Bio-Derived Liquids to Hydrogen Distributed Reforming Targets

Arlene F. Anderson
Technology Development Manager, U.S. DOE
Office of Energy Efficiency and Renewable Energy
Hydrogen, Fuel Cells and Infrastructure Technologies Program

Bio-Derived Liquids to Hydrogen Distributed Reforming Working Group and Hydrogen Production Technical Team Review

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Bio-Derived Liquids to Hydrogen Distributed Reforming Working Group (BILIWG)

The Bio-Derived Liquids to Hydrogen Distributed Reforming Working Group (BILIWG), launched in October 2006, provides a forum for effective communication and collaboration among participants in DOE Hydrogen, Fuel Cells, and Infrastructure Technologies Program (HFCIT) cost-shared research directed at distributed bio-liquid reforming.

The Working Group includes individuals from DOE, the national laboratories, industry, and academia.

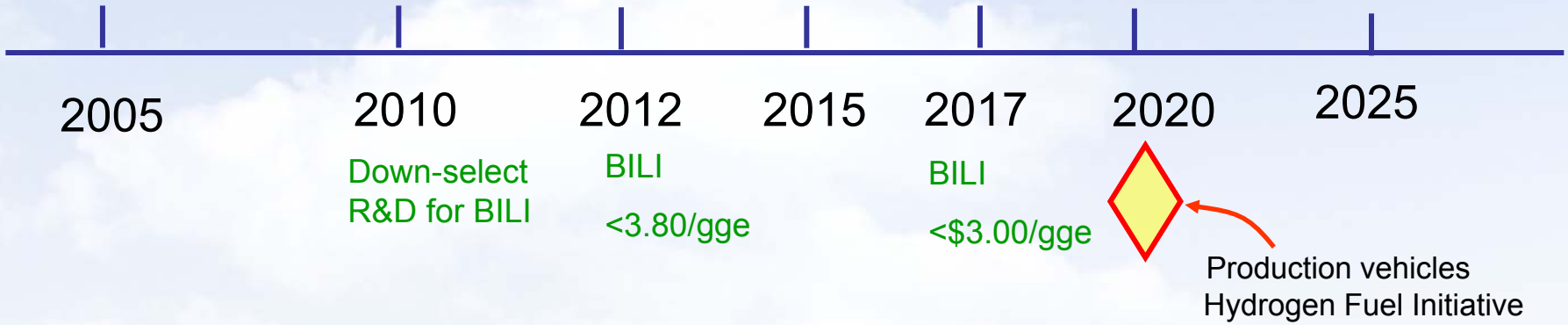
Bio-Derived Liquids Reforming

Distributed reforming of biomass derived liquid fuels could be commercial during the transition to hydrogen.

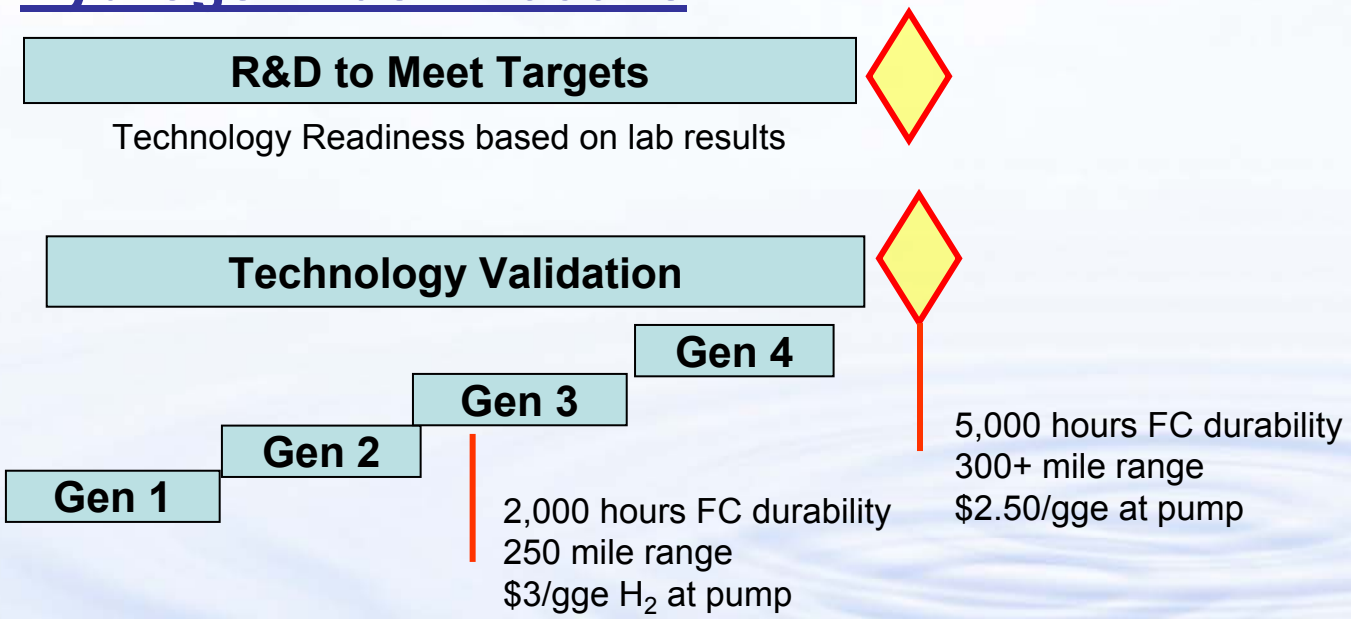
Current Approaches:

