Using Biomass Gasification to Replace Natural Gas in a Corn Ethanol Plant

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CVEC

Shakers Vodka

Frontline BioEnergy LLC

- Creating a biomass powered gasifier to help reduce dependence on natural gas in corn ethanol plants
- “To lead the nation in biomass gasification solutions for energy and products”

Frontline Board

- Norman Reese – General Manager
- John Reardon – Research & Development Manager
- Jerod Smeenk – Engineering and Production Manager

- Bill Lee – CVEC General Manager
- Daniel Benson – CVEC Board Member

CVEC/Frontline Partnership

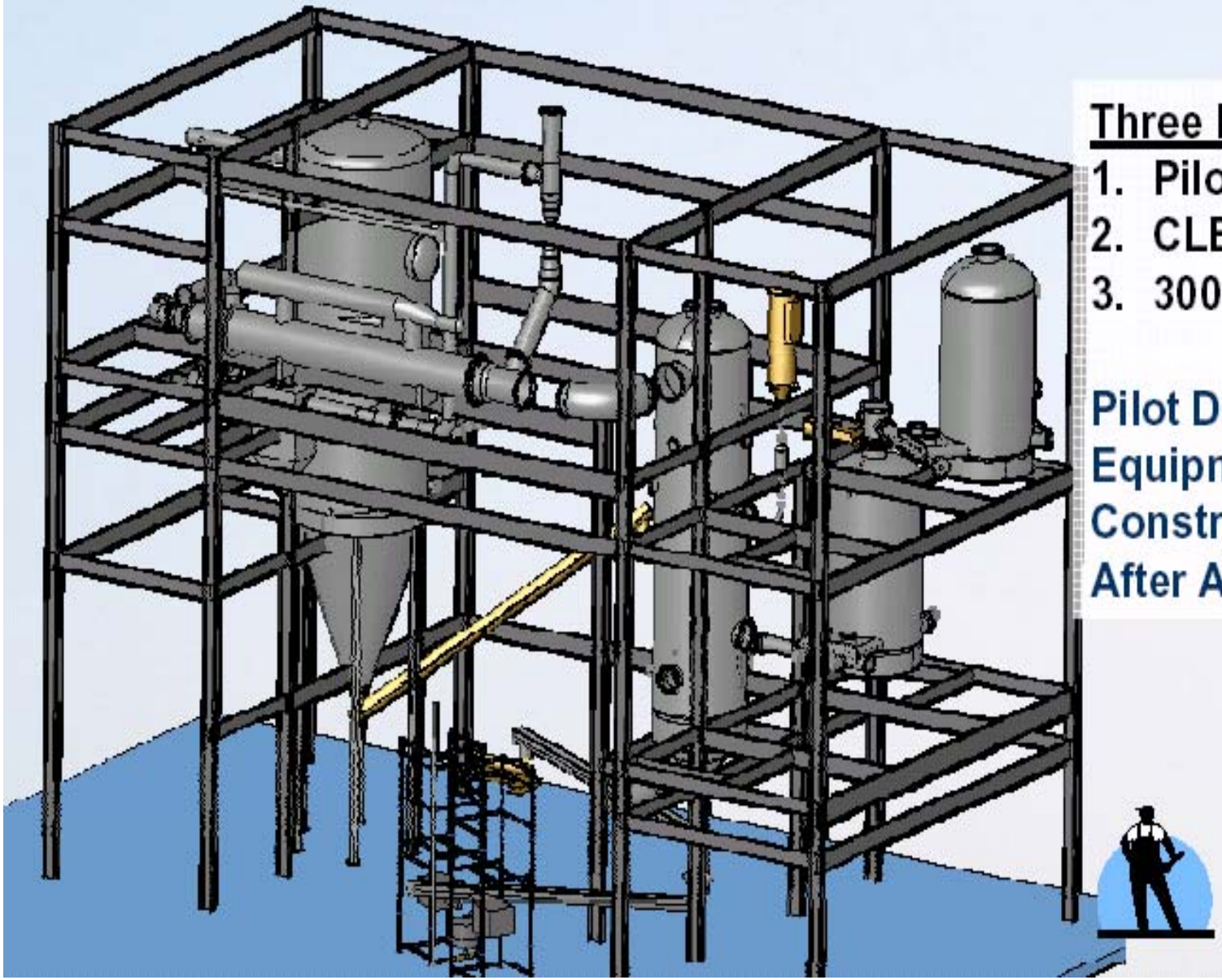
- Developing gasifier project to eliminate natural gas usage at ethanol plant
- Research the level of biomass that can be sustainably removed from the soil without increasing erosion.
- How to harvest, transport, and store the biomass in the most efficient manner.

