Renewable Fuel Combustion Technologies

Western Regional Boiler Association
Spokane, Washington
March 10-12, 2009

Bob Morrow
Detroit Stoker Company

National Emission Standards for Hazardous Air Pollutants (NESHAP)

- ✓ Final (1st time) Rule published by EPA Sept 2004 also known as the Industrial, Commercial & Institutional (ICI) Boiler BMACT "Maximum Available Control Technology"
- ✓ Implementation Sept 13, 2007
- ✓ Courts vacated rule 100% August 1, 2007
  - ✓ Why – poor definition of "waste fuel firing" conflicting with Commercial, Industrial Solid Waste Incineration (CISWI) Rule, Part 129 of CCA.
- **ANPR "Advance notice of Proposed Rulemaking" on CISWI Dec 2008 with 30 day comment period.**
- **ANPR for Revised BMACT Mid-late 2009. Finalize in 2010**

So…. What else ??????????

States Forged Ahead as Suspected (State Implementation Plans) SIP's

- ✓ **Vacated rule is perceived as a *"Hammer"* to individual states to proceed. "Assumed that Congress intended the law to go ahead regardless"**
- ✓ **Most states did go ahead and began using BMCT Criteria for New and Existing Title V permits. "Particularly for coal"**

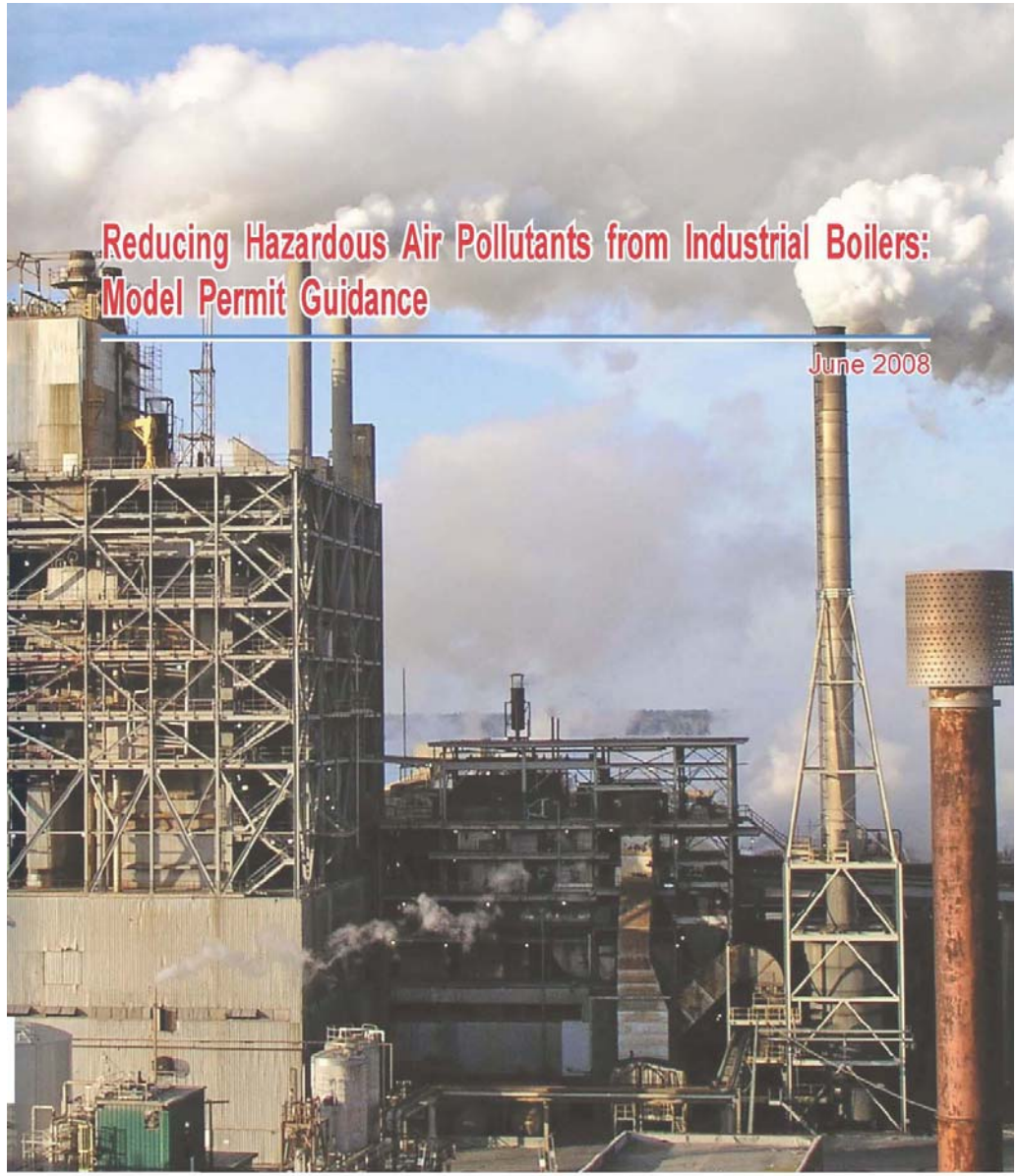
☞ **New ISSUE……**

NACAA

National

Association of

Clean Air Agencies



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NACAA
national association of clean air agencies

NACAA Guidance

CO Limits

	Coal	Wood
NACAA boiler Database	10	57
Original BMACT	400 ppm	400 ppm (0.38#/MMBtu)
NACAA Proposed	35-60 ppm	100-150 (0.10-0.14 #/MMBtu)

PM Limits

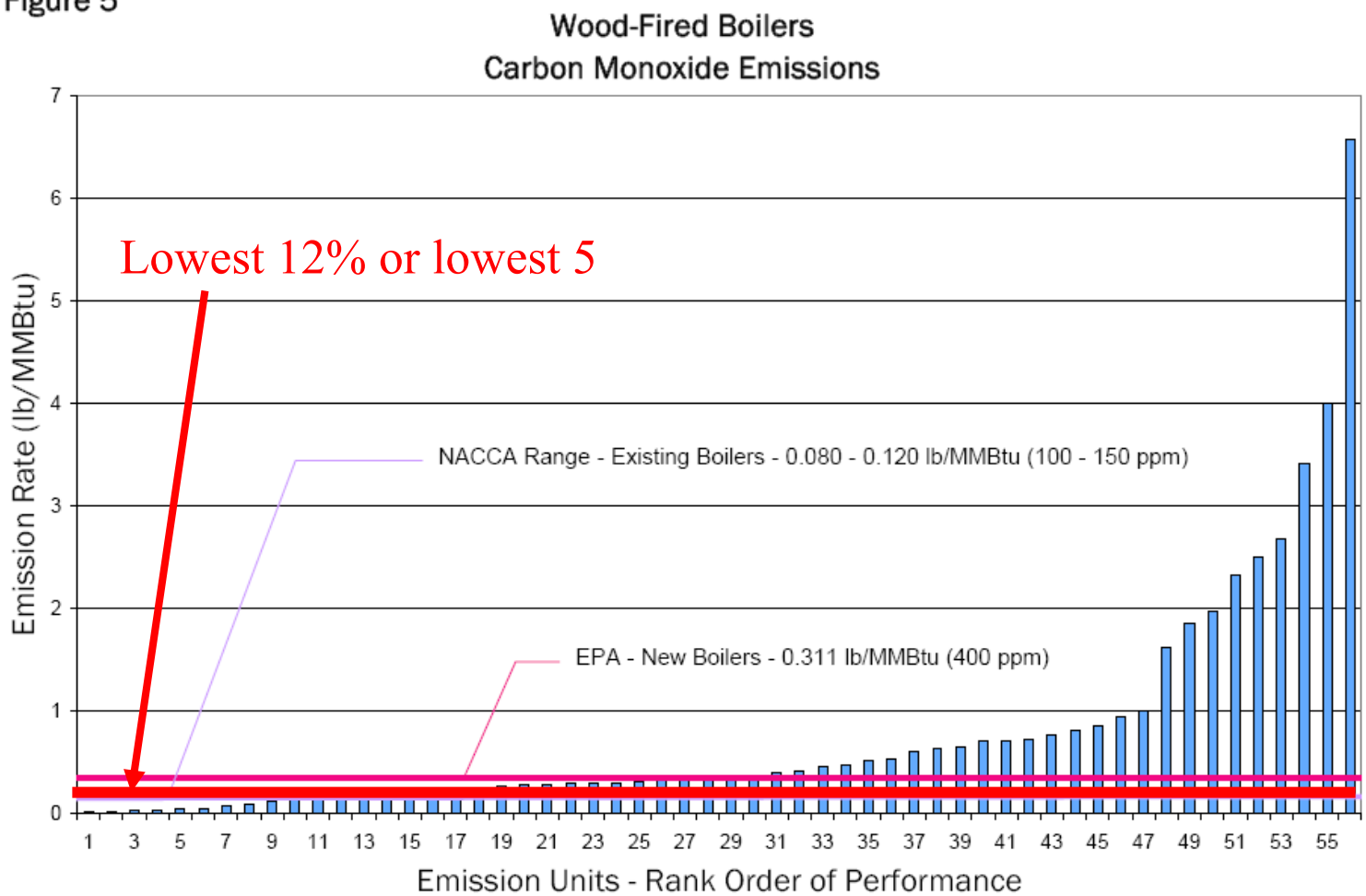
NACAA boiler Database	67	109
Original BMACT *Lbs/MMBtu*	0.025 New 0.07 Existing	0.025 New 0.07 Existing
NACAA Proposed	.008-0.012 Existing	0.01-0.02 Existing

