasoline, and jet fuel

Source- Forisk & Schiamberg Group

Wood-based Biomass Types

Primary mill residues

Wood materials [illegible] nufacturing plants (primary wo[illegible]ills) when r[illegible]d products are processed [illegible]nary wood prod[illegible]

Slabs, e[illegible], trimmings, s[illegible]veneer [illegible]gs and cores, and pu[illegible]enings.

Wood-based Biomass Types

Secondary mill

Wood scrap … dust from … ng shops, furniture factories, … ntainer and pal… , that use lumber, … d and other "pri… rials.

Wood-based Biomass Types

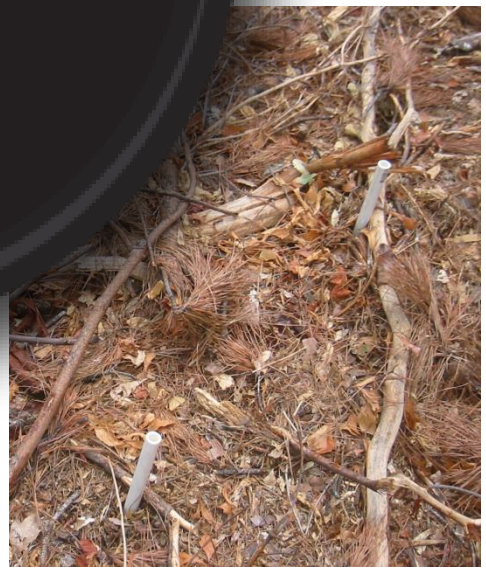
Urban wood wast

Discarded wo mings, m construction and demolition .

Wood-based Biomass Types

Forest residues/Logging S

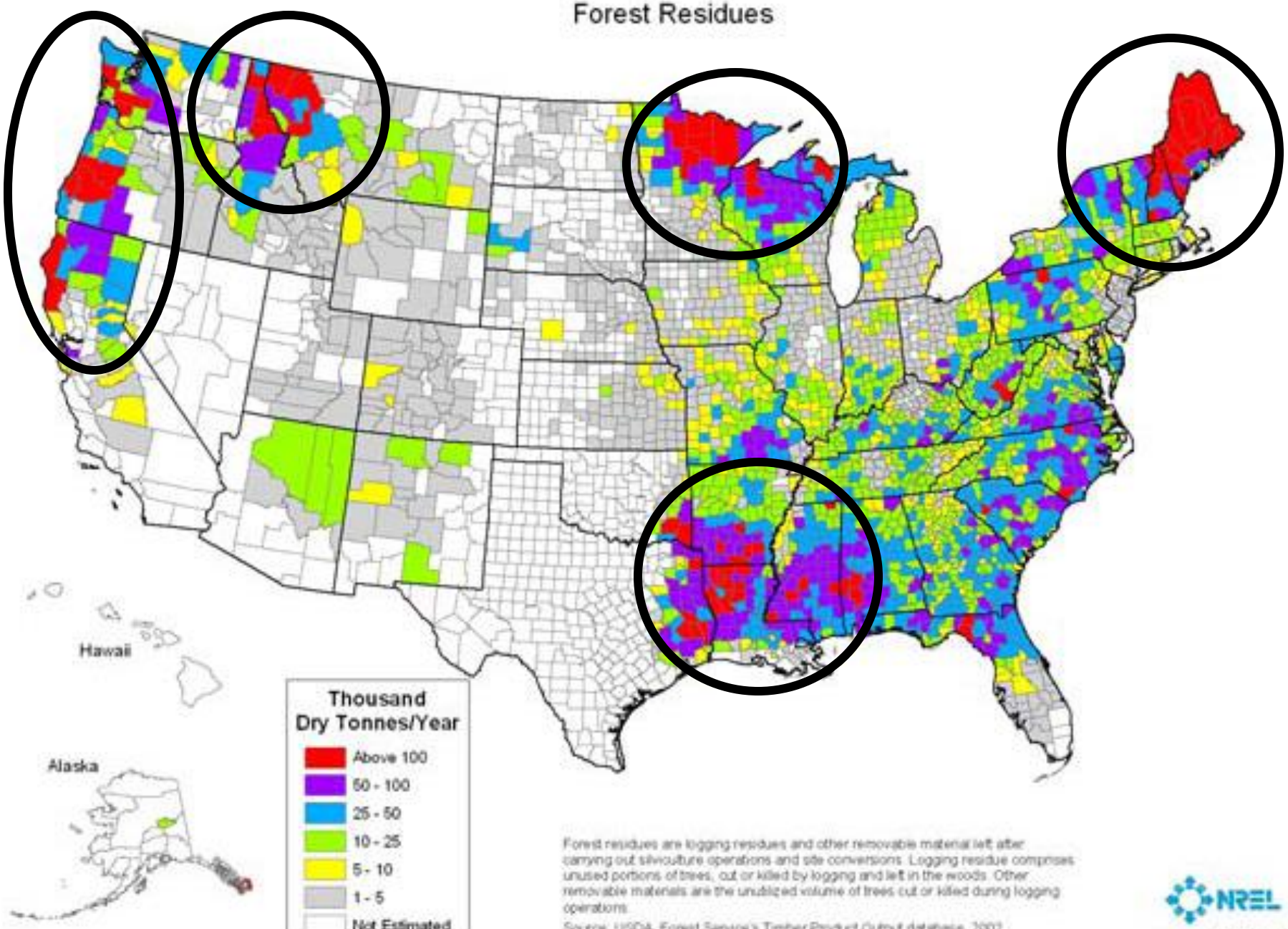
Logging residue, un cut or killed during logging or silvicu e woods; unutilized volu logging operations.