Sources of Biomass

- Corn Stover
- Switchgrass
- Wheat Straw
- DDGs
- Wood


www.worldofstock.com

Frontline's Pilot Gasifier Ready for Build



Three Phase Project

1. Pilot 25 to 100 TPD
2. CLEANGAS™ Added
3. 300 TPD throughput

Pilot Design Ready
Equipment Ordered
Construction Starts
After Air Permit Issued

Tar sample tubes (~212°F)

3.5 g before

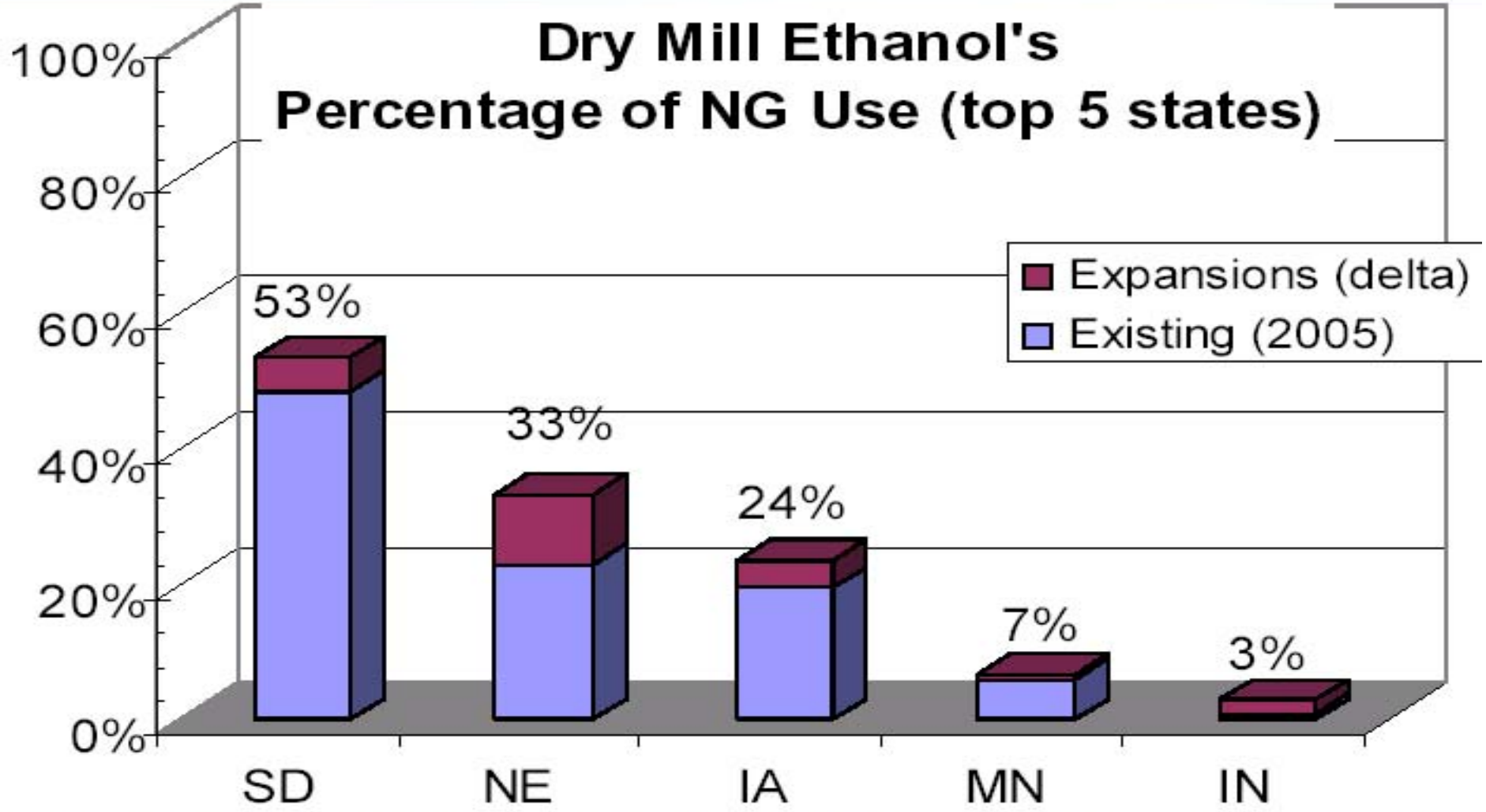
~0 g after *(below detection)*

Frontline Gasification Project

Staged Approach for Feedstock Logistics & Technology Scale-up

- **Phase I (25-100 TPD)**
  - Fire "old thermal oxidizer" HRSG
  - Feedstocks: primarily wood, test corn stover & DDGS
- **Phase II (Integrate CLEANGAS™)**
  - Further gas conditioning gas for gas distribution (lower tar)
  - Fire multiple appliances
- **Phase III (300 TPD) producer gas generator**
  - Feedstocks: corn stover, wood, DDGS
  - Provide producer gas to all major natural gas appliances (boilers and dryers)