Hg Limits

NACAA boiler Database	10	8
Original BMACT *Lbs/TBtu*	3.0 New 9.0 Existing	3.0 New
NACAA Proposed	4.5-7.5 or 90% removal	2.5 - 4.5

How did they arrive at these values??

Figure 5



EPA Considering MACT Floor Using Med Waste Methodology

- Consider only emission test data from units in the lowest 12% of units with test data
  - Testing plan also focused on best performers
- Address variability using standard deviation of individual runs in the test data for the lowest 12% at the 99.9% upper confidence level:
  - Limit = $avg_{lowest\ 12\%} + 3.09 * st.\ dev_{lowest\ 12\%}$

The Good, Bad & Ugly Wood

NACAA boiler Database	CO Limits	57
Original BMACT		400 ppm (0.38#/MMBtu)
NACAA Proposed		100-150 (0.10-0.14 #/MMBtu)
Med Waste Method		50 ppm

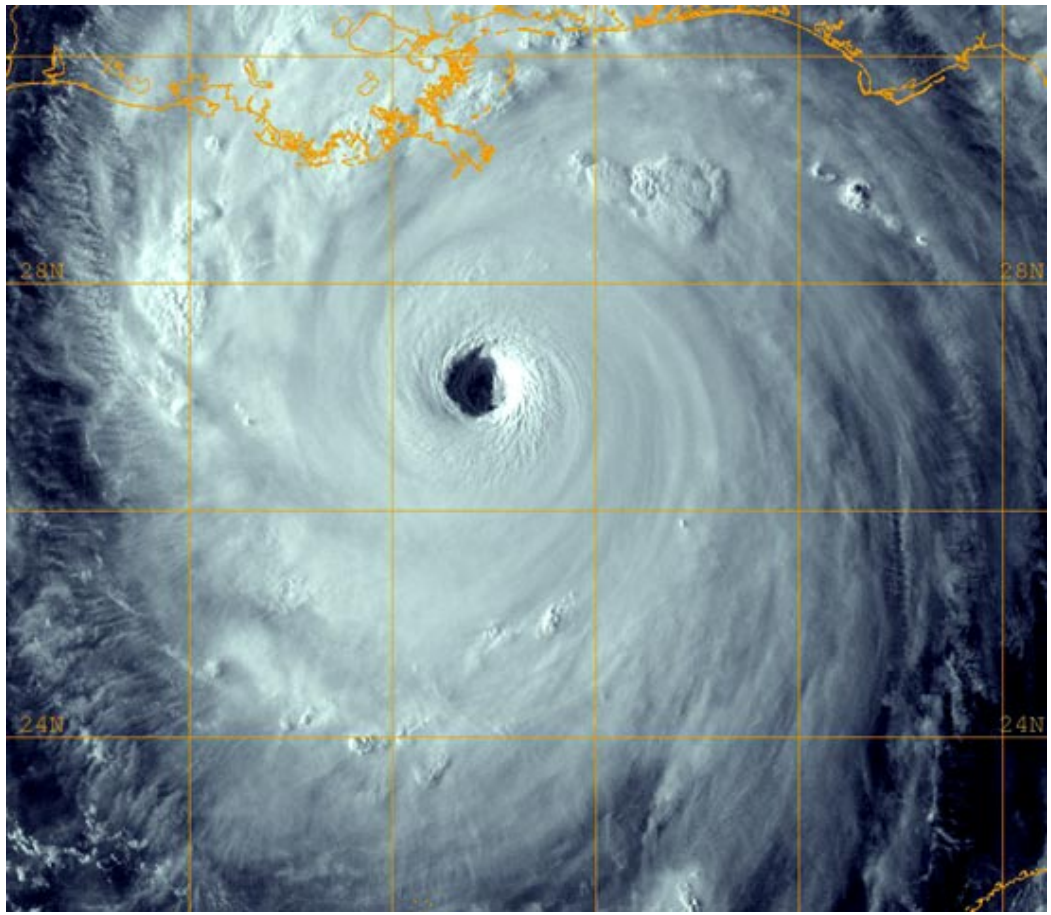
NACAA boiler Database	PM Limits	109
Original BMACT *Lbs/MMBtu*		0.025 New 0.07 Existing
NACAA Proposed		0.01-0.02 Existing
Med Waste Method		0.009

NACAA boiler Database	Hg Limits	8
Original BMACT *Lbs/TBtu*		3.0 New
NACAA Proposed		2.5 - 4.5
Med Waste Method		0.34

CISWI

- Comments are in for ANPR
- Time frame “Late Spring 2009 NPR”
- Notable Factors defining Waste
  - Concept of “Discarded”
  - Sham recycling
  - Never leaves mill = Fuel
  - Leaves mill = Waste
  - OCC - Screen wire & Plastics = Fuel, Otherwise??
  - Btu value (3500-5000 Btu/lb??)

Green House Gases



CO_2 and the other five (5) CH_4, N_2O, SF6, PFC's & HFC's

Health

With global warming comes a rash of poison ivy

Higher temps, increased CO_2 levels a win-win' for the weed, report says

By Anita Manning
USA TODAY

Poison ivy loves global warming.

As carbon dioxide levels have risen, the nasty weed has grown more vigorously and is producing more of the evil oil that makes people itch, says a report in this month's issue of the journal *Weed Science*.

Lead author Lewis Ziska, an ecologist in the U.S. Department of Agriculture's office on crop systems and global change in Beltsville, Md., grew poison ivy in chambers under conditions that matched CO_2 levels as they were in 1950, about 300 parts per million (ppm), and as they are today, about 400 ppm. "Even with the small change (in CO_2 level) that has already occurred, poison ivy was able to double in size," he says.

Poison ivy grown at CO_2 levels up to 600 ppm, the predicted level at the end of this century, were even bigger, tripling the 1950s-size plants, the researchers report.

The work is a continuation of a study published last year that found that poison ivy plants in a wooded area at a Duke University research center that were exposed to high CO_2 levels grew faster than other weeds. The plants also produced a more concentrated amount of urushiol, the substance in poison ivy leaves that causes an allergic reaction in about 80% of the population.

Ziska says removing some of the leaves, to simulate natural nibbling by deer and rabbits, did nothing to impede growth. Higher CO_2 levels and higher temperatures that make for a longer growing season are "a win-win for poison ivy … but not necessarily for human health," Ziska says.