- Gas Phase Reforming
- Aqueous Phase Reforming

2010-2025 BILI Milestones & Scenarios

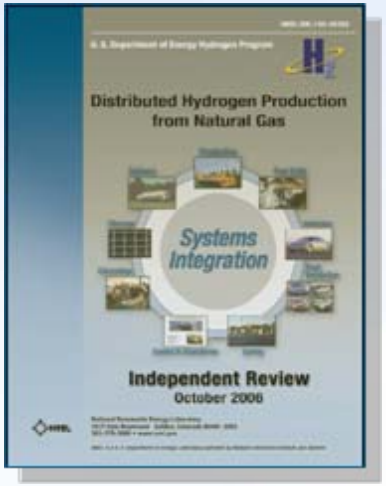


Hydrogen Fuel Initiative



Transition to Bio-Derived Liquids

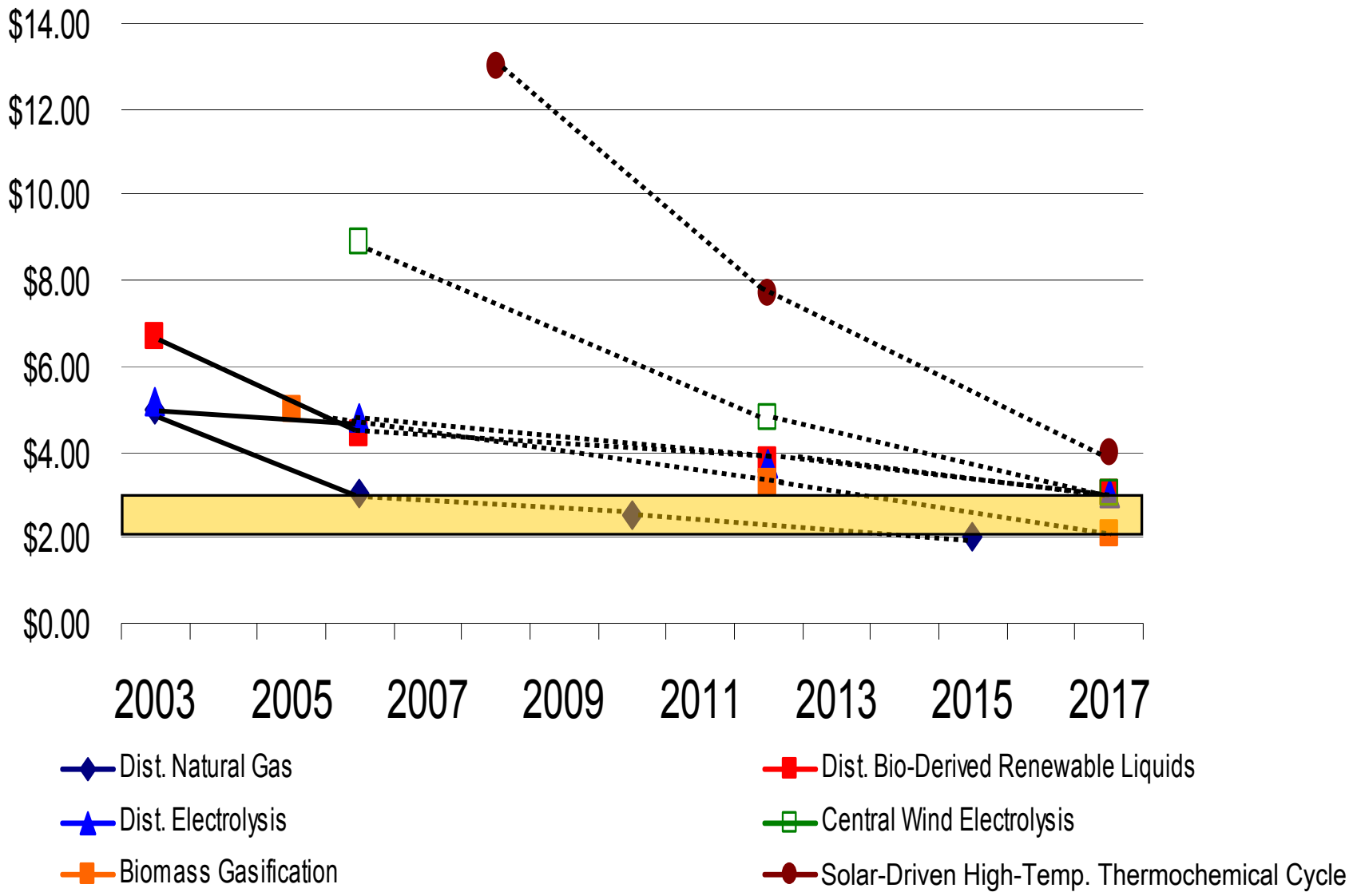
Independent Validation of progress towards 2006 interim target of $3/gge for distributed natural gas reforming.