Wood-based Biomass Types

- **Logging slash:**
  - 1.2 to 3.2 tons per hectare generated from needles, branches left on site
  - Potential:
    - Chip tree tops instead of pushing it back into stand

Forest Residues



Forest residues are logging residues and other removable material left after carrying out silviculture operations and site conversions. Logging residue comprises unused portions of trees, cut or killed by logging and left in the woods. Other removable materials are the unutilized volume of trees cut or killed during logging operations.

Source: USDA, Forest Service's Timber Product Output database, 2002

NREL

March 2005

Forests for Biofuel:
Potential forest biofuel products

- Logging slash bundled to support power plant
  - 100-MW Southern Energy wood-fired power plant in Nacogdoches, Texas (currently idled)
  - 20-year power purchase agreement with Austin (Texas) Energy

Management Approaches: Short-rotation woody crops

- Fast-growing plantations that produce large amounts of biomass in short time
- Whole tree chipped in harvest
- Rotation lengths:
  - 3 to 7 years
  - Possibly get 1.5 rotations per planting due to re-sprouting

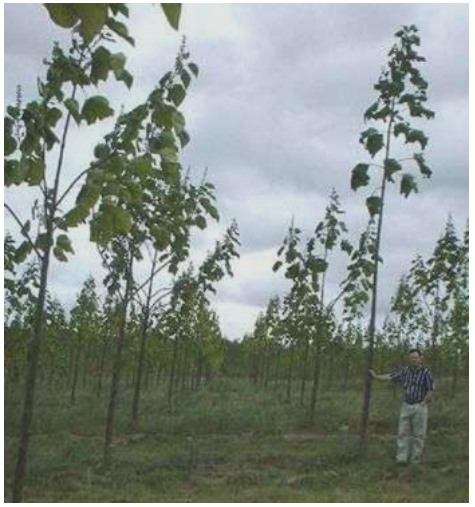
Short-rotation woody crops

- Species grow along SE coastal region
  - *E. benthamii, macarthurii, camadulensis*
- Tolerant to temperatures down to 17 degrees F
- Yields:
    - 5-8 tons/ha per year (loblolly pine = 1.2 tons/ha per year)
    - Mature by age 6-9

Short-rotation woody crops

Hybrid Poplar

Paulownia (1 year)



Eucalyptus globulus
(3 years)
Australia

Eucalyptus sp.
(6 years-rotation age)
Brazil

Short-rotation woody crops

Genetically Modified – Low Lignin Poplar

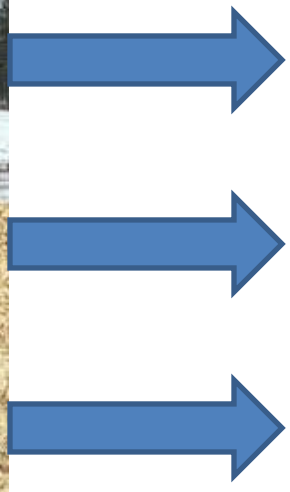
Genetically Modified Eucalyptus (5 years)-FutureGene-Israel

VERY High volume- short rotation woody crop

Frankensteinus sempervirens

6 years old

Wood to Energy
What are the options?