Every summer, doctors see poison ivy rashes, which usually can be treated with anti-itch creams or lotions. But Robin Gehris, a pediatric dermatologist at Children's Hospital of Pittsburgh, says she has never seen so many severe cases as she has this year. That includes five cases of "black dot" poison ivy, an unusual form of the familiar rash that begins with black spots caused by the oxidation of the plant oil on the skin and develops into a fiercely itchy rash.

Caused by common poison ivy, it may result from a greater-than-usual exposure to the oil on the leaf surface, Gehris says. Patients "end up with a more nasty dermatitis," she says, so for doctors, the black dots "identify that select population of patients that need to be treated more aggressively."

One of Gehris' patients is Clayton Coppola, 7, of West Homestead, Pa. This month, while playing near a local athletic field, he, his brother, Tyler, 5, and a 7-year-old neighbor picked blackberries and pulled on ivy weeds growing on a fence. Within minutes, says Dawn Coppola, his mother, the boys sprouted black dots on their faces. "We thought it was oil on the fence or blackberry juice," she says.

She tried to wash the dots off or scrape them with her fingernail. She even tried mascara remover, but the spots wouldn't go away. She took the boys to a doctor, who was puzzled and e-mailed a photo to Gehris at Children's Hospital.

Tyler's and the neighbor boy's black spots and poison ivy rashes, though worse than average poison ivy cases, have eased.

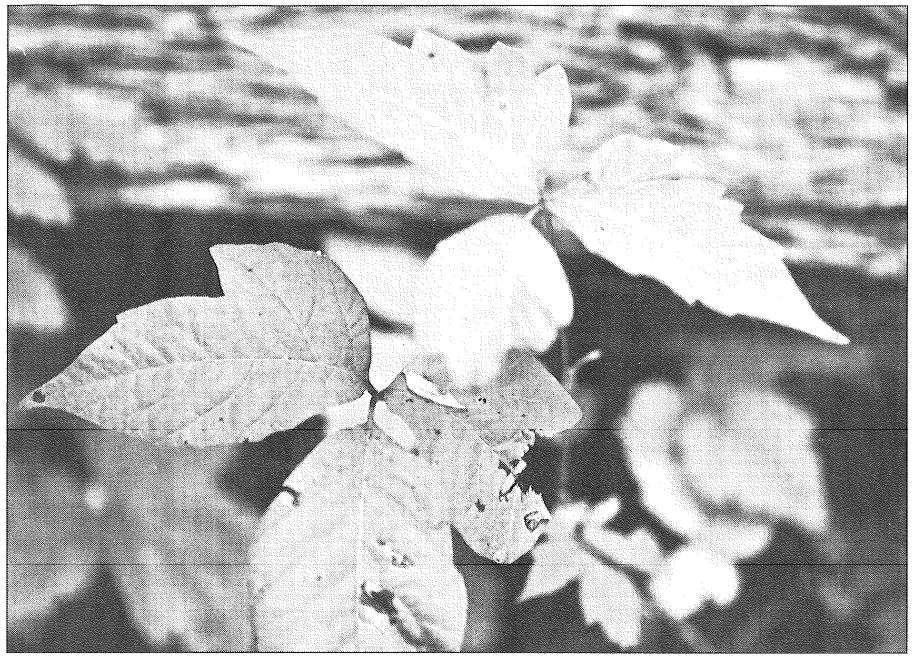
Clayton, who had about 10 black dots, still has a fierce poison ivy rash all over his body and is being treated with steroids. His mother says he "looks like he got stung by a thousand bees."

Fight the itch

If you're exposed to poison ivy:

- Wash area with alcohol; rinse with water.
- Wash clothes and wipe shoes with alcohol and water.
- If itchy blisters erupt, wet compresses, oral antihistamines and over-the-counter anti-itch creams and lotions may help.
- Severe rash may require a prescription corticosteroid; see your doctor.

Source: Food and Drug Administration

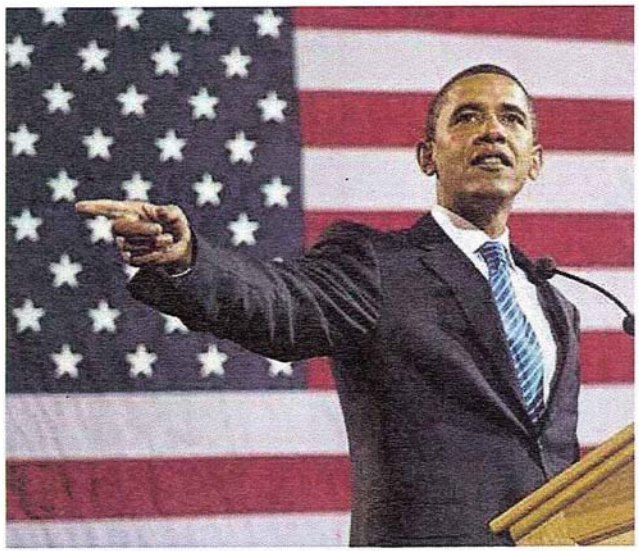


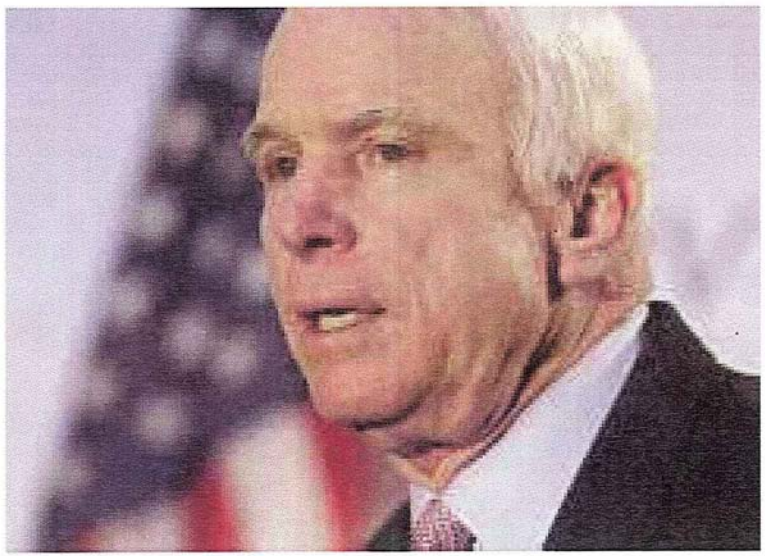
By Anne Ryan, USA TODAY

Itching to grow: Research shows that plants exposed to higher CO_2 levels grew faster and produced a more concentrated oil.

