Liquid Transportation Fuels from Coal and Biomass

Technological Status, Costs, and Environmental Impacts

America's Energy Future Study
Panel on Alternative Liquid Transportation Fuels

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PANEL ON ALTERNATIVE LIQUID TRANSPORTATION FUELS

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CHARGE TO THE PANEL

- Evaluate technologies for converting biomass and coal to liquid fuels that are deployable by 2020.
  - Current and projected costs, and CO_2 emissions.
  - Technically feasible supply of liquid fuels.
  - R&D needs.
- Estimate the potential supply curves for liquid fuels produced from biomass and coal.
- Evaluate environmental, economic, policy, and social factors that enhance or impede development and deployment.
- Today, we will focus biomass feedstock and conversion.

PANEL'S APPROACH

- Estimated supply and costs of different cellulosic feedstocks.

- Estimated costs and yields of the biochemical and thermochemical conversion processes.

- Estimated life cycle CO2 emissions from conversion and burning fuel.

- Estimated amount of fuel that is technically feasible to deploy by 2020.

- Estimated market penetration of fuels in 2020 and 2035.

Panel's Analyses Showed That

1. About 500 million tons/year of biomass can be sustainably produced in the US without incurring significant direct or indirect greenhouse gas emissions

2. Cellulosic ethanol and other liquid fuels made from this biomass or from coal-biomass mixtures with CCS, markedly reduce greenhouse US gas emissions and increase US energy security

3. Timely commercial deployment may hinge on adoption of low carbon fuel standards, a carbon price, and accelerated federal investment in technologies

Estimated Cellulosic Feedstock That Could Potentially Be Produced for Biofuel

Feedstock Type	Current	2020
	Millions of dry tons	
Corn stover	76	112
Wheat and grass straw	15	18
Hay	15	18
Dedicated fuel crops	104	164
Woody residues[a]	110	124
Animal manure	6	12
Municipal solid waste	90	100
TOTAL	**416**	**548**

[a]Woody residues currently used for electricity generation are not included in this estimate.

BIOMASS COSTS

Biomass costs include costs of:

- Nutrient replacement.
- Harvesting and maintenance.
- Transportation and storage.
- Seeding.
- Opportunity cost (e.g., cropland rental cost).

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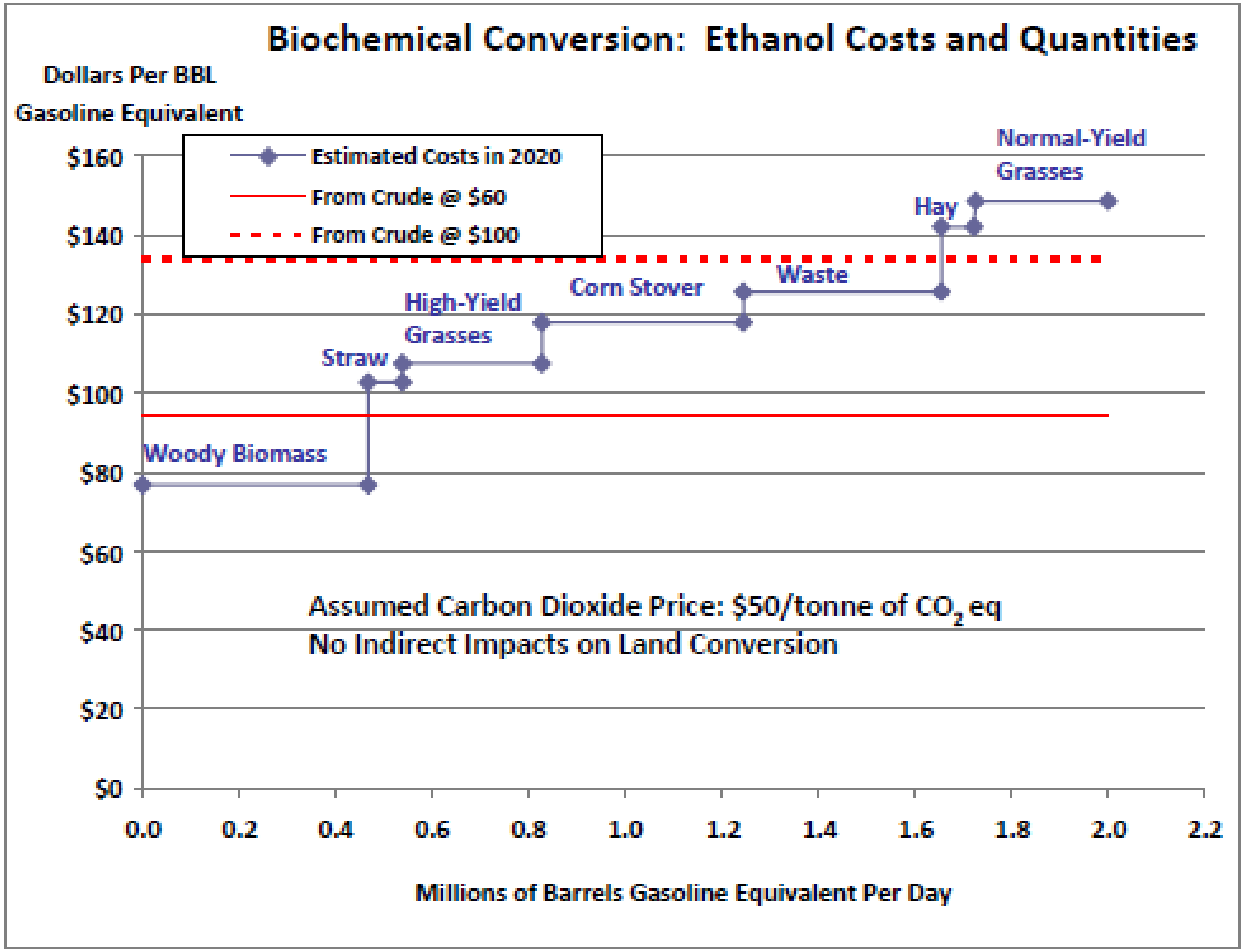
BIOMASS COSTS

