



Alcohol Fuels from Biomass: Well-to-Wheel Energy Balance

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Outline

Introduction

Approach

Energy Inputs

GHG Emissions

Conclusions

Research shows ethanol isn't worth the energy

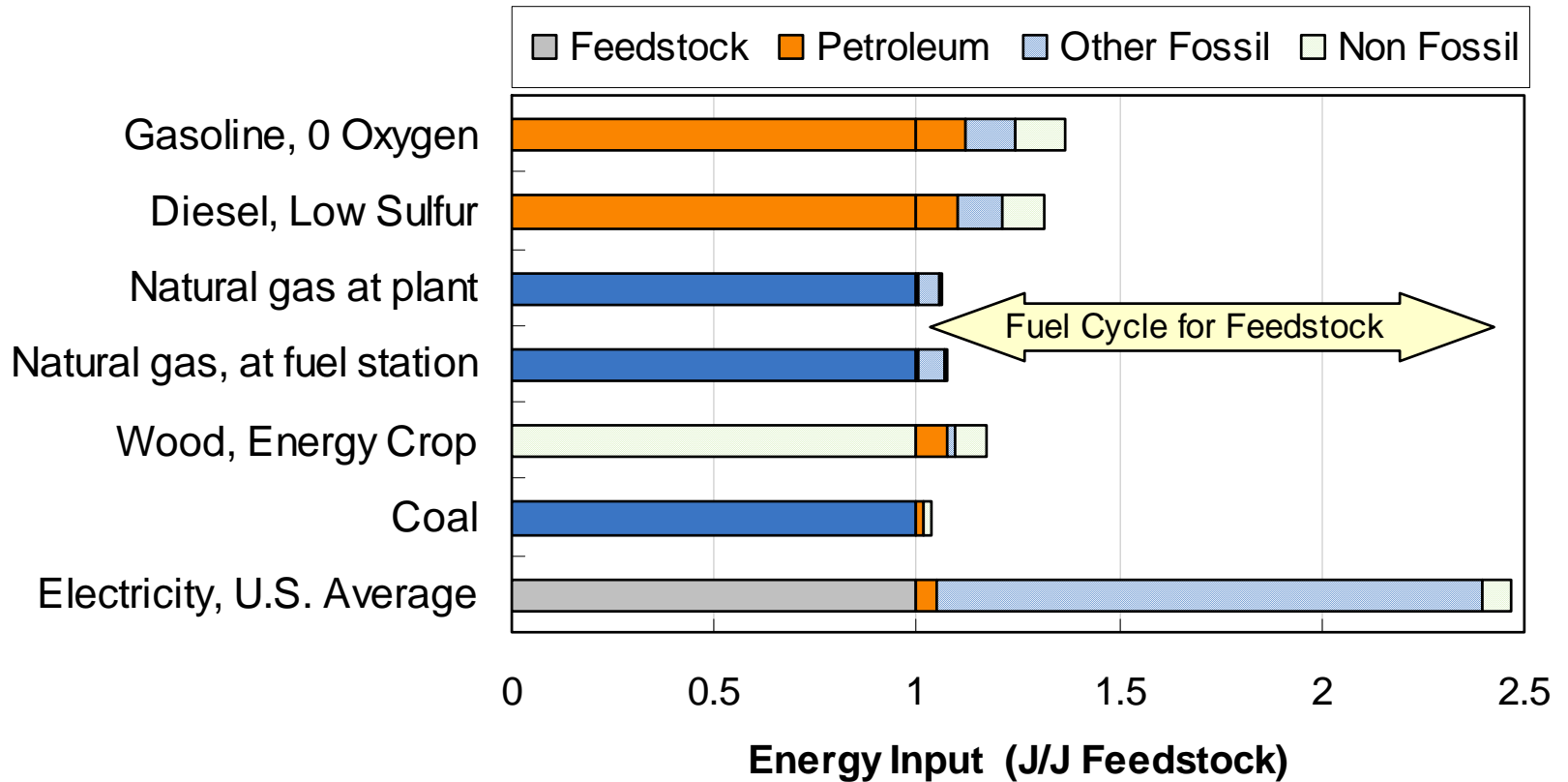
*UC scientist says ethanol uses more energy than it makes
A lot of fossil fuels go into producing the gas substitute*

We analyzed biomass to alcohol pathways and alternative uses of fossil fuels.