The Death Blow

Both Presidential Candidates Supported Global Warming Legislation

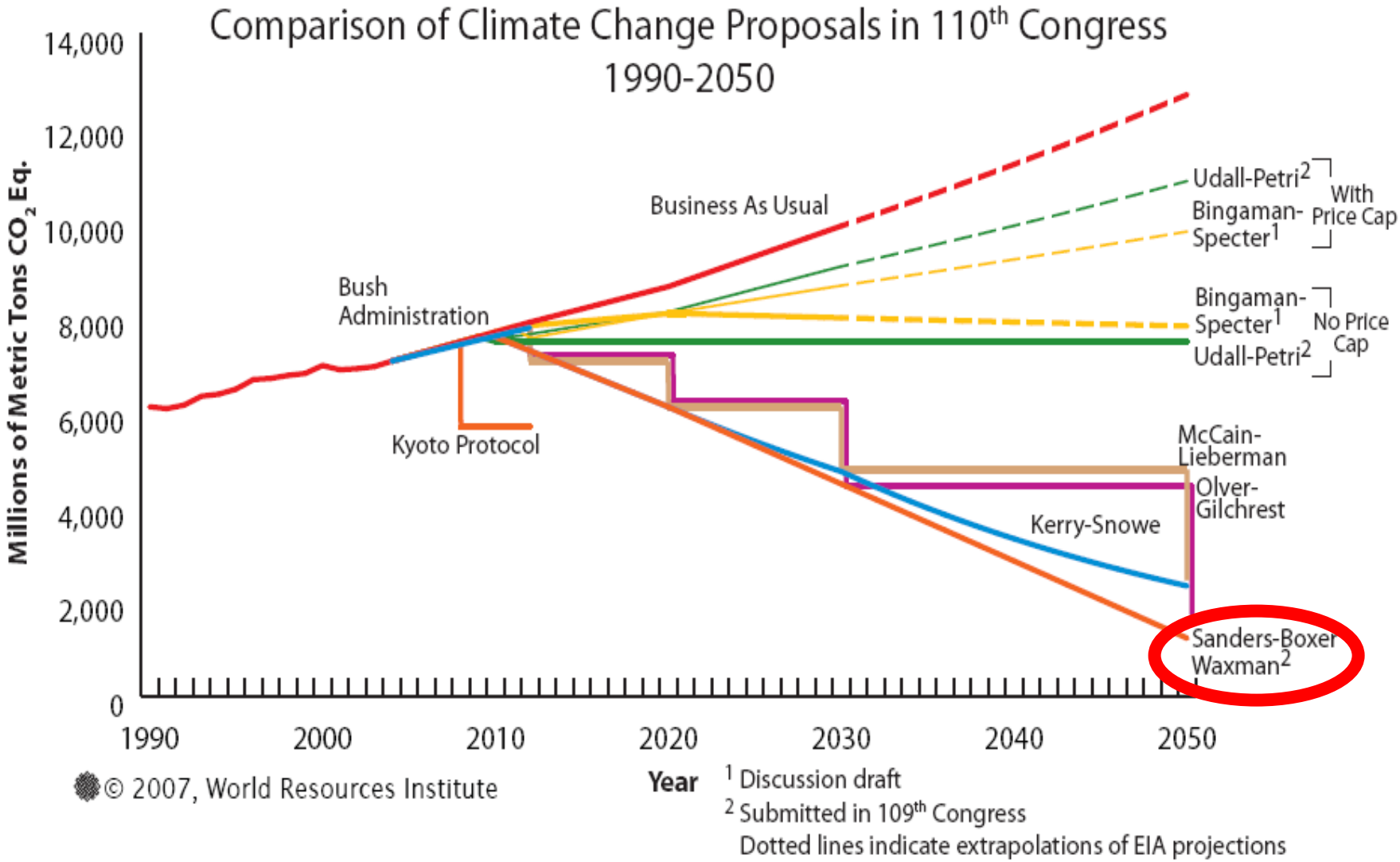




GHG Enforcement

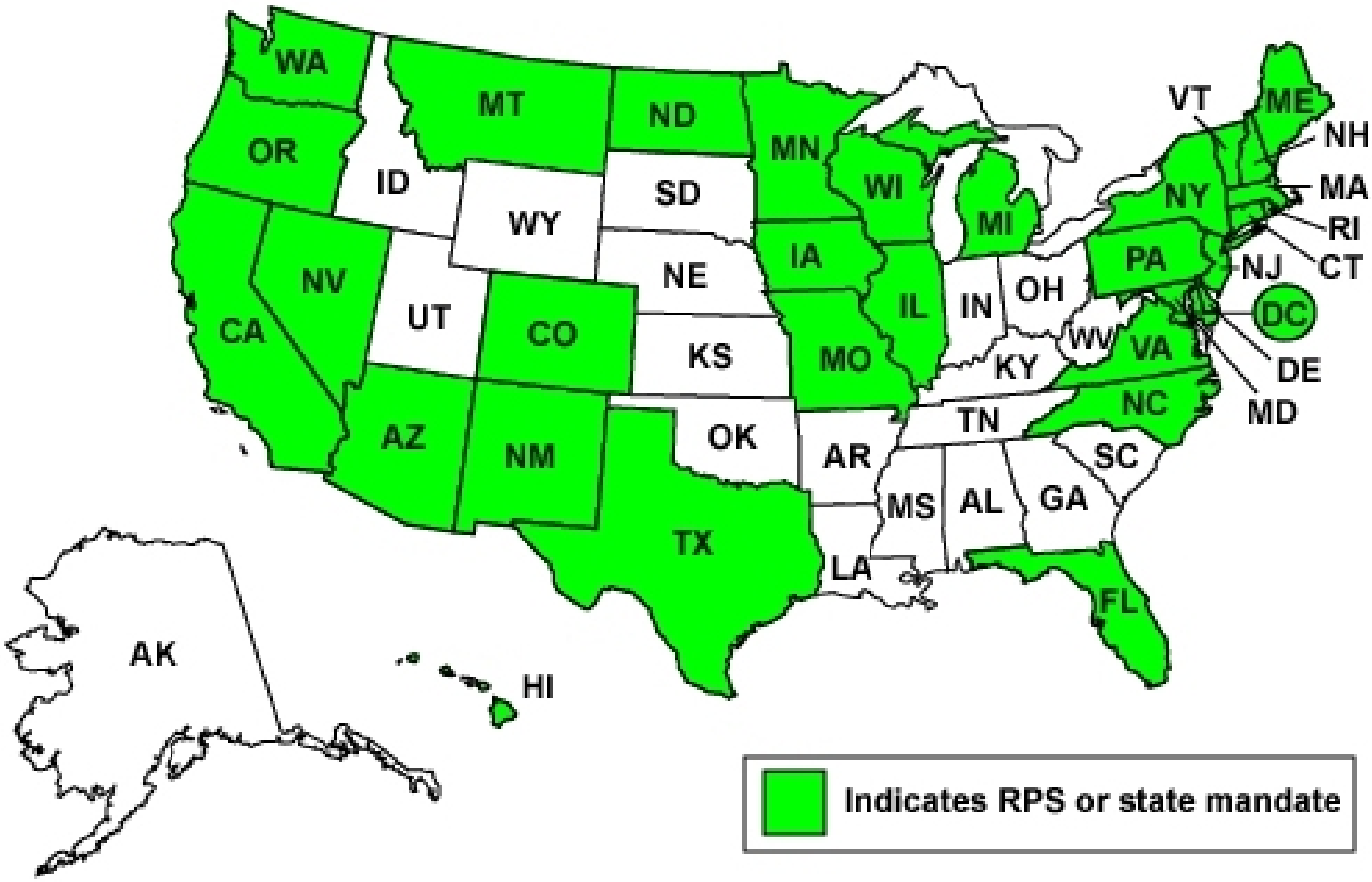
- April 2007 US Supreme Court (MA. Vs. EPA) Said…. “EPA you need to develop enforceable rules for GHG limits”
- July 2008 EPA publishes ANPR
  - Reflects complexity / magnitude of issue and IF and HOW GHG’s could be effectively controlled under CCA.
  - Summary of EPA work and concerns raised by other federal agencies
- Comment period (120 days) NOV 28, 2008
- April 2009 expect EPA to announce results of “Endangerment findings”

Federal GHG Legislation



RENEWABLE FUELS

Renewable Portfolio Standards



Source: DOE – Energy Efficiency and Renewable Energy 2008

Eligible Technologies Under State RPS

Energy Source	AZ	CA	CO	CT	DE	DC	HI	IA	IL	MA	MD	ME	MN	MO	MT	NC	ND	NH	NJ	NM	NV	NY	OH	OR	PA	RI	SD	TX	UT	VA	VT	WA	WI
Biofuels		•					•		•	•								•			•	•			•							•	
Biomass	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
CHP/Waste Heat	•		•	•			•			•						•	•				•		•		•		•		•		•		
Energy Efficiency				•			•		•					•		•					•		•		•							•		
Fuel Cells[b]				•								•	•									•	•		•								
Geothermal	•	•	•		•	•	•			•	•	•			•	•	•	•	•	•	•		•	•	•	•	•	•	•	•		•	•
Hydro	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Landfill Gas	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
Municipal Waste		•		•		•	•	•		•	•		•						•		•		•		•		•						
Ocean Thermal		•		•	•	•	•			•	•							•				•		•		•		•	•			•	
Photovoltaics	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Solar Thermal Electric	•	•		•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•		•	•	•	•	•	•	•
Tidal		•		•	•	•	•			•	•	•				•		•	•			•		•		•		•	•	•		•	•
Waste Tire																					•												
Wave		•		•	•	•	•			•	•					•		•	•			•		•		•		•	•	•		•	•
Wind	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

