"Odd Energy"

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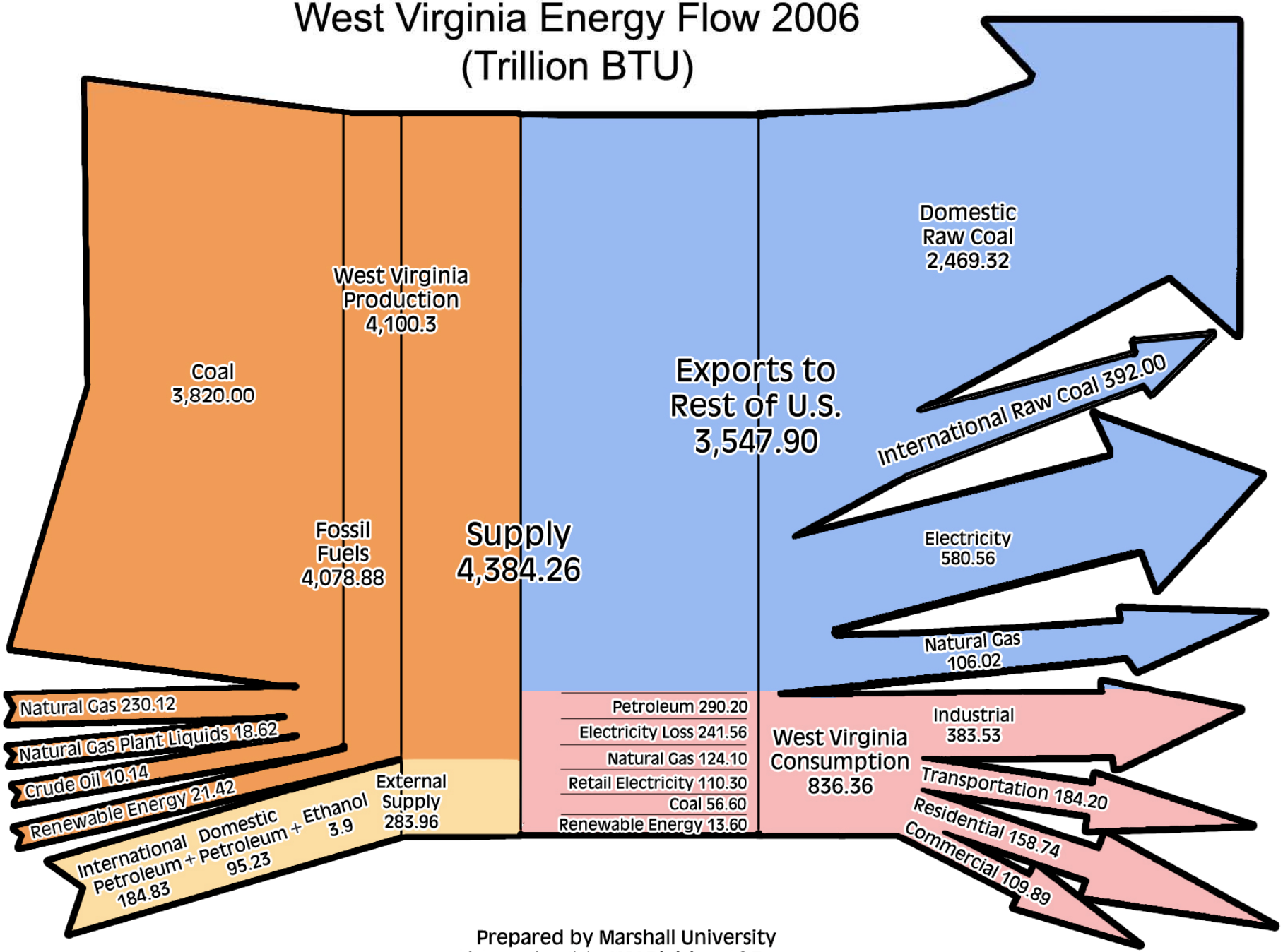
Some of WV's Unique Energy Facilities

- Largest wind facility in the Eastern U.S. – Dominion's Mt Storm
- One of the largest coal-fired power generation units in the country – John Amos Unit #3 (1300 MW). Only five units generated more electricity in 2006.
- 4 of 21 largest deep coal mines – McElroy first at 9.7 million tons in 2007.
- 2 of the 31 largest surface mines (only eastern state in top 31 in 2007) – Twilight and Hobet 21
- Location of major gas and electricity transmission thoroughfare to the East Coast.