Dollars per dry ton		
Biomass	**Estimated in 2008[a]**	**Projected in 2020**
Corn stover	110	86
Switchgrass	151	118
Miscanthus	123	101
Prairie grasses	127	101
Woody biomass	85	72
Wheat straw	70	55

[a]2008 costs = baseline costs

SUPPLY OF CELLULOSIC ETHANOL—TECHNICALLY FEASIBLE



SUPPLY OF ALTERNATIVE LIQUID FUELS—COMMERCIAL DEPLOYMENT

Cellulosic Ethanol

- 0.5 million bbl of gasoline eq./day by 2020,
- Then 1.7 million bbl of gasoline eq./day by 2035.
- CO2 emissions close to zero

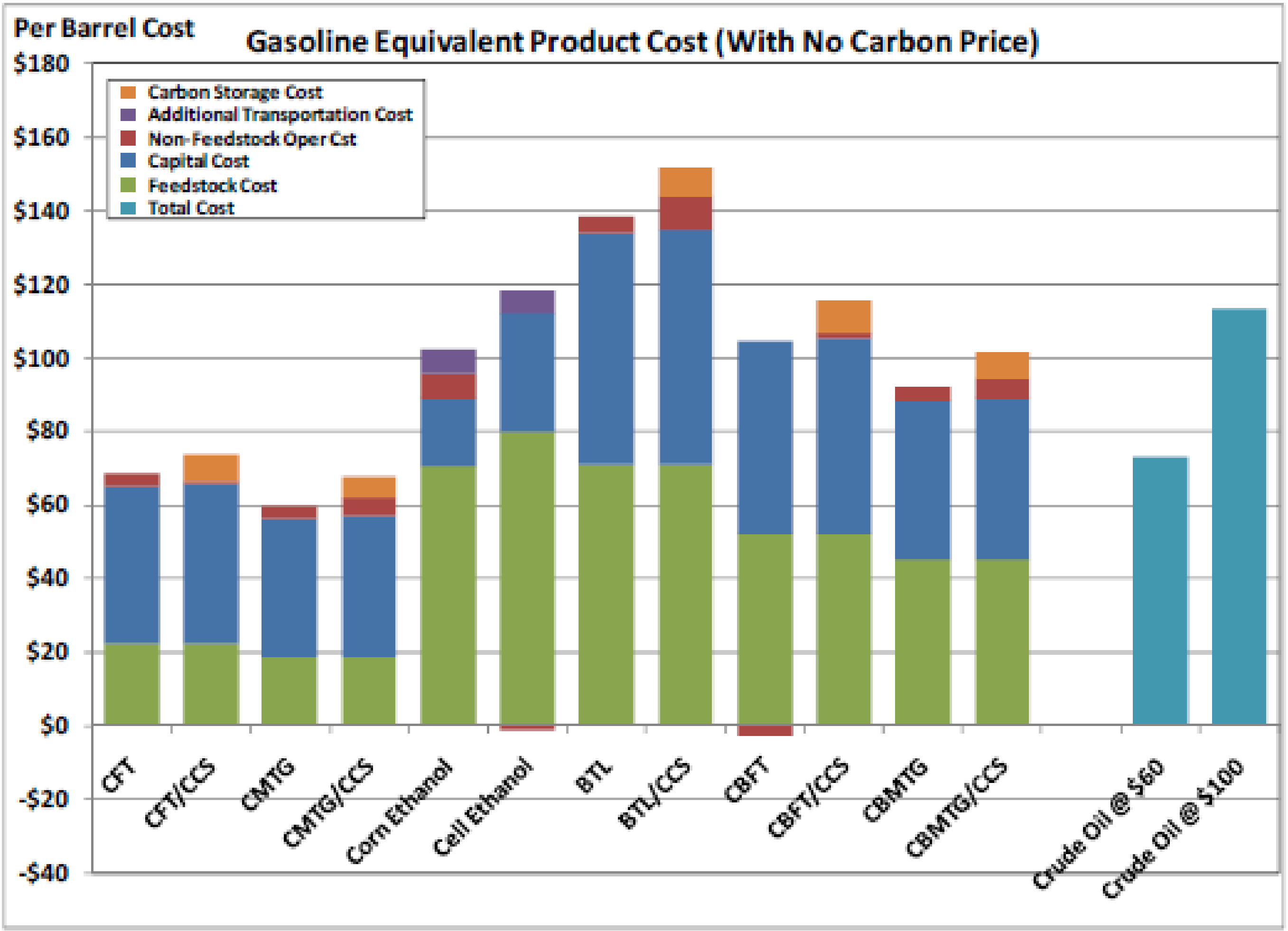
Coal-and-Biomass-to-Liquid (CBTL) Fuels

- CBTL fuels could reach 2.5 million barrels of gasoline eq./day by 2035.
- CO2 Emissions close to zero with CCS

Coal-to-Liquid (CTL) Fuels

- Then CTL fuels can reach 3 million bbl of gasoline eq./day by 2035, with a 50 percent increase in US coal production.
- If CCS used, CO2 emission equivalent to petroleum fuels

COMPARISON OF LIFE-CYCLE COSTS



Miscanthus used as feedstock in all comparisons

EFFECT OF LIFE-CYCLE GREENHOUSE GAS PRICE ON FUEL COST – for $0 and $50/tonne CO_{2eq} price

Fuel Product	Cost without CO_2 Equivalent Price ($/bbl gasoline equivalent)	Cost with CO_2 Equivalent Price of $50/tonne ($/bbl gasoline equivalent)
Gasoline at crude-oil price of $60 and $100/bbl	75, 115	95, 135
Cellulosic ethanol	115	105
BTL without CCS	140	130
CTL with CCS	70	90
CBTL without CCS	95	120
CBTL with CCS	110	100

CONCLUSIONS

Liquid transportation fuels from coal and biomass have potential to supply 2-3 MBPD of oil equivalent fuels with significantly reduced CO2 emissions by 2035

- And thus play an important role in addressing issues of energy security, supply diversification, and CO_2 emissions

- But their commercial deployment by 2020 will require aggressive large-scale demonstration in the next few years.

- Investor confidence will most likely require a carbon price or low carbon fuel standards requiring specified reductions in GHG emissions

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Thank You!

- Any Questions?