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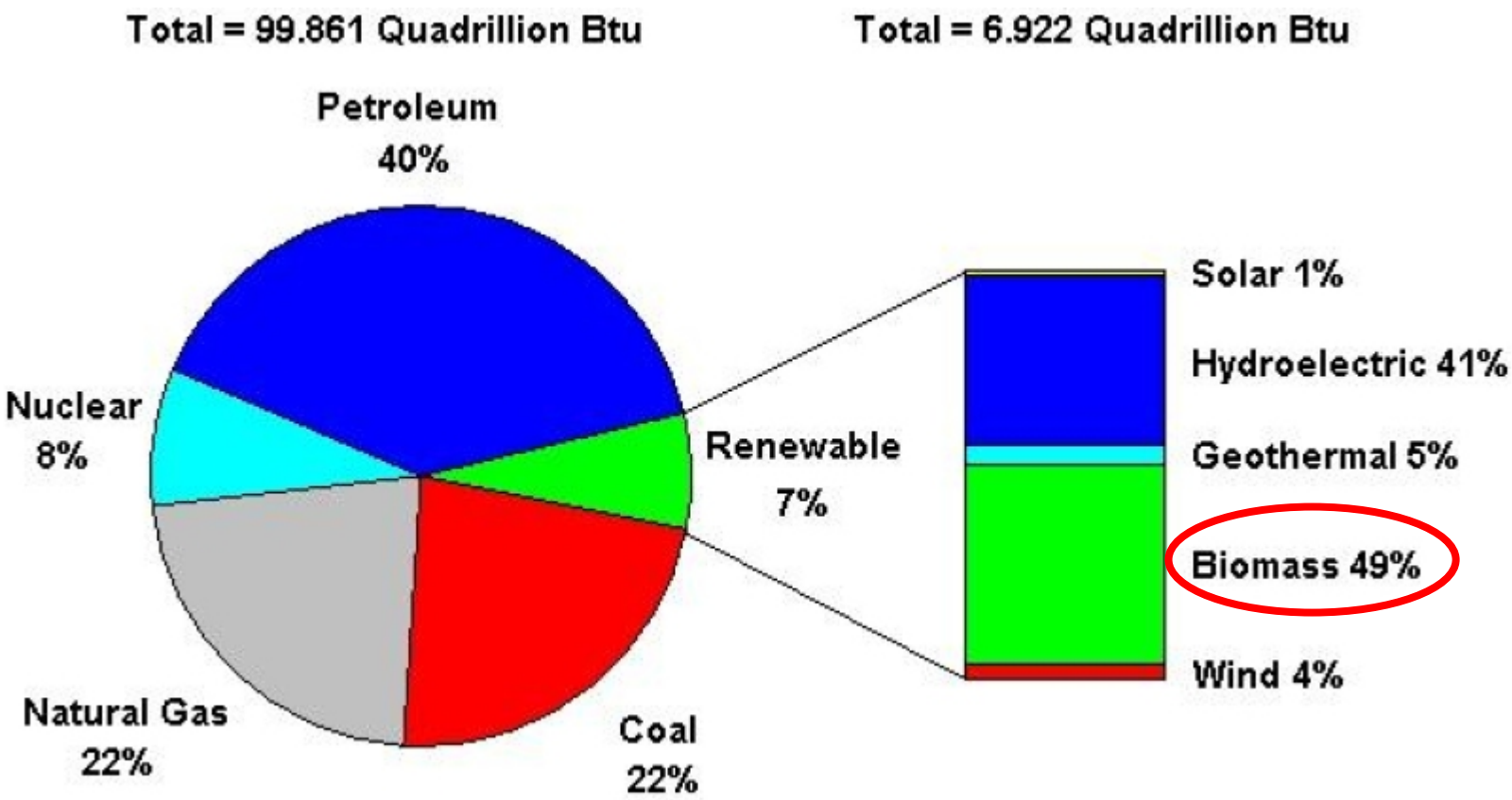
Source: Database of State Incentives for Renewable Energy