- Methodology: Independent panel used the H2A model to analyze data and produce cost estimates.

- Conclusion: "…the hydrogen total cost range to be $2.75-$3.50 per kilogram. The 2005 total cost target of $3.00/gge … is well within the estimated range."

Production Cost Targets & Status



Distributed Production Targets

Table 3.1.2. Technical Targets: Distributed Production of Hydrogen from Natural Gas[a, b, g]					
Characteristics	Units	2003[c] Status	2006[d,e,h] Status	2010[d] Target	2015[d] Target
Production Unit Energy Efficiency[f,i]	%(LHV)	65.0	70.0	72.0	75.0
Production Unit Capital Cost (Uninstalled)	$	12.3M	1.1M	900K	580K
Total Hydrogen Cost	$/gge H_2	5.00	3.00[f]	2.50	2.00

Table 3.1.3. Technical Targets: Distributed Production of Hydrogen from Bio-Derived Renewable Liquids[a,b, e,h]				
Characteristics	Units	2006 Status[c]	2012 Target[c]	2017 Target[d]
Production Unit Energy Efficiency[f]	%	70.0	72.0	65-75[g]
Production Unit Capital Cost (Un-installed)[c]	$	1.4M	1.0M	600K
Total Hydrogen Cost	$/gge	4.40	3.80	<3.00

Cost Inputs

Table 3.1.3.A Distributed Bio-Derived Renewable Liquids H2A Example - Cost Contributions[a,b,e,h]				
Characteristics	Units	2006 Status[c]	2012[c]	2017[d]
Production Unit Capital Cost Contribution[b]	$/gge	0.75	0.45	0.40
Storage, Compression, Dispensing Capital Cost Contribution[h]	$/gge	0.75	0.55	0.35
Fixed O&M Cost Contribution	$/gge	0.60	0.50	0.40
Feedstock Cost Contribution	$/gge	2.10	2.10	1.55
Other Variable O&M Cost Contribution	$/gge	0.20	0.20	0.30
Total Hydrogen Cost	$/gge	4.40	3.80	3.00

"Forecourt Production Modeling Tool"
http://www.hydrogen.energy.gov/h2a_production.html.

Overcoming Technical Barriers

- Bio-Derived liquids, composed of larger molecules with more carbon atoms, are more difficult to reform than natural gas. Research is needed to identify better catalysts to improve yields and selectivity.