Gasification

- Converts carbon-based materials, such as coal, petroleum, biofuel, or biomass…..
- into carbon monoxide and hydrogen…..
- by reacting the raw material, at high temperatures controlled *with oxygen* and/or steam.
- The resulting gas mixture is called synthesis gas or syngas and is itself a fuel.

Pyrolysis

- Chemical decomposition of a condensed substance by heating.
- Does not require oxygen.
- Extreme pyrolysis, which leaves only carbon as the residue, is called *carbonization* and is also related to the chemical process of *charring*.
- Pyrolysis is used in the to produce charcoal, activated carbon, methanol and other chemicals from wood.

Cogeneration

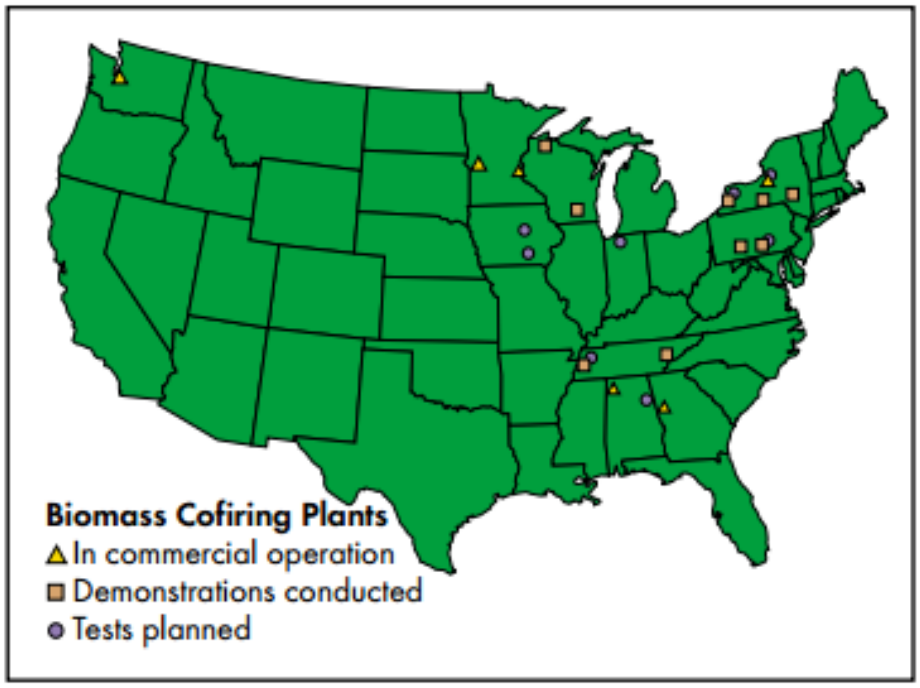
- Simultaneous production of heat and electricity, commonly called combined heat and power (CHP), from a single fuel.

- Traditionally, a steam turbine is used to produce electricity, although a wood gasification/ internal combustion unit can also be a cogeneration unit.

- Most of **U.S**. CHP capacity is in wood products manufacturing industries.