- ◆ Biomass to alcohol production pathways use fossil fuels
- ◆ What could be produced with the fossil fuels without the biomass energy input?
- ◆ Other vehicle options:
 - Battery electric
 - Hydrogen
 - Natural gas

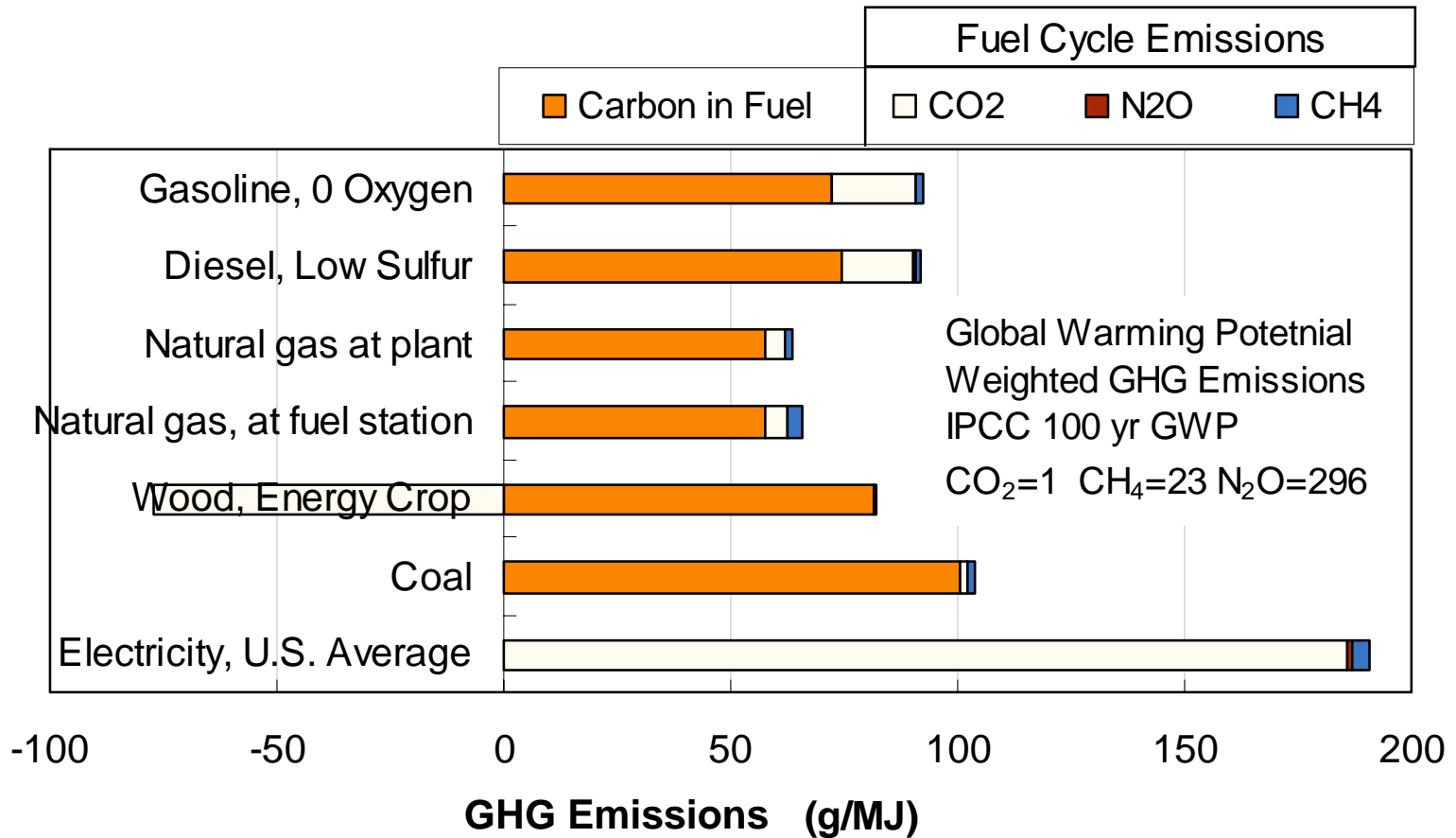
Fuel	Pathway
Gasoline	Petroleum Refining
Ethanol	Corn Fermentation Cellulose Biomass Hydrolysis
Methanol	Steam Reforming Coal Gasification Biomass Gasification
FT Diesel	Steam Reforming Coal Gasification Biomass Gasification