Growing Local Supply/Demand Concerns



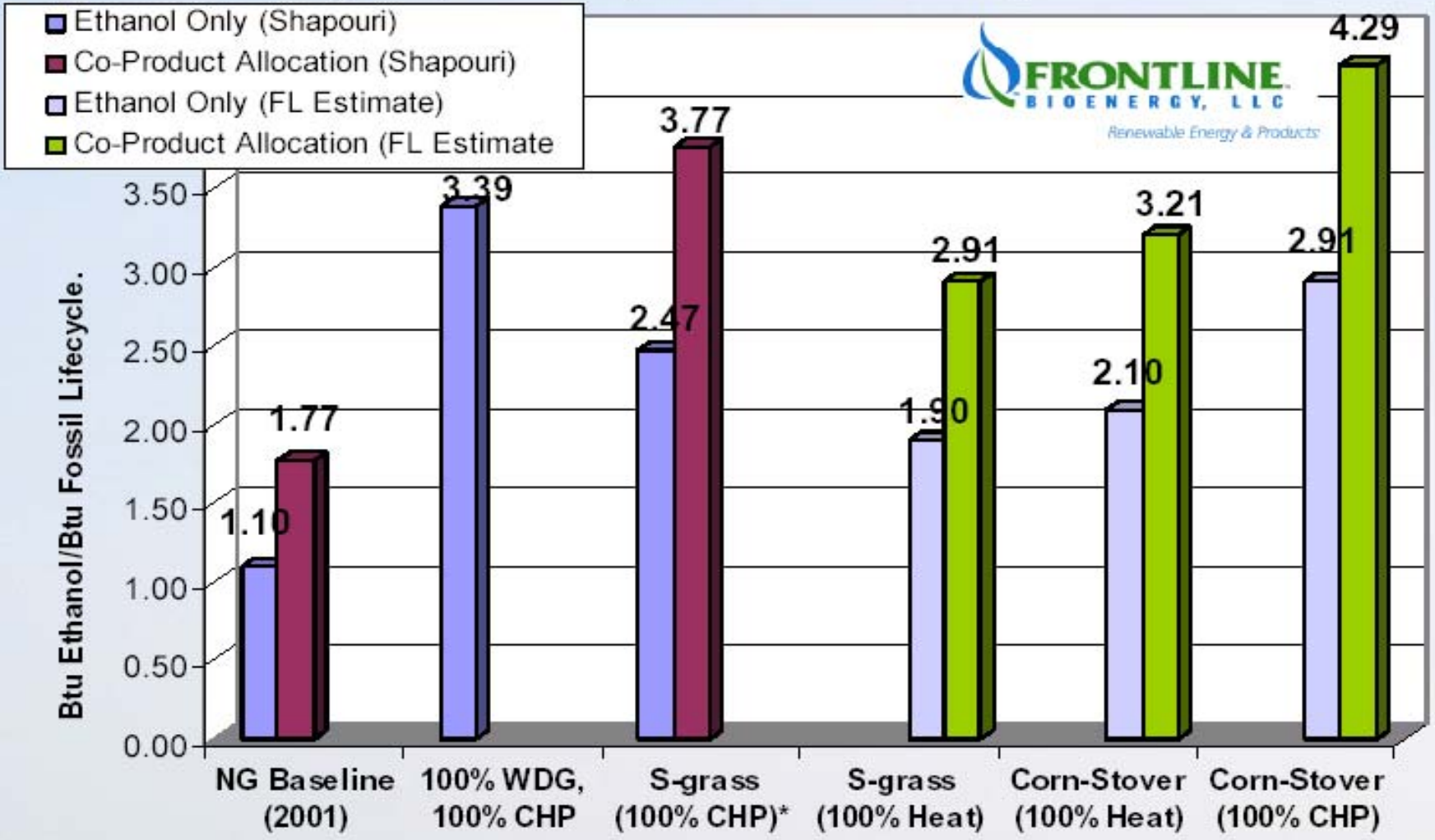
Frontline BioEnergy, LLC (2006); Concept proposed by Prof. Robert Brown (Iowa State

–Rapid changes to natural gas use creates competition for local supply, pipeline supply limits may be reached in cold season, curtailment to LPG