- Reducing the cost of ethanol and/or other biomass-derived liquid fuels (research conducted by DOE's Office of Energy Efficiency and Renewable Energy Biomass Program).

- Reducing capital equipment costs, as well as operation and maintenance costs, and improving process efficiency (similar to challenges of natural gas reforming).

Bio-Derived Liquids Tasks

- Analyze and research options for alternative renewable feedstocks for distributed production.
- Utilizing technology concepts developed for distributed natural gas reforming.
- Explore novel technology that could result in cost breakthroughs.

Key Decision Points

2007 Distributed Reforming of Biomass Pyrolysis (Bio-Oil) Catalyst Performance Milestone

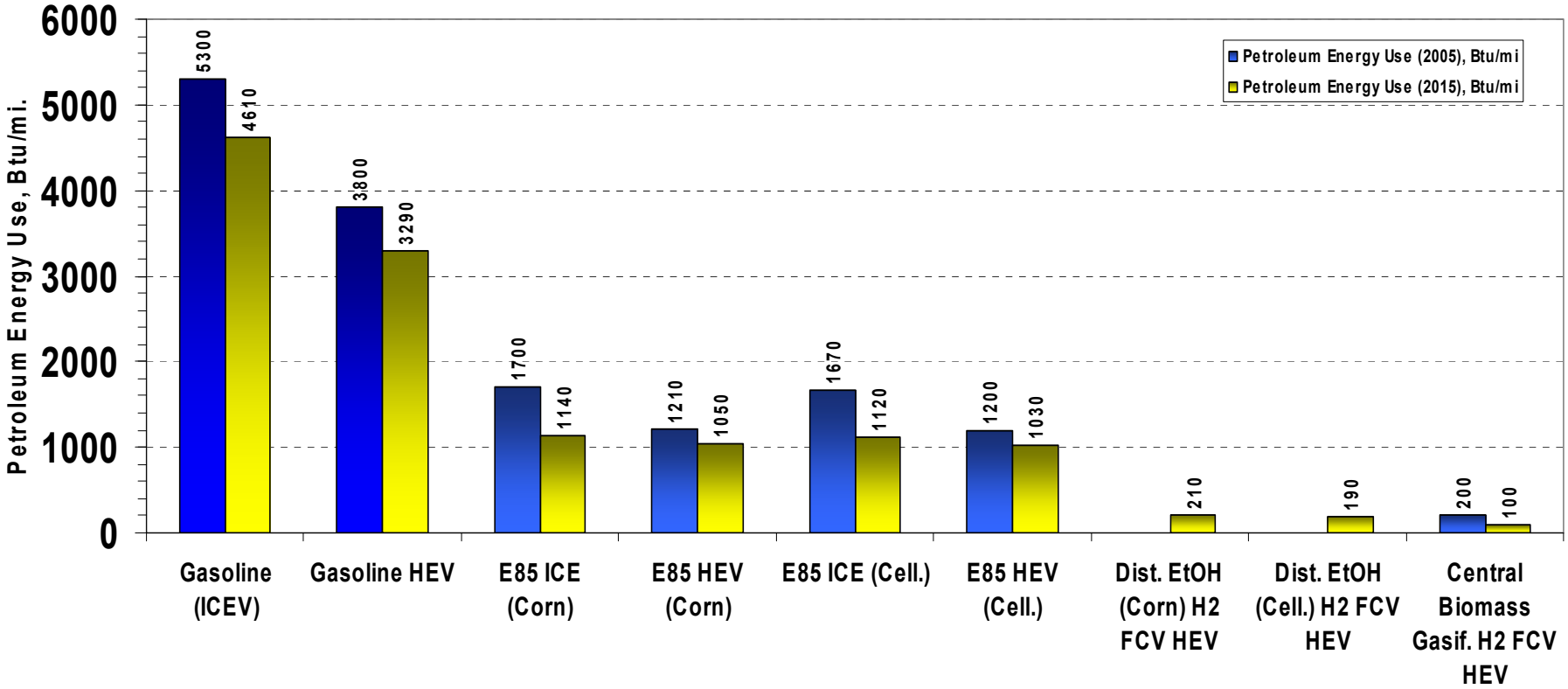
2008 Downselect Hydrogen Separation and Purification membrane for integrated membrane reactor / reforming