WTT energy inputs were determined for feedstocks.



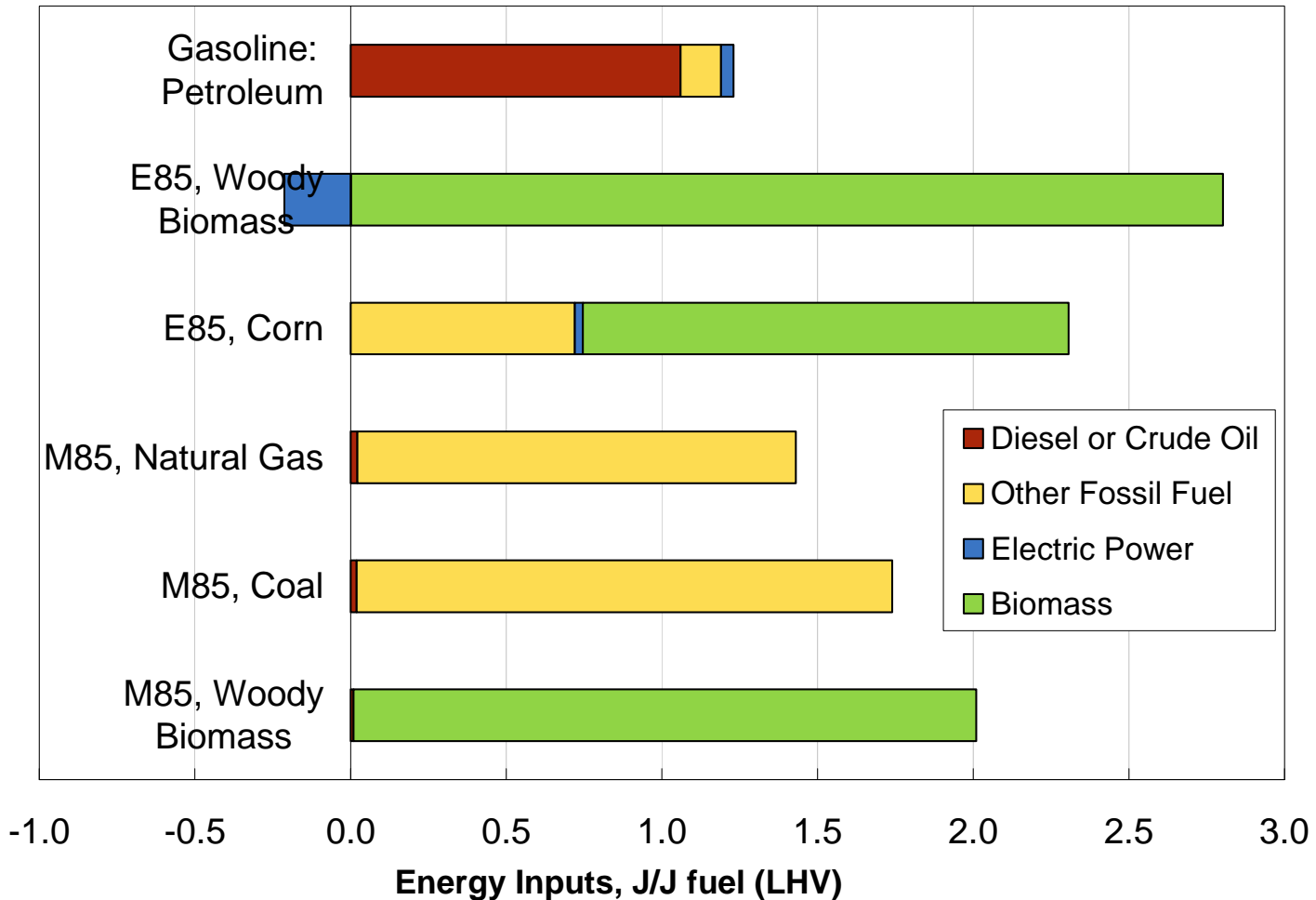
¹ Source: Argonne National Laboratory, GREET 1.6