–Biomass use stimulates local economies through biomass supply

Renewable Energy Ratio Can be Improved

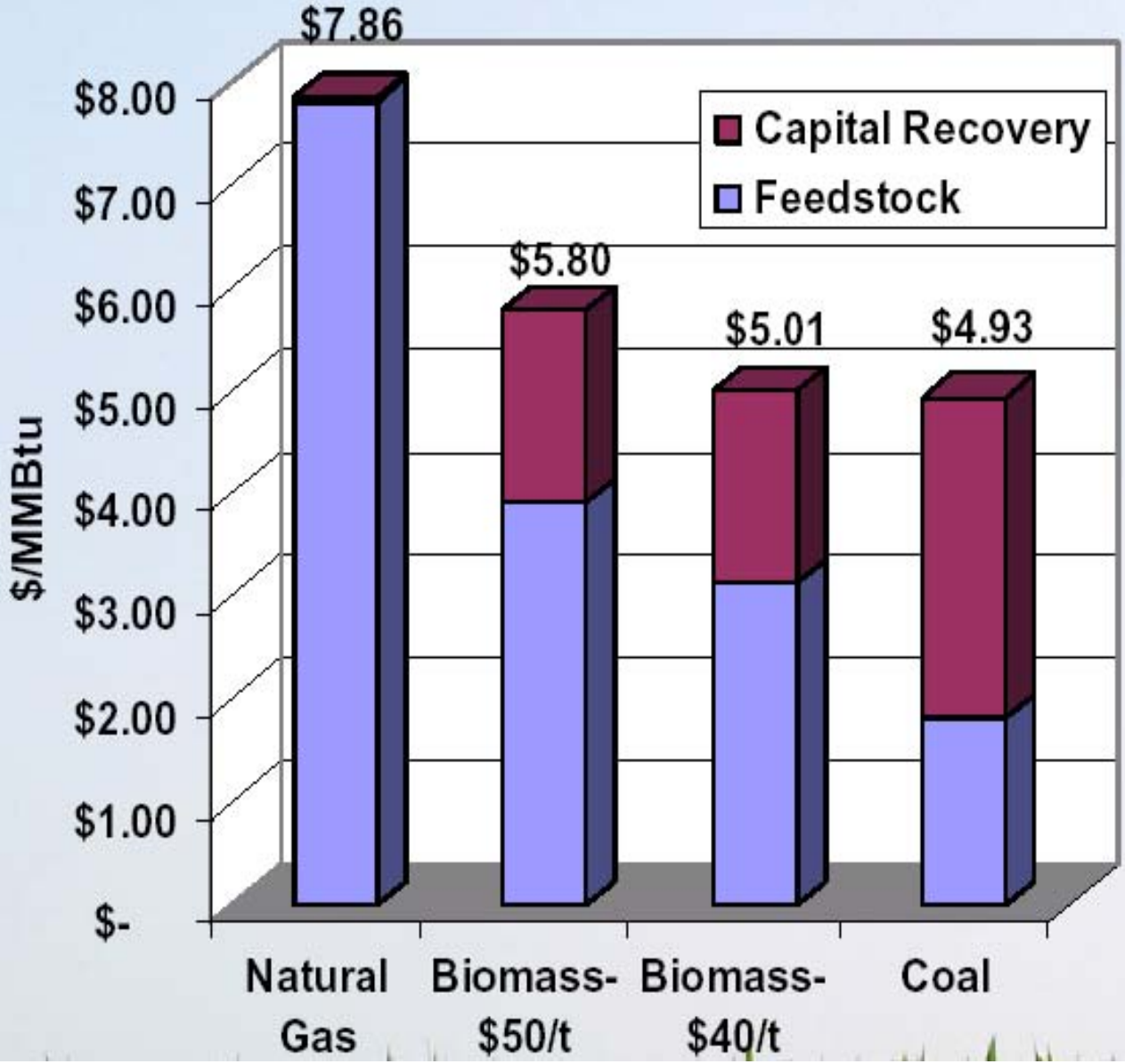
Estimates Using Shapouri Data, Parameter matching



- What is the value of the RER or GHG CO_2 emissions to marketing the future of ethanol?
- Coal use gives slight loss of RER, but 100% increase in non-renewable GHG CO_2 emissions
- CONTRAST: Using Biomass for Energy will decrease non-renewable GHG CO_2 by 90%

Economics of Fuel Options

Biomass is Cost Competitive and Renewable!



Capital Costs:

Nat gas $0.3M

Biomass: $15M

Coal: $25M coal

(A/P) = 20% (Amortization Factor)

Fuel assumptions:

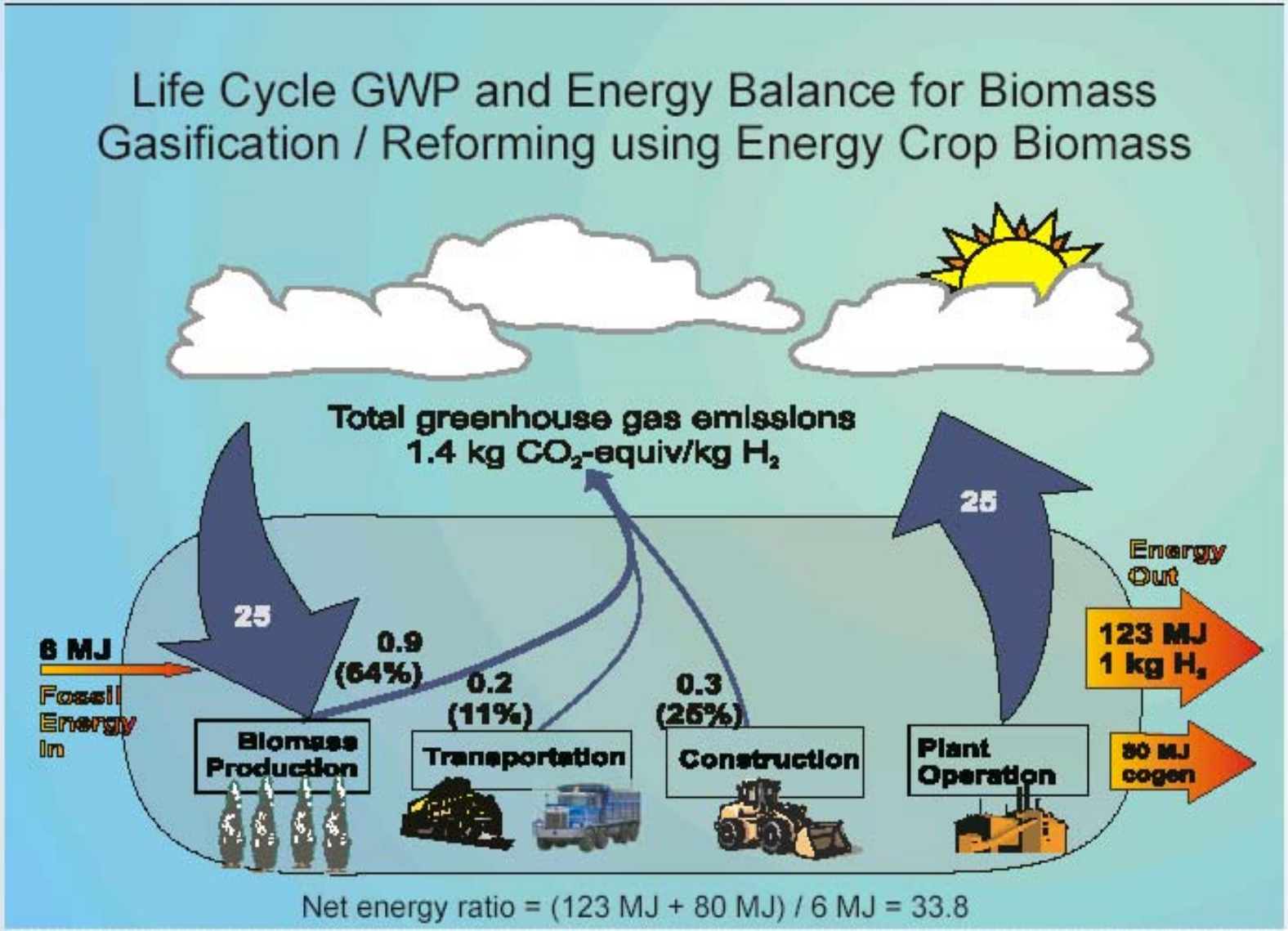
Nat Gas: $7.86 (3-yr ave)

Biomass: $40-$50/ton

Coal: $40/ton (2 yr average) (mid-west north-central industrial delivery)