Co-firing Biomass and Wood

- Proven technology but…still few large-scale operations
- 15%:85% Coal to biomass ratio is typical
- Challenges:
  - Biomass storage
  - Biomass moisture content
  - Boiler adaptability-retrofit
  - Ash content
  - Dust and mold



Pellets

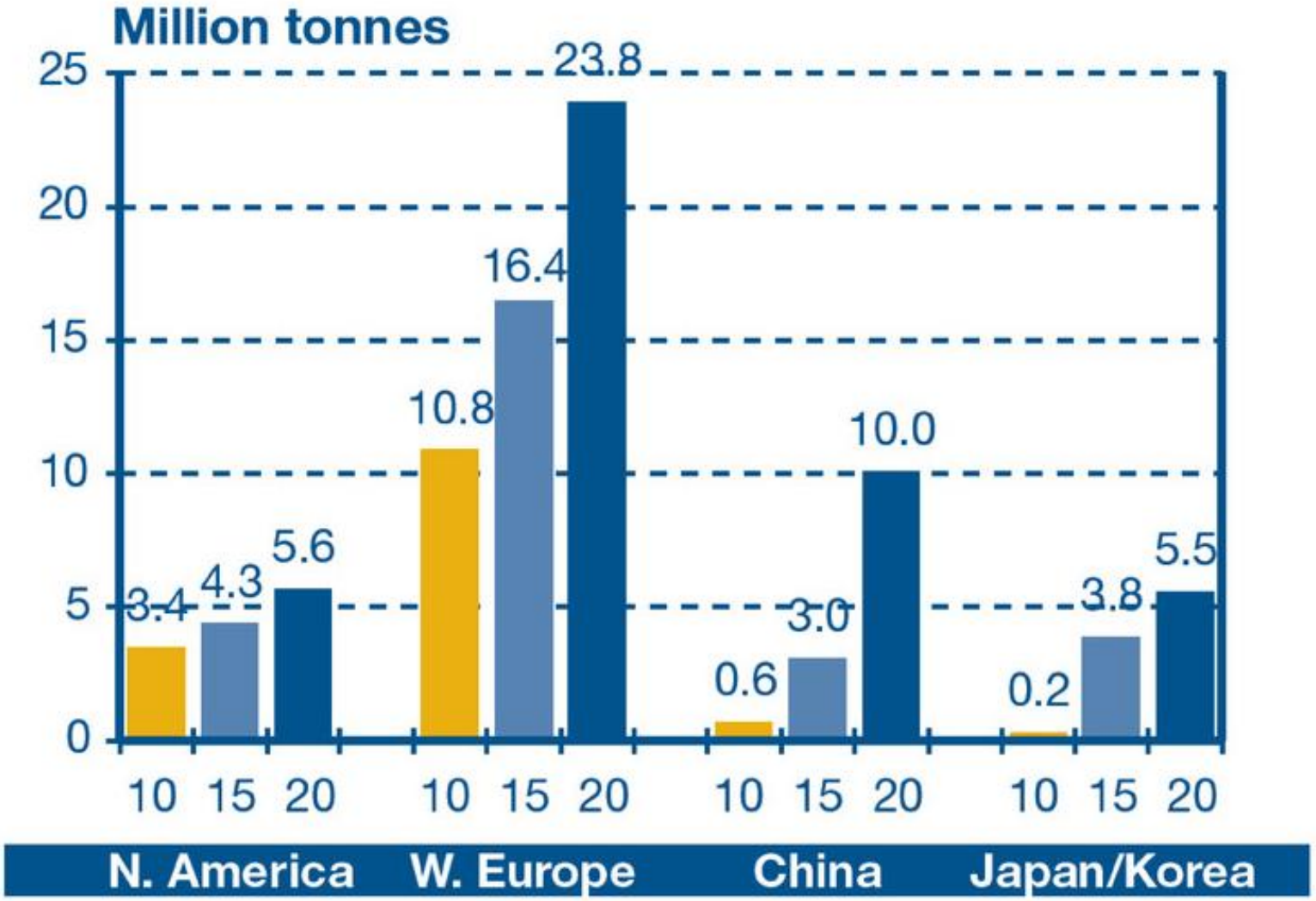
Pellets

- European Union nations imported some 4.46 million metric tons of wood pellets in 2012 up from 3.2 million in 2011.
- Sweden consumes more than 20% of the world's wood pellets and demand is growing.
- 36% of those pellets came from the United States, the most of any nation.
- Wood pellets have about 70 percent of the calorific value of coal.