GHG emissions include the fuel cycle, carbon in fuel, plus vehicle CH₄ and N₂O.



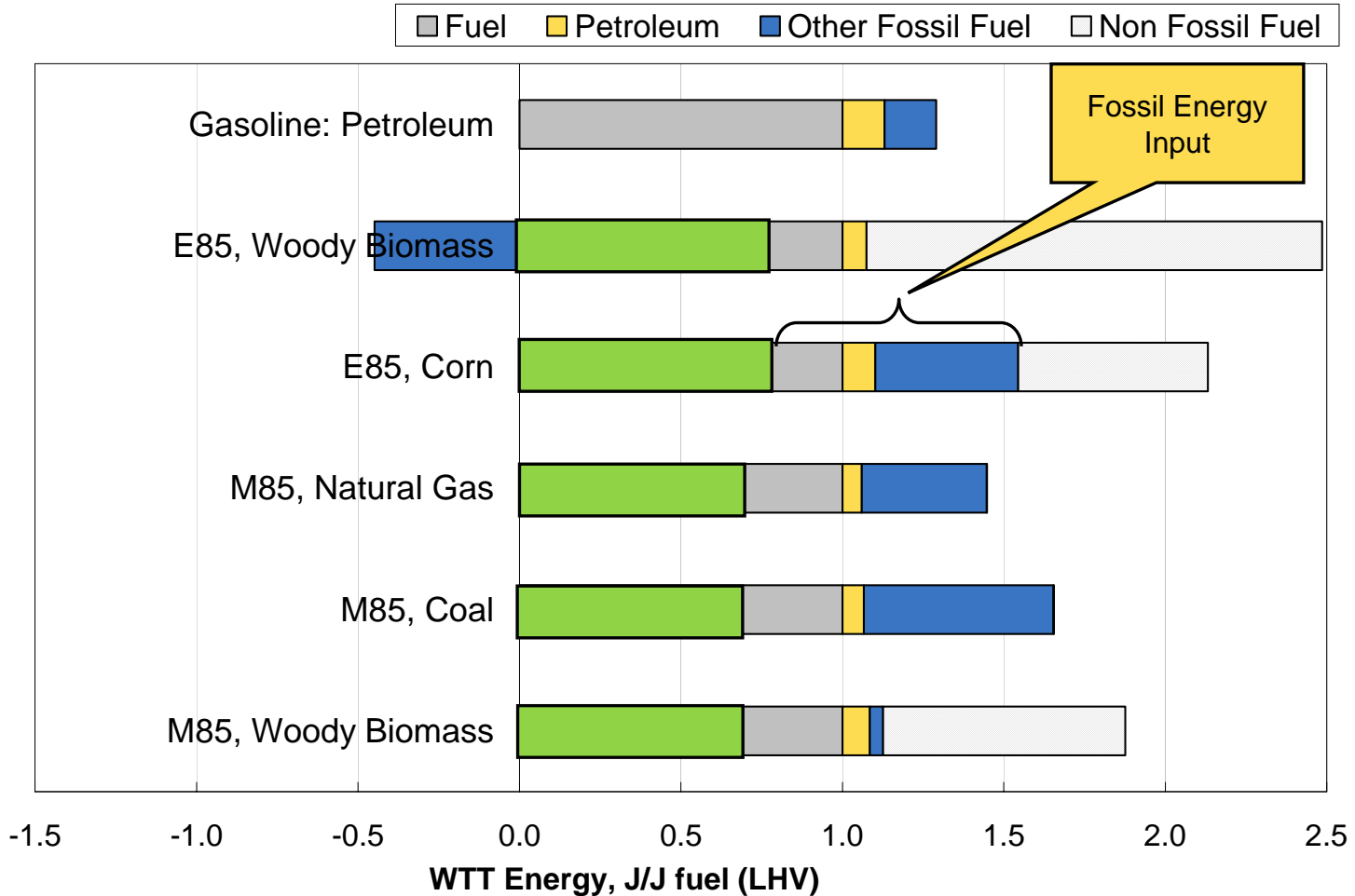
¹ Source: Argonne National Laboratory, GREET 1.6 plus carbon content of fuels