West Virginia Energy Flow 2006
(Trillion BTU)

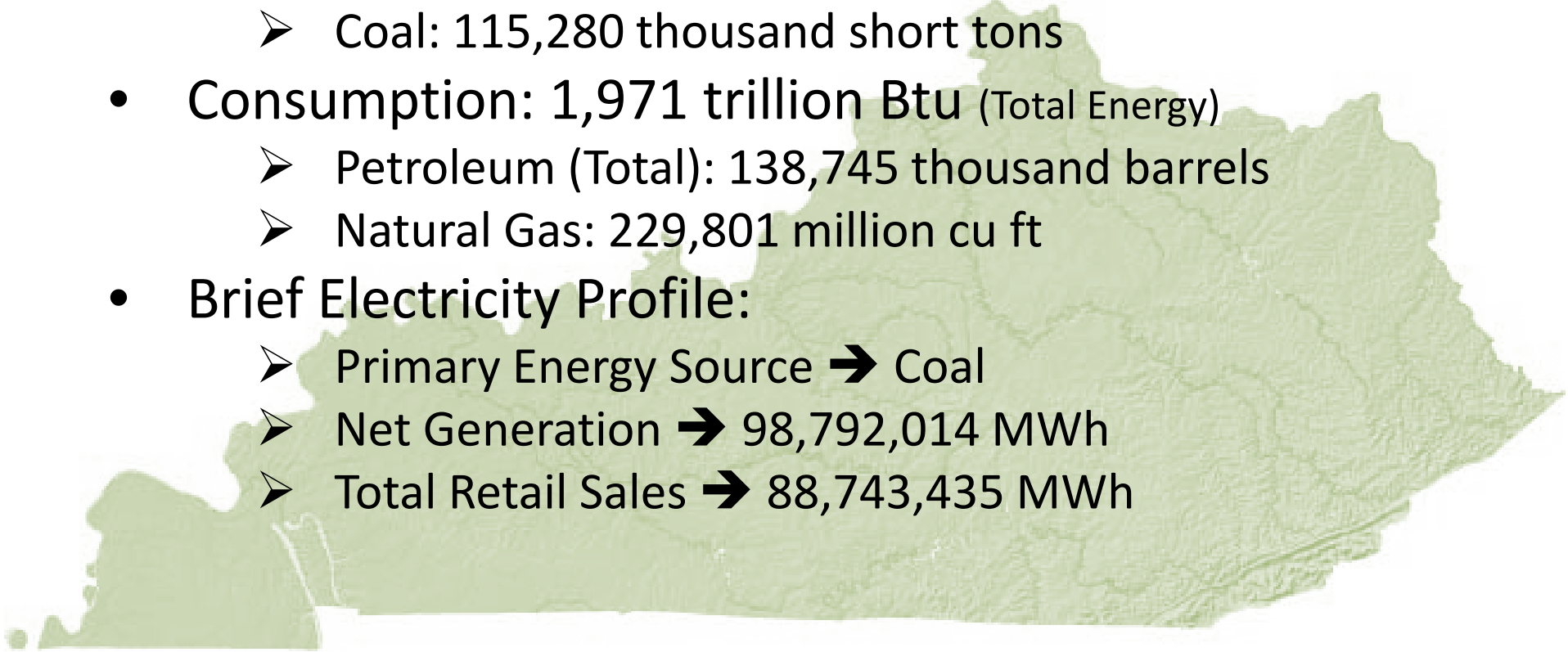


Prepared by Marshall University
under contract to WV Division of Energy

A Little Bit About Kentucky

Condensed Energy Flow in 2006:

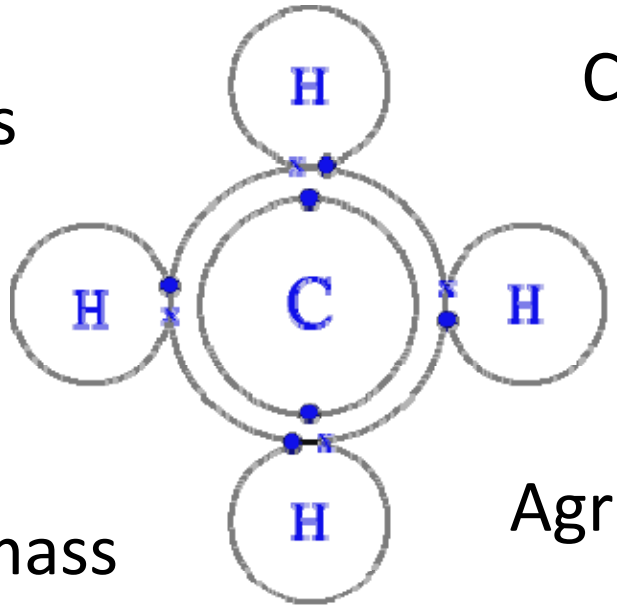
- Production: 3,176 trillion Btu (Total Energy)
  - Crude Oil: 244 Thousand Barrels
  - Natural Gas (Marketed): 95,437 million cu ft
  - Coal: 115,280 thousand short tons
- Consumption: 1,971 trillion Btu (Total Energy)
  - Petroleum (Total): 138,745 thousand barrels
  - Natural Gas: 229,801 million cu ft
- Brief Electricity Profile:
  - Primary Energy Source → Coal
  - Net Generation → 98,792,014 MWh
  - Total Retail Sales → 88,743,435 MWh



Some “Odd” Energy Resources

Landfill Gas

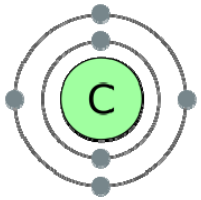
Coal Waste



Wood Biomass

Agricultural Waste

Most have <u>methane</u> in common, the principal component in natural gas, or carbon.



Landfill Gas-to-Energy (LFGTE)

- Operational Projects in the U.S. - 445
- Candidate Landfills in the U.S. - estimated 535
- States without projects - AK, CO, HI, NV, PR, SD, VI, **WV**, WY

Regional Projects

State	Electricity	Direct Use	Cogeneration	Other
KY	5	1	0	0
MD	5	2	0	0
OH	9	10	0	6
PA	25	9	5	11
VA	18	9	0	0

How Would You Do This?

- Capture – this requires installation of a piping system to collect the gas
- Clean – a system to remove impurities that includes a flaring system to get rid of excess gas
- Compress – the gas must be compressed prior to placement in a combustion engine or a pipeline

Why Would You Do This?

Landfill Flare in TX

State Energy Conservation Office

1. Supply-side: To create a market for an energy source that would otherwise be flared.
   - Green Power pricing programs
2. Demand-side: To acquire fuel at stable prices
3. To reduce methane emissions: By weight, methane is about 21 times more powerful at warming the atmosphere than carbon dioxide. (EPA)

Bavarian LFGTE Project

"Bavarian & East Kentucky Power turned our landfill into a mini energy factory!" - bumper sticker

Some Other Interesting Projects

BMW in South Carolina:

- Begin operating in 2003
- CHP plus direct thermal use for paint shop ovens and heating.
- Methane is from a large WM landfill (17.5 million tons of waste in place)
- Covers nearly 70 percent of BMW's energy consumption
- Gas is delivered via a 9.5-mile pipeline

Sanitation Districts of Los Angeles County:

- CNG – equivalent to 1,000 gallons of diesel fuel per day
- From a landfill with > 105 million tons of waste in place

* Source: Landfill Methane Outreach Program

Anaerobic Digestion

- A biological process wherein biomass is broken down by bacteria in the absence of oxygen.
- Takes place inside a bioreactor where various microscopic bacteria consume the biomass and in the process release methane and carbon dioxide as it ferments.
- A thermophilic digester operates at a temperature of 134 degrees F.
- Applications are primarily farm waste (chicken litter, duck litter, swine and dairy cattle manure) but any organic waste is a source, e.g. composts, municipal wastewater

Some Current Projects

About 130 projects around the country:

- Allentown, PA municipal WWTP – collects gas from treatment plant and uses it to fuel 390 KW turbines, also captures warm water to feed digesters
- Racine, WI – Maple Leaf Farm, the largest duck farm in the country; 500,000 ducks produce 40,000 gallons of manure
- Dairy farms in IA –
- West Virginia State University's Bioplex Project, a 10,000 gallon demonstration project that digests broiler litter (manure and bedding)

Waste Coal
a.k.a “gob” (garbage of bituminous)

- Small particles of coal (fines) and debris leftover after preparation for burning.
- Every site is different.
- Also covers coal-bed methane.