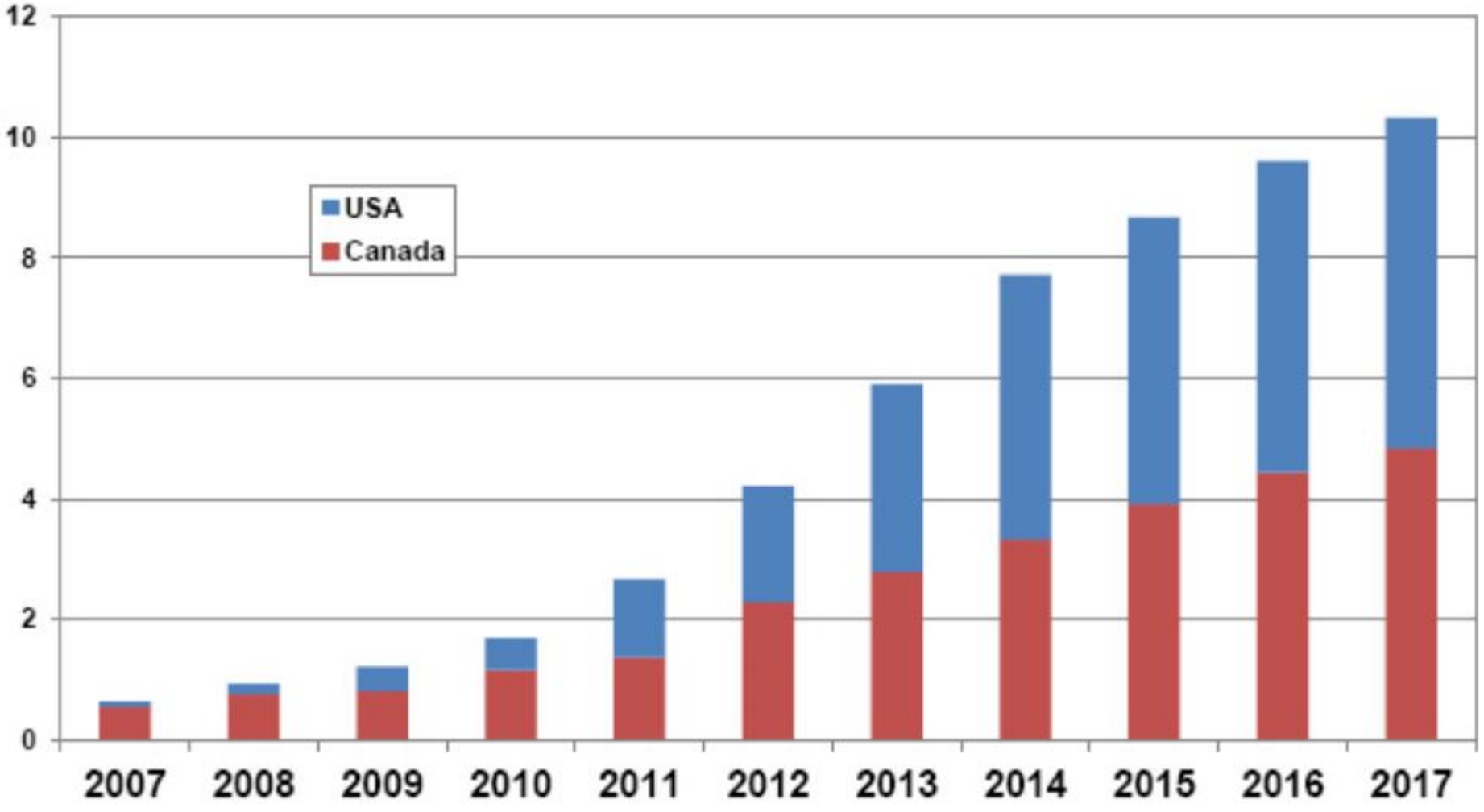

Source: Baton Rouge Business Report, June 26, 2013

Global Wood Pellet consumption Outlook to 2020

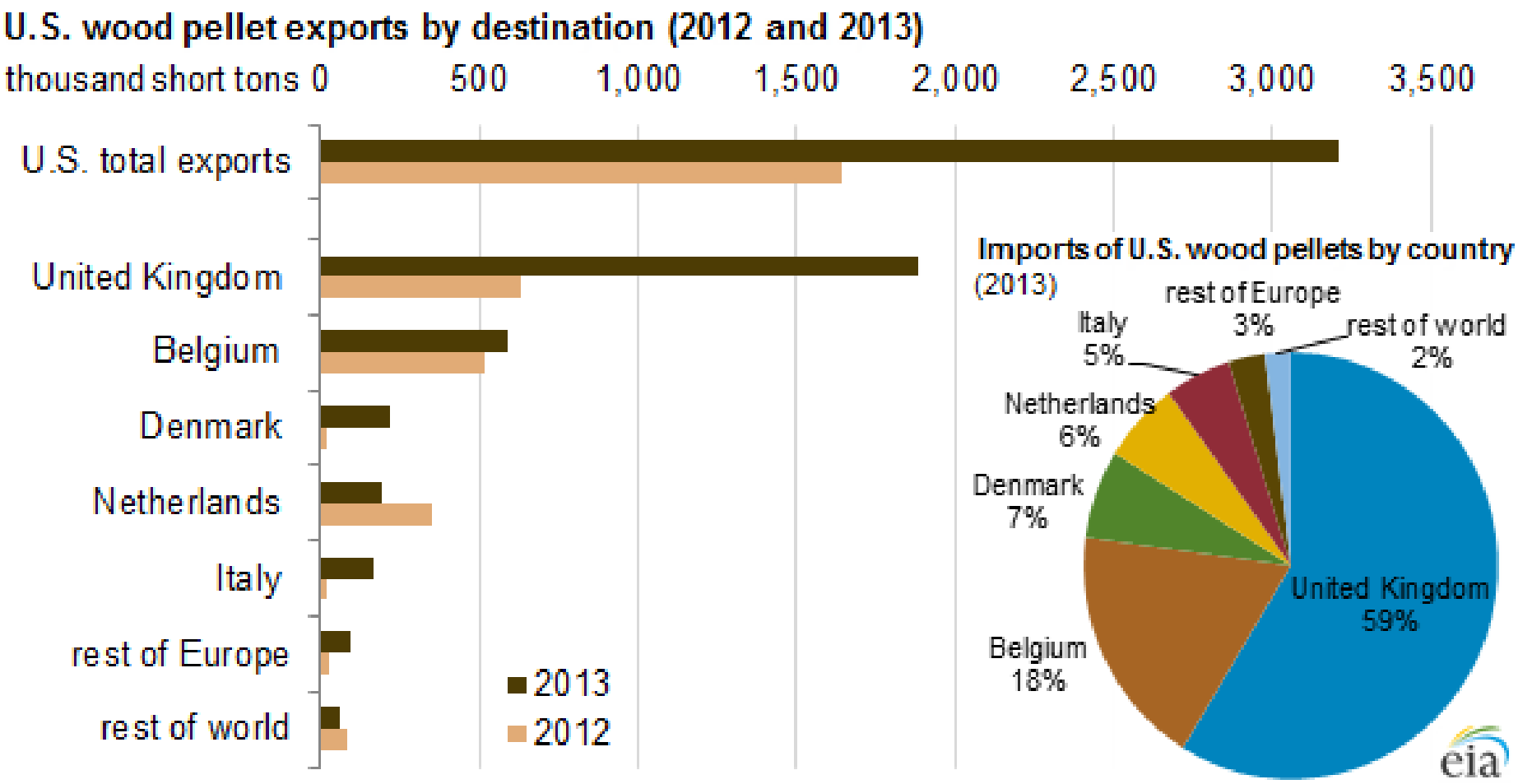


Source: Wood Markets, February 2013, Wood Pellet Association of Canada

Forecast of wood pellet exports from North America 2007-2017, in million tonnes.