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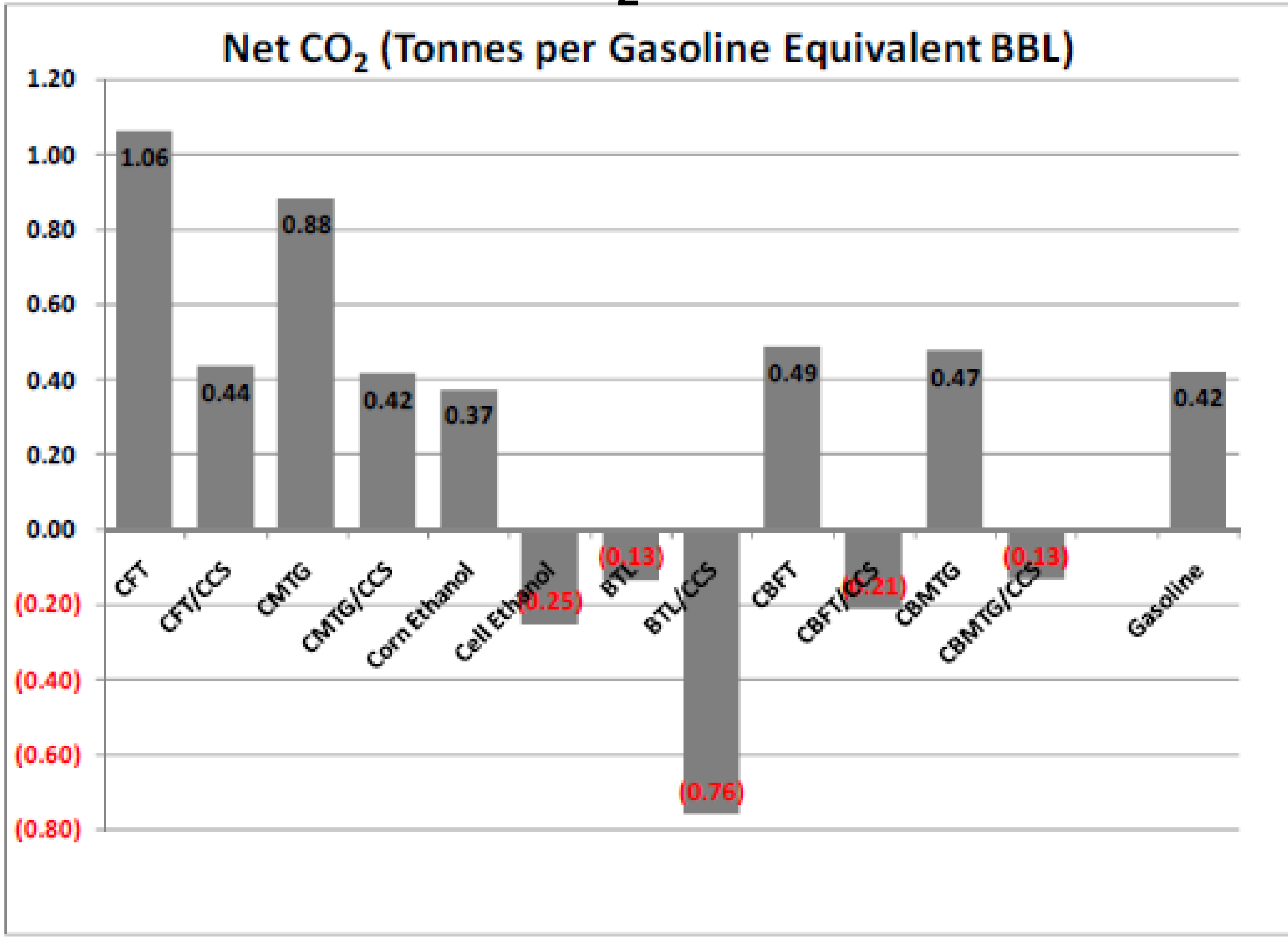
COMPARISON OF CO_2 LIFE-CYCLE EMISSION



Analysis assumes that conversion plants sell net electricity to the grid. Electricity-related CO_2 emissions are dependent on the case: IGCC venting CO_2 for vent cases, and IGCC-CCS(90%) for CO_2 storage cases.

BARRIERS TO DEPLOYMENT

- Developing a well-organized and sustainable cellulosic biofuel industry

- Implementing commercial demonstrations of conversion processes ASAP

- Completing megatonne geologic storage demonstrations ASAP

- Developing more efficient, economical pretreatment and improving enzymes to free up sugars

- Permitting and constructing tens to hundreds of conversion plants

- Approaches that recognize commodity prices, especially oil prices, vary widely.

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Support for this Project was Provided by

- U.S. Department of Energy
- BP America
- Dow Chemical Company Foundation
- Fred Kavli and the Kavli Foundation
- GE Energy
- General Motors Corporation
- Intel Corporation
- W.M. Keck Foundation
- Presidents' Circle Communications Initiative of the National Academies
- National Academy of Sciences through the following endowed funds
    - Thomas Lincoln Casey Fund
    - Arthur L. Day Fund
    - W.K. Kellogg Foundation Fund
    - George and Cynthia Mitchell Endowment for Sustainability Science
    - Frank Press Fund for Dissemination and Outreach.