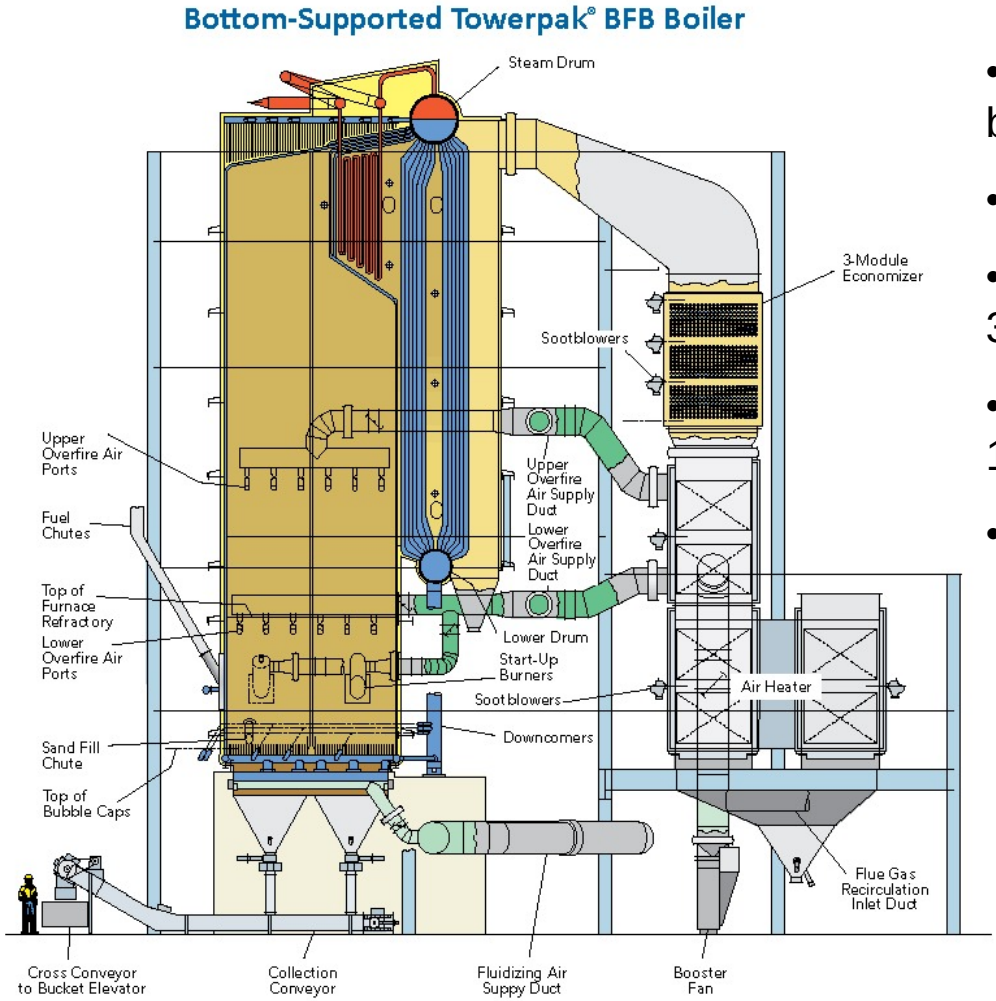
Where Renewables Sit



ICI Combustion Technologies

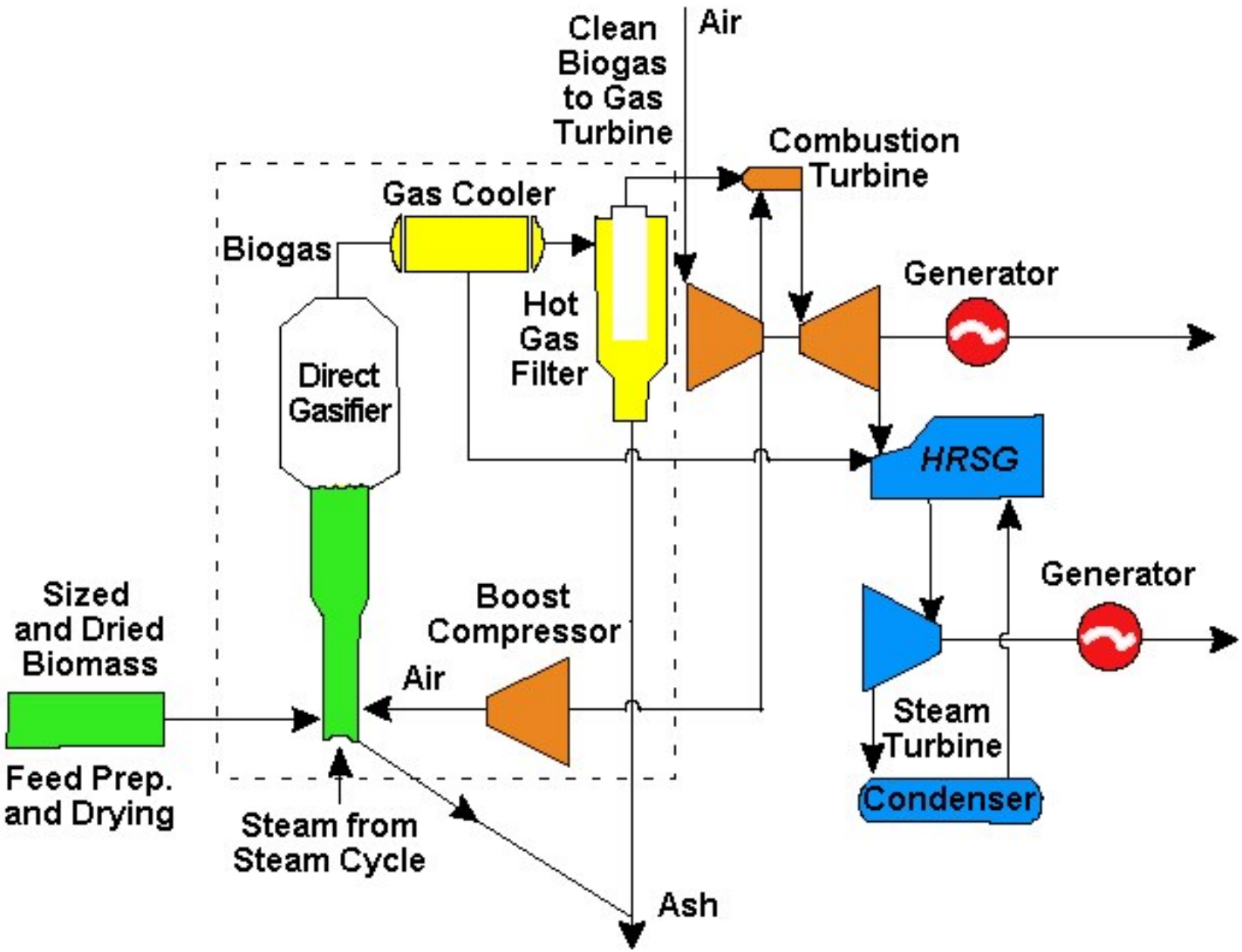
- **FLUID BEDS**
  - Circulating Fluid Bed
  - Bubbling Fluid Bed
- **GASIFIERS**
  - IGCC (Integrated Gasification Combined Cycle
  - Industrial Scale Steam Producers
    - Fluidized Bed
    - Entrained Flow
    - Fixed Bed
- **STOKERS**
  - Underfeed
  - Mass Fed
  - Spreader

Bubbling Fluid Bed



- Heated Silica sand bed 0.039” dia.
- Fuel fed into bed
- Fluidizing velocities 3.6-8.2 ft/s
- Bed temperatures 1490°F. SR <0.9
- Excess air 20-35%

IGCC



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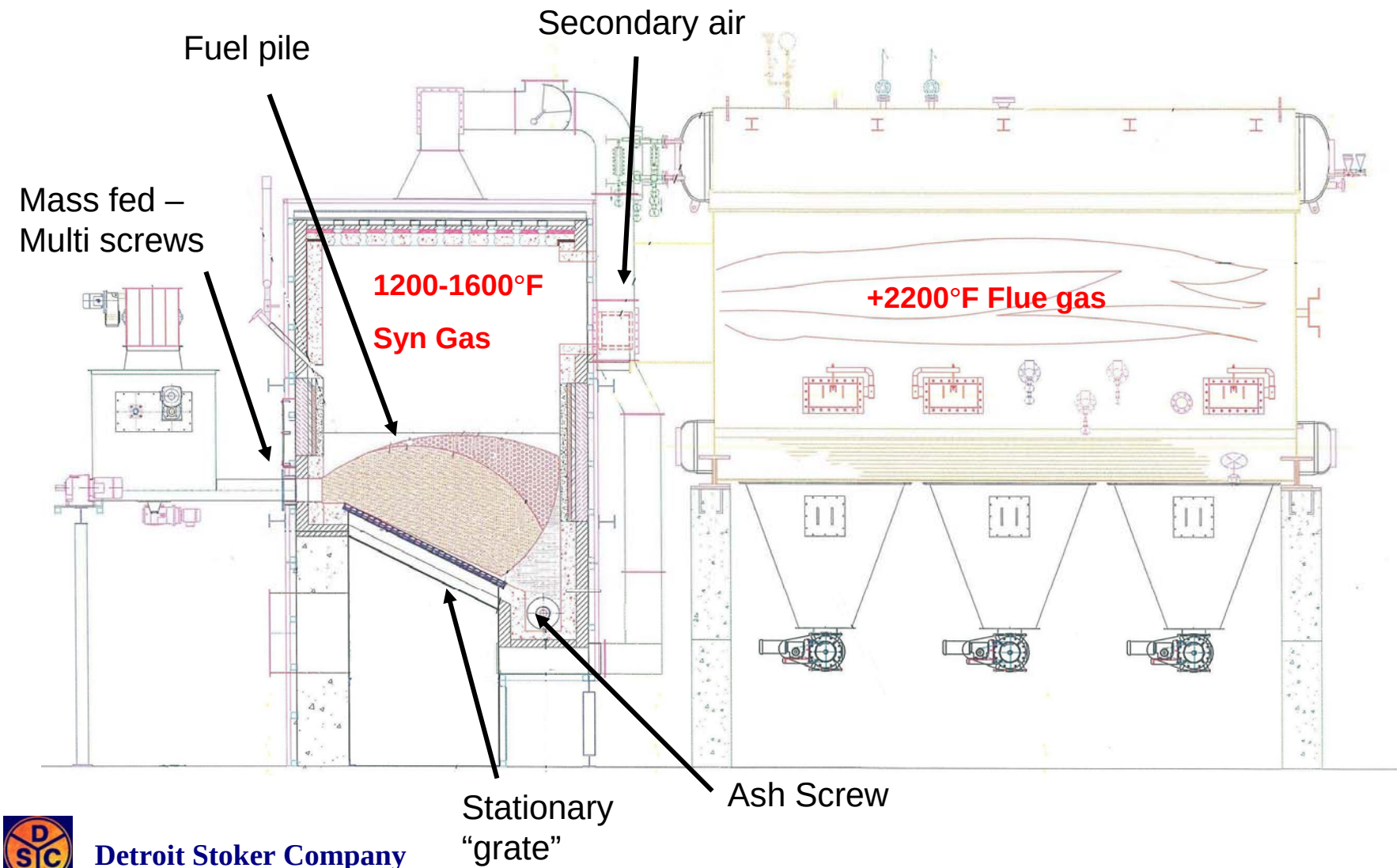
Industrial Gasifier