Process energy inputs are the basis for WTW calculations.



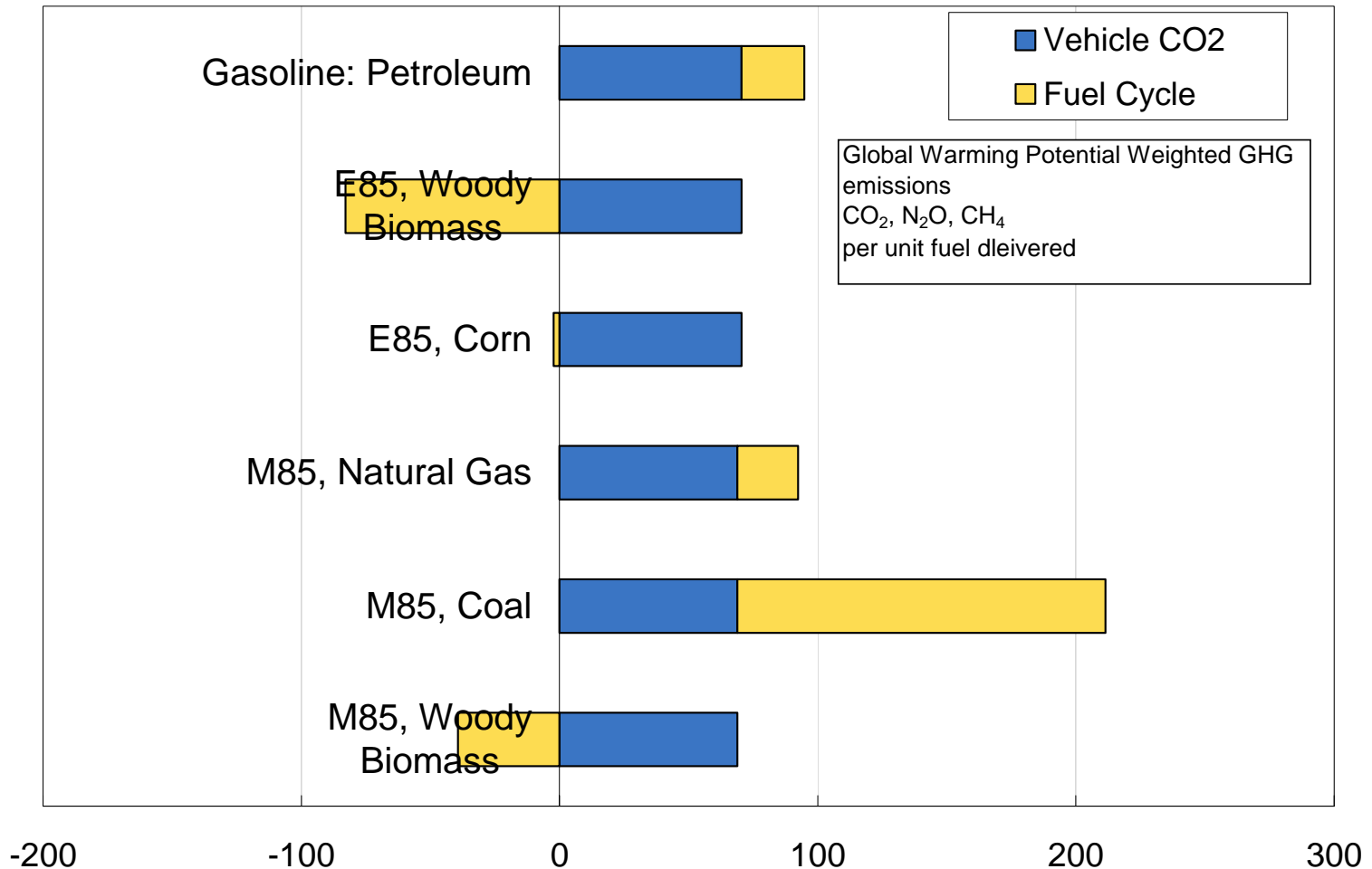
¹ Does not include allocation to corn byproducts