National Renewable Energy Laboratory

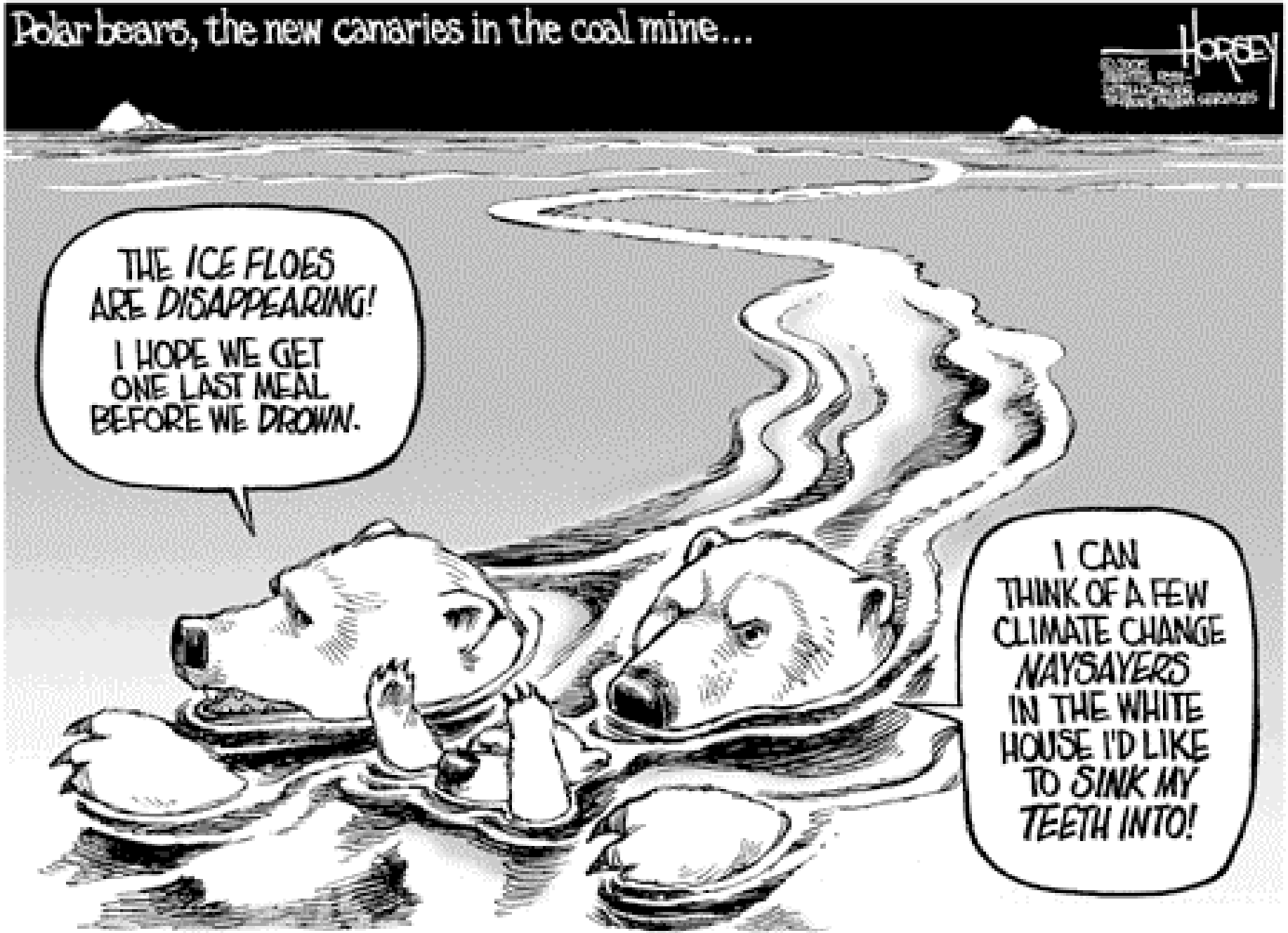
Backup Slide: Biomass Syngas is ~97% renewable fuel, or Potential RER: ~34



Mann, M.K., and Overend, R.P. (National Renewable Energy Laboratory) Presentation to the National Academy of Sciences Committee Meeting; (Jan 22, 2003) Washington, DC

Frontline's Future

- Develop and market commercial gasifier systems to help ethanol plants reduce dependence on natural gas
- Gasifier systems that are still natural gas compatible in case of emergency or production changes
- Syngas to products technology


Polar bears, the new canaries in the coal mine...
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Summary

- Future of gasification from biomass
- Developing systems for commercial applications
- Biomass sources and benefits for farmers
- Reducing natural gas usage and environmental benefits