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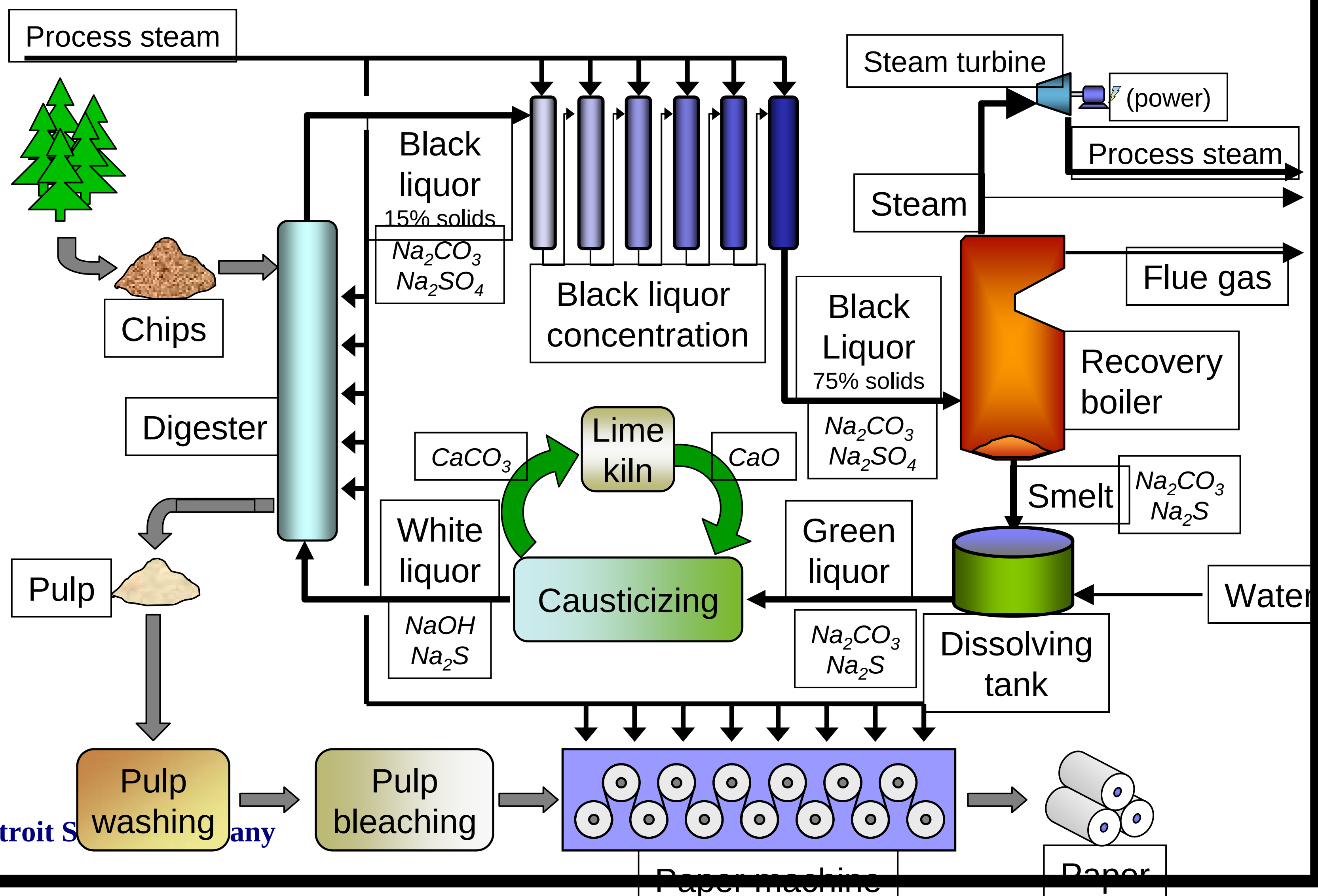
Lime Kiln Fuel Displacement



Detroit S... any

Lime Kiln Fuel Displacement

- **Typical paper mill**
  - **350,000 tons pulp per year (1000 tpd)**
  - **Lime kiln processing 350 tpd lime**
  - **Requires 75 MBtu/hr fuel**
    - **Natural gas (70,000 scfh)**

      $6 million/year at $10 per thousand scf
    - **Fuel oil #2 (650 gal/hr)**

      $16 million/year at $3 per gallon

Stoker-Gasifier Requirements

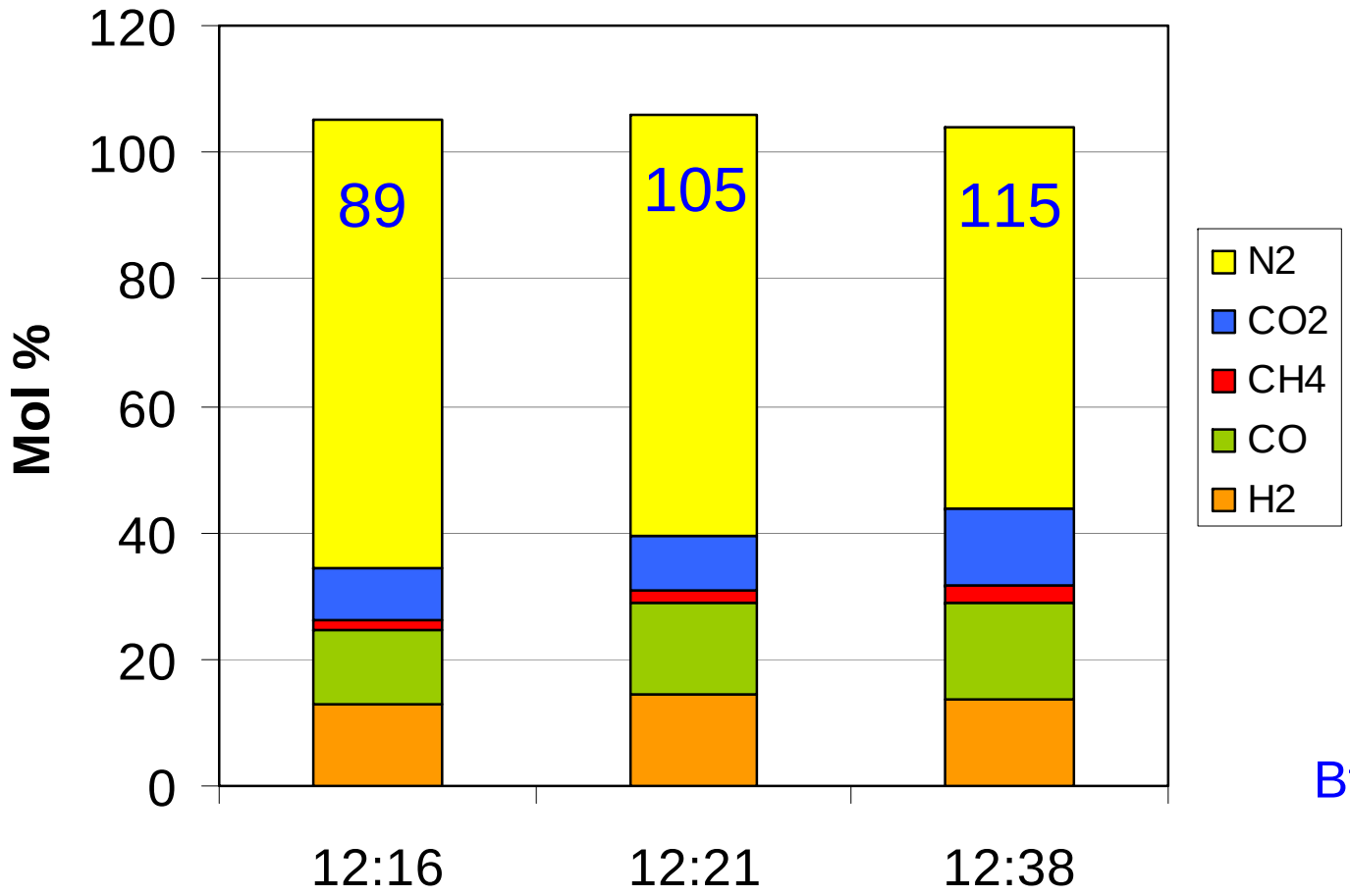
- Relatively inexpensive
- Able to produce gaseous fuel suitable for combustion in a boiler or kiln
- Able to process low-Btu fuel
- Limited need for gas clean-up
  - Sulfur, ammonia
  - Tars
  - Particulates