Fossil energy inputs for biomass options are less than the energy in the alcohol product.



¹ Based on: Carlson, E., et al. (TIAX), "Cost Analyses of Fuel Cell Stacks/Systems", Merit Review, Philadelphia, PA, May 24-27, 2004.

GHG emissions depend on conversion efficiency and fossil energy inputs.

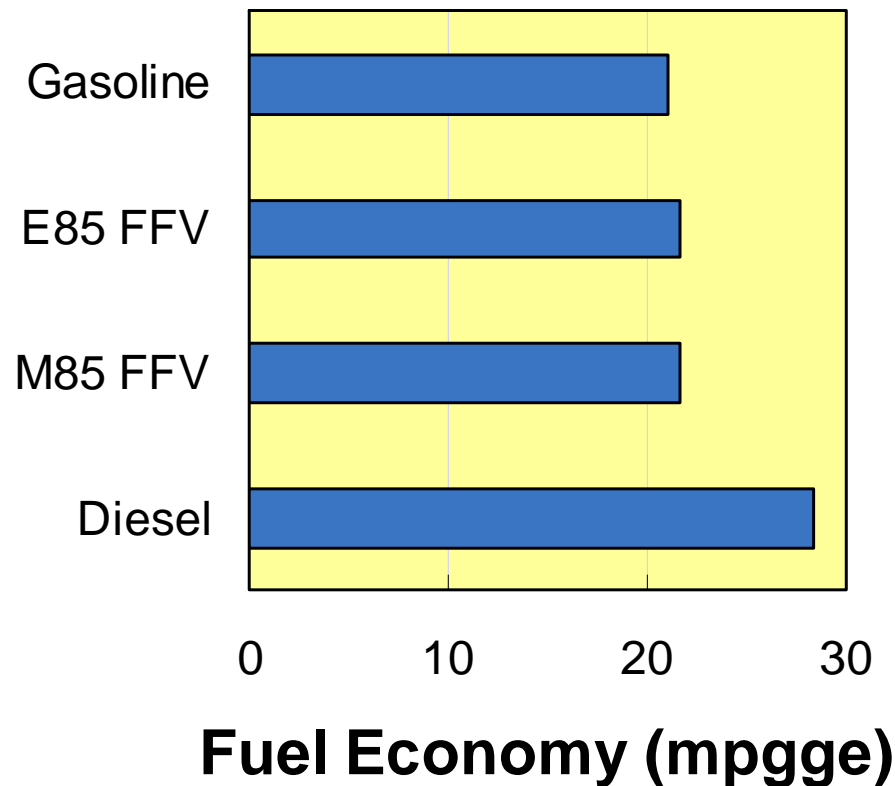


¹ Based on: Carlson, E., et al. (TIAX), "Cost Analysis of Fuel Cell Stacks/Systems," Merit Review, Philadelphia, PA, May 24-27, 2004.