Keppler Mine Impoundment
N
© 2009 Tele Atlas
Google
37°34'17.31" N 81°34'09.74" W
elev 1665 ft
Aug 25, 2007
Eye alt 5912 ft

Where does it come from?

- Washing and sizing, then discarding the rest
  - Must be washed to remove ash and sources of emissions, like sulfur, and to maximize heat content.
  - Must be sized to remove small particles that are not optimum for conventional transport and power plants. (harder to transport small particles and harder to burn)
- Usually done near the mine to reduce transportation and waste disposal costs.
- Size and purity screening both produce waste that can be used in non-conventional processes.
- Coal is usually separated from refuse via gravity

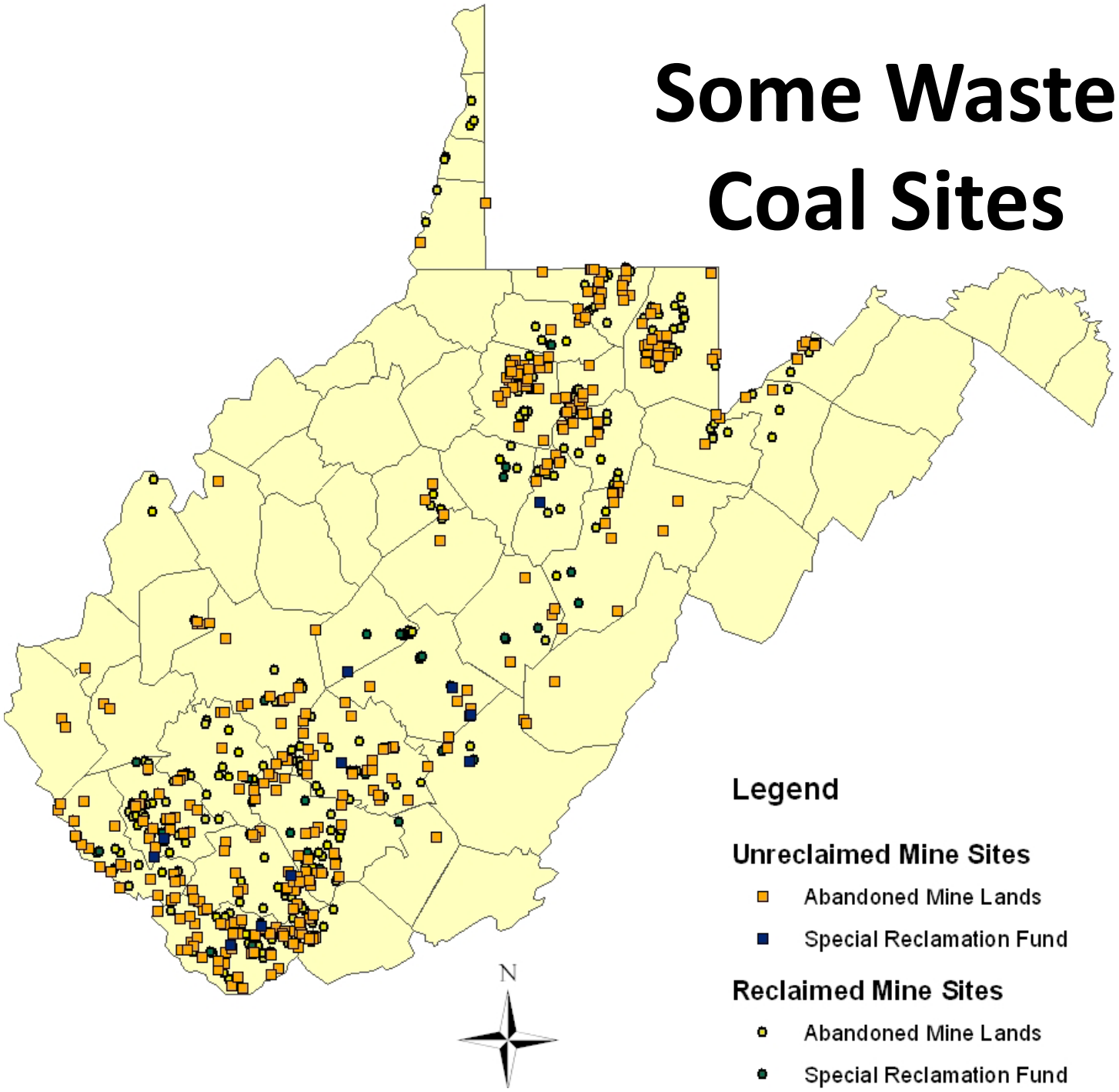
How Much Waste is there?