Pilot Scale Combustor (PSC)

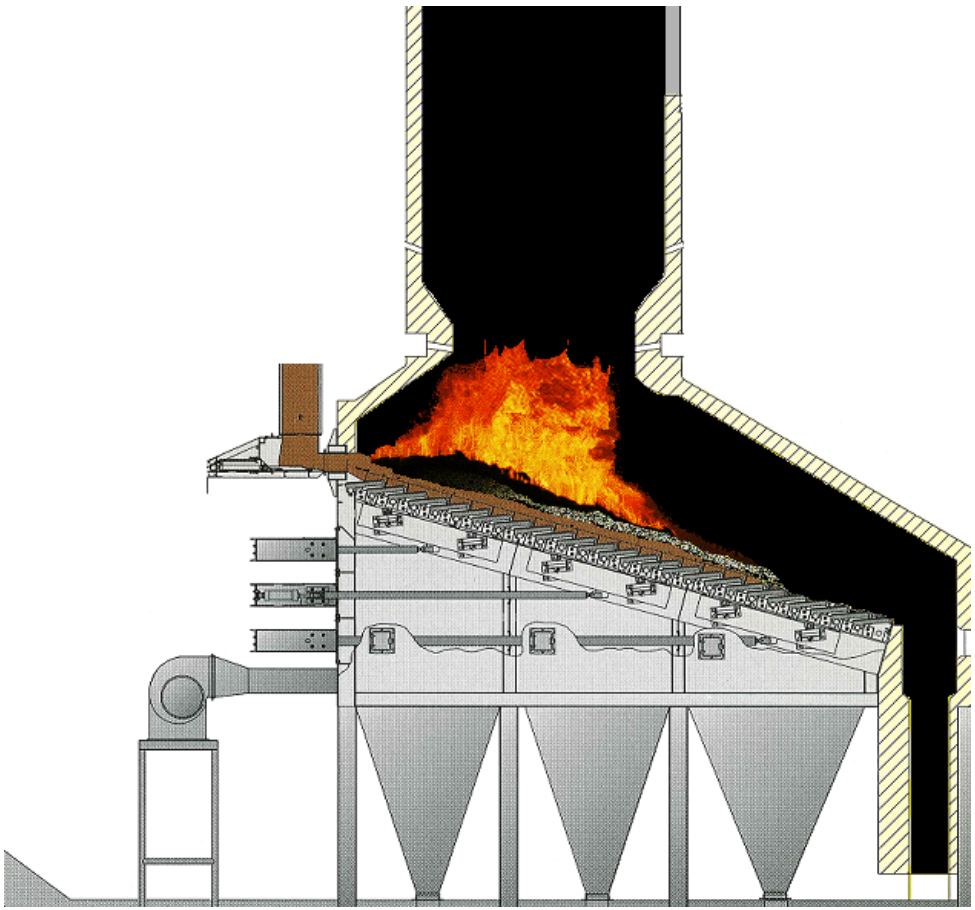
Gasification vs. Conventional Combustion

Syngas Analysis

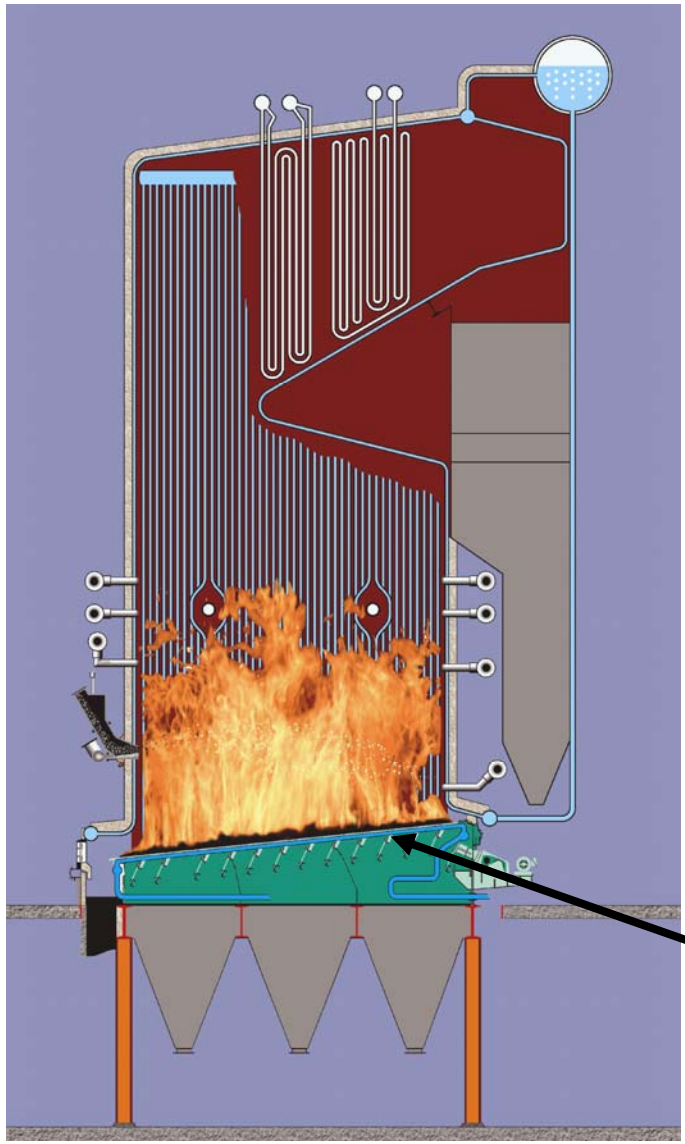
Nitrogen through Feeder



GTS Acquisition



Spreader Stoker



- Fuel fed above bed
- Furnace velocities 16-23 ft/s
- Combustion Temp +2200°F.
- Excess air 25-35%

Water-cooled grate

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	BFB	IGCC	Industrial Gasifier	Stoker
Capital Cost	High complex fuel and ash systems	Very High multiple combustors, flue gas clean-up	Low for most occasions. (Small outputs)	Medium-Low
Operating costs	High Fan HP, Bed material	High Fan HP, syngas clean-up	Low	Low
Availability	<85% Depending on fuel	Low ≤50%	Medium - High	High >95%
Fuel Flexibility	Limited Higher % H_2O	Good and bad	Undetermined	Good Flexibility
Emissions #/MMbtu	NOx 0.10-0.25 CO 0.10-0.40	Very low theoretically	Low -Medium	NOx 0.12-0.30 CO 0.07-0.40

50 MW Net Plant Comparison

Assuming current low level CO and NOx emissions (0.10 #/MMBtu & 0.07 #/MMBtu)

	BFB	Stoker
Steam lbs/hr Gross	**503,000**	**453,000**
Steam lbs/hr Net	**450,000**	**450,000**
Fuel oil input for RSCR MMBtu/hr	**NR**	**3.00**
Net System Efficiency (BFB req. sat steam for SCR)	**69.4**	**74.2**
Auxiliary loads kW	**5,430**	**2,324**
Modeled gross plant kW req	**57,900**	**54,500**
Est. Net plant Heat Rate btu/kWh	**13,605**	**12,635**
Req. fuel input for 50 MW net MMBtu/hr	**680.25**	**631.75**
CO_2 Emission lbs/hr	**150,977**	**140,212**

7% less CO_2


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