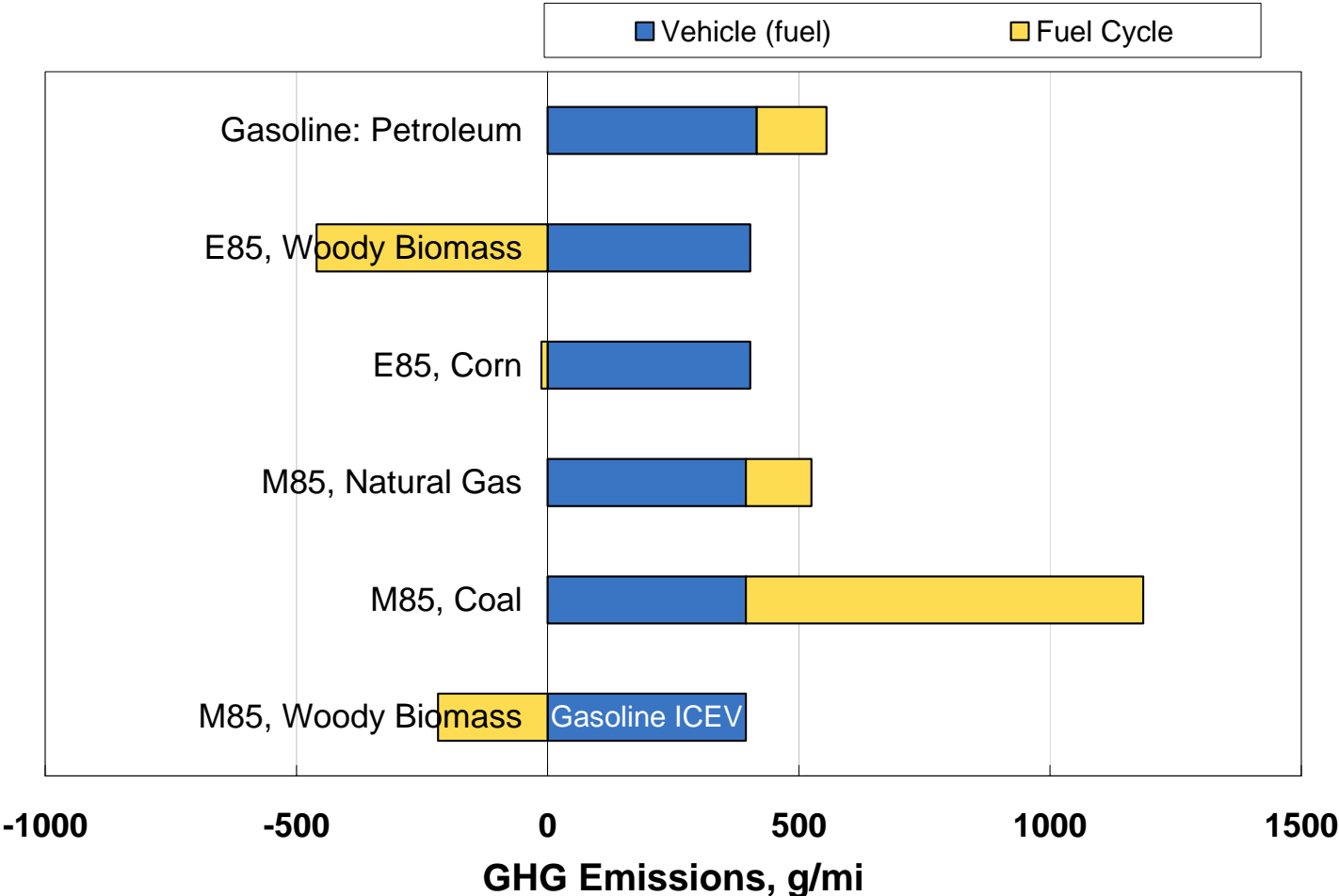


GHG emissions are proportional to fuel consumption.

- ◆ Alcohol vehicles have potential for improved fuel economy
- ◆ Assumed 3% improvement for FFVs
- ◆ Calculated WTW emissions for blend of 15% gasoline (vol)
- ◆ GHG impact of low level blends would be proportional to WTT results



Biomass options result in the lowest GHG emissions.



Conclusions

Biomass to alcohol pathways produce more energy than the fossil fuel input.

- ◆ Ethanol from corn requires less fossil energy input than the energy content of the ethanol product.
- ◆ Almost no fossil fuel is used for biomass derived ethanol or methanol
 - Lignin from biomass can be used to generate excess power from cellulose based ethanol
- ◆ Feedstock type relates closely to GHG emissions
 - Coal
 - Petroleum
 - Natural Gas
 - Corn
 - Woody Biomass