- In 1994, was estimated that the annual production of fines produced by coal washing was > 38 million tons (Electric Power Research Institute)
- There are at least 864 disposal sites in WV at reclaimed and unreclaimed slurry impoundments, dry waste piles
- There is more on open mining permits
- In KY…?

If you want to know more go to a CAST website….

The Center for Advanced Separation Technologies is consortium of seven universities, including VT, WVU and UKY. Funded by U.S. DOE.

Some Waste Coal Sites



Current Case Studies

- Beard Technologies in Wyoming County, WV - recovers former U.S. Steel waste slurry from the Smith Branch Coal Slurry Impoundment
- Deepgreen in McDowell County, WV – recovers metallurgical waste that is blended with regular coal and burned in conventional power plants
- CFB (circulating fluidized bed) Power Plants – 3 in WV, 17 in PA?
- Pelletized fines

UK Center for Applied Energy Research - briquettes made from coal fines and biomass (sawdust & weeds)

Former Synfuel Plants

- In 2006, there were approximately 55 synfuel plants in the U.S. that processed 125 million tons of coal, including waste coal
- Their existence was driven by tax credits that expired in 2007
- Many of these plants produced coal briquettes from fines, regular coal and a binding agent that was then sold to power plants
- The coal was required to undergo a “significant chemical change”
- Future re-mining incentives to use coal fines…?