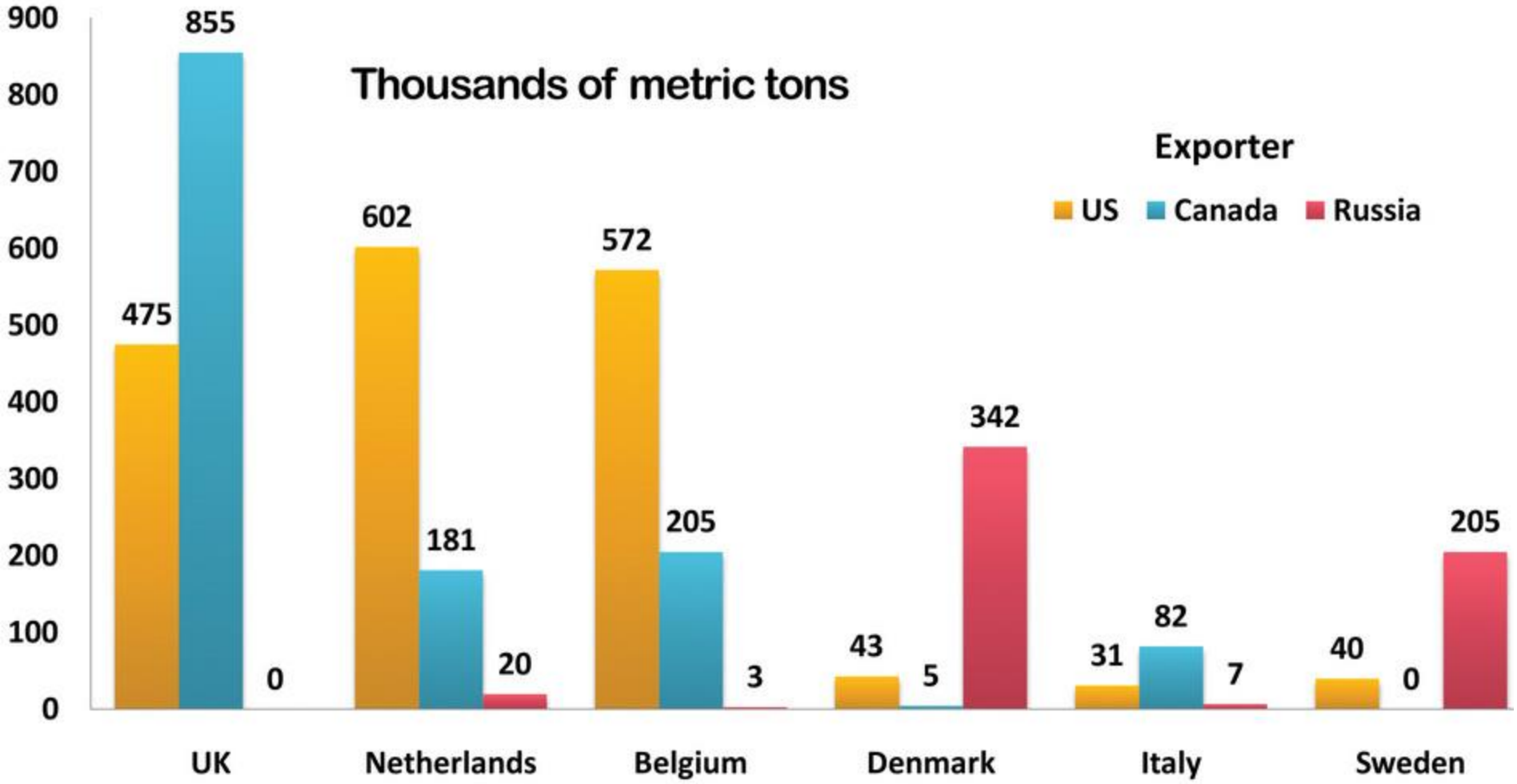


Sources – Seth Walker-RISI



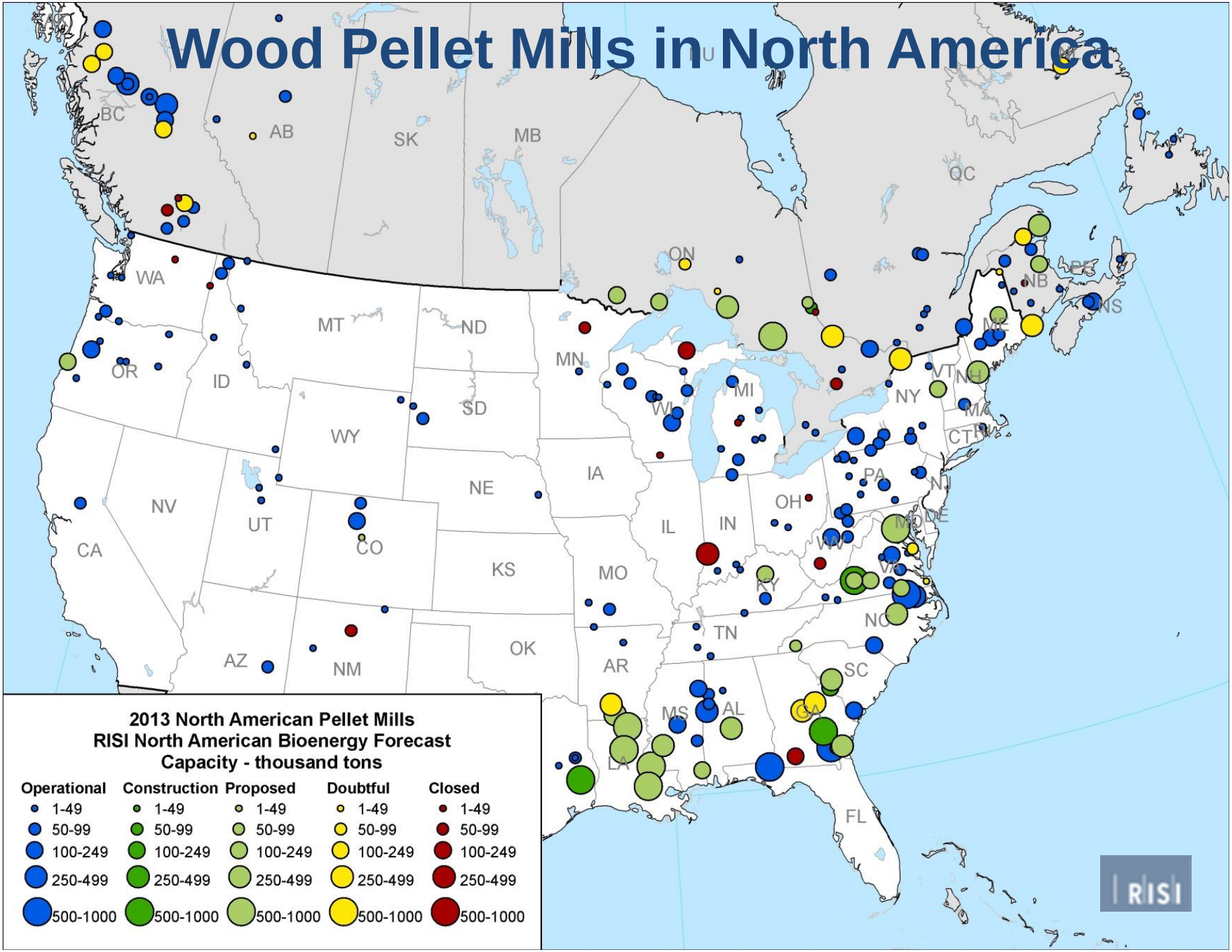
Source: U.S. Energy Information Administration, based on U.S. International Trade Commission data

Wood Pellet Imports by Selected Countries (2012)



Sources: Biomass Magazine 9/23/13

Wood Pellet Mills in North America



Mega Challenges

National Security

Economy

Environmental Degradation

Brent Bailey-25x25, 2014

Challenges/Issues

- Infrastructure remains one of the biggest challenges in bringing renewable energy online.
  - Transmission lines need to be modernized and expanded to tap into rural sources of electricity, especially wind.
  - Biofuels need expanded pipelines, rail, ports and other shipping facilities to get to urban consumers; expansion of blender pumps and flex fuel vehicles are also needed.
- Significant long term *public and private investment* is needed to achieve a new, renewable energy future.
- Regulatory actions and proposals from government agencies.

Challenges/Issues

- Competition for raw materials-chips.
  - Pulp/Paper
  - Composite Panels (OSB, Particleboard, Chipboard)
  - Upward price pressure for all sectors utilizing same raw material.
- Limited facility location options.
- Policy changes in demand markets.
- Relative prices of alternative fuel sources.

Thank You

Questions???

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