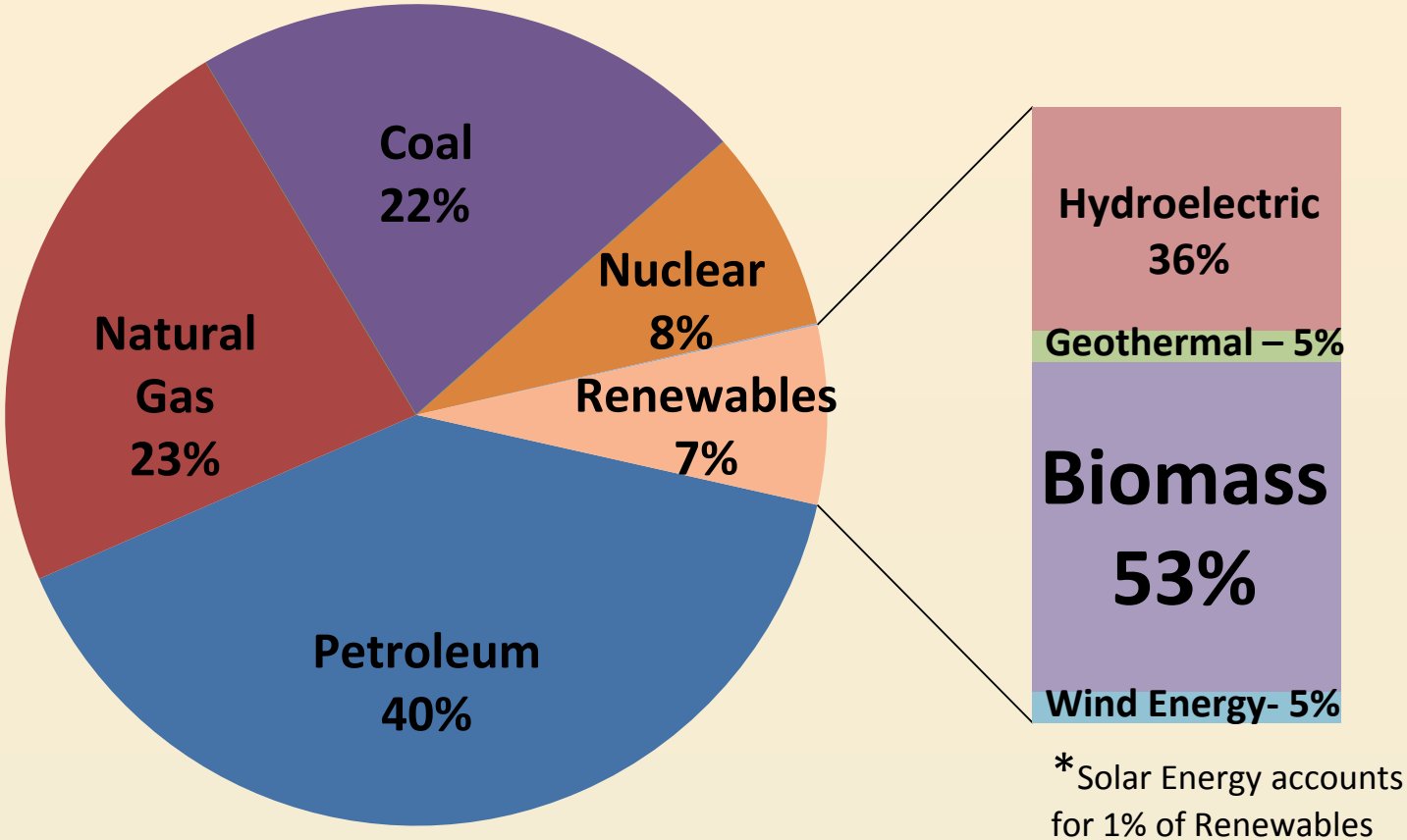
Wood Biomass for Energy

- Renewable and thus sustainable
- Available in large quantities, particularly in the western U.S.
- Prices not linked to global energy markets
- Does not include the risk associated with potential carbon regulation (no net GHG emissions)
- Because is largely a waste product reduces demand for landfill space

Photo Courtesy of Appalachian Hardwood Center

Total U.S. Energy Demand

101.605 Quadrillion Btu in 2007



*Solar Energy accounts for 1% of Renewables

SOURCE: Energy Information Administration

Ways Wood Biomass is Used

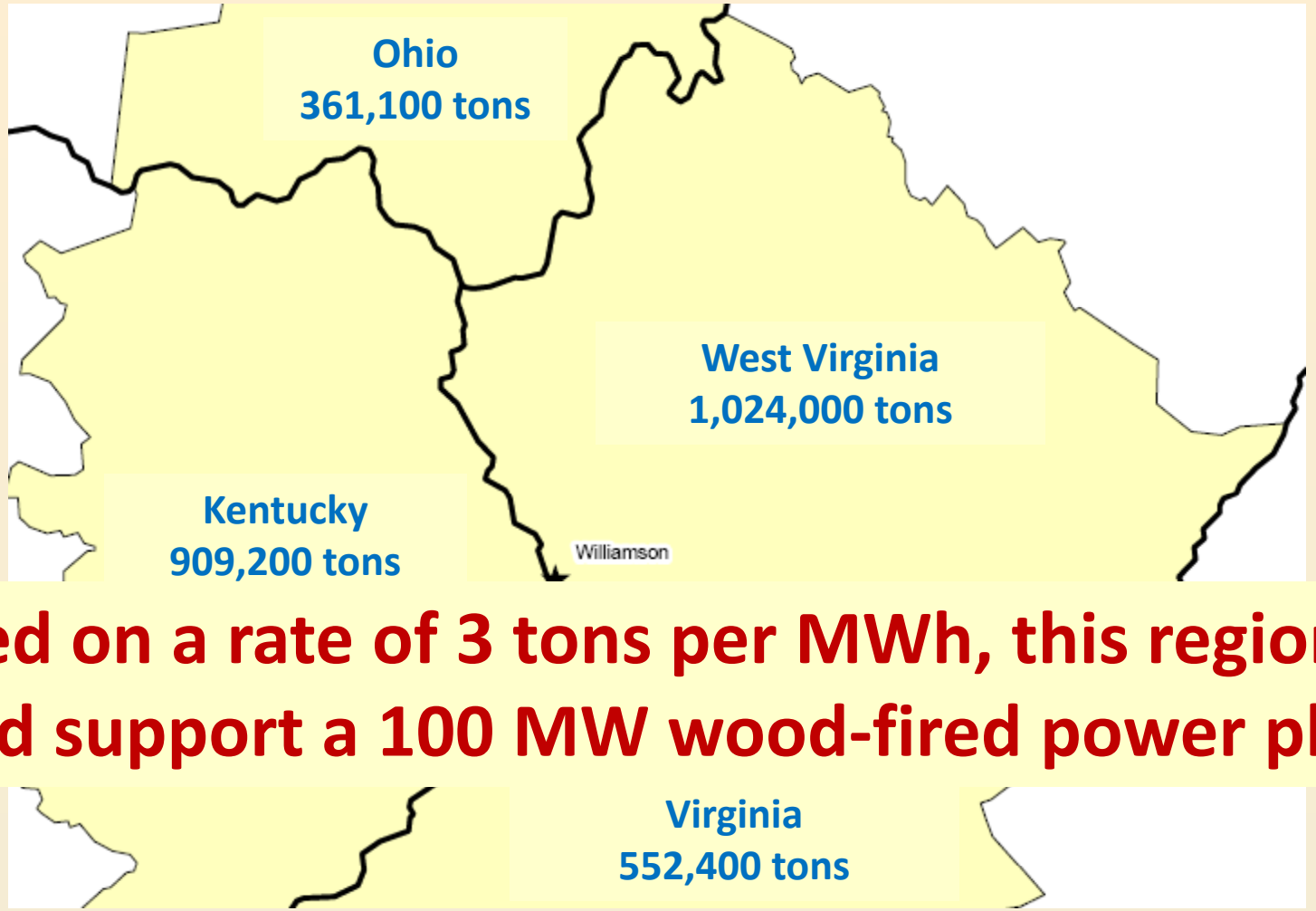
Markets are well-established for:

- Direct burning in industrial boilers - #1 energy market for wood, largely the paper industry using its residue
- Power generation – 16% of renewable electricity is generated from wood, including co-firing with coal. Closest project is an 80 MW Multitrade plant in VA. It burns ≈ 700,000 tons/year:
  - Sawmill chips and whole tree chips (78%); Sawdust (17%); Shavings, bark, and tub grindings (5%)
- Wood pellets for stoves and smaller-scale power gen
- Non-energy products: animal bedding, mulch (bark), spill absorber (sawdust)

Roundwood Logging Residue

Photo Courtesy of the Appalachian Hardwood Center

Regional Logging Residue estimated at around 3 million tons



Based on a rate of 3 tons per MWh, this region could support a 100 MW wood-fired power plant.

SOURCE: Appalachian Hardwood Center/ USDA Timber Products Output

Some Co-Fired Coal and Wood Plants

- Burlington, VT – coal and wood chips
- Chesterton, IN – coal and urban wood waste
- Dresden, NY – coal, wood residue and willow grown as an energy crop
- Johnstown, PA – coal and various wood waste
- Oakridge, TN – coal and hardwood sawdust
- Pittsburgh, PA – coal and wood chips
- At least 14 others in the U.S.
- Dozens more throughout the world

Production Tax Credits are in place that incentivize this.

Comparative Fuel Prices 2003

Fuel	Net fuel cost per MMBtu
Hardwood Chips	$3.10 - $5.30
No. 2 Fuel Oil	$7.85 - $13.75
No. 6 Fuel Oil	$7.60 - $11.45
Electricity	$17.60 - $43.95
LP Gas	$10.85 - $20.40
Natural Gas	$8.15 - $12.50
Coal	$5.70 - $8.55

Biomass Energy Resource Center

In the future…. A liquid fuel?

Cellulosic Ethanol:

- 3 demonstration plants sponsored by U.S. DOE will use wood as a feedstock - closest one is in Georgia.
- A private developer is pursuing a plant in Ohio.
- Sweden - Etek pilot project began operations in 2005
- Norway - Norske Skog, a paper manufacturer

Synthetic Fuel (Biomass-to-liquid from synthesis gas):

- A company called Choren in Germany is trying it. They call it SunDiesel.
- At least two regional efforts to develop a BCTL plant.

Wood Biomass Resources

Biomass Energy Resource Center in VT

http://www.biomasscenter.org/

Appalachian Hardwood Center at WVU

http://ahc.caf.wvu.edu/ and www.wvbiomass.com

Cooperative Extension Forestry Program at UK

http://www.ca.uky.edu/forestryextension/index.php

Video of wood residue going through a tub grinder

http://www.youtube.com/watch?v=8Jjufewc4m8

Have a Great Weekend!

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