2010 Downselect Distributed Bio-derived Liquid Technology

Biomass - An Abundant Domestic Resource

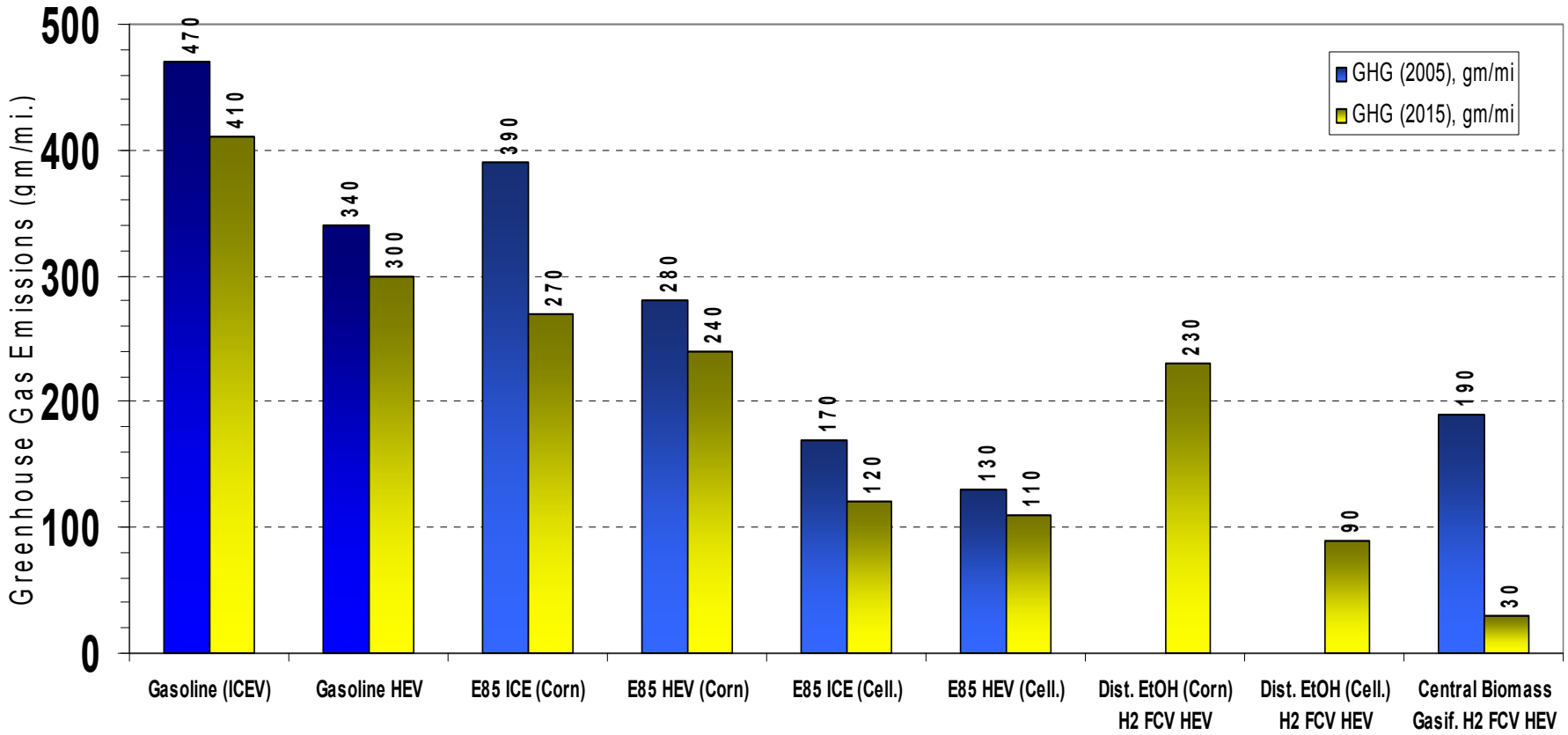
- More domestic biomass available than is required for food and animal feed
- Improved agricultural practices and plant breeding could result in 500 million to 1 billion dry tons of biomass for energy use by 2050
- Current energy use for personal vehicles is about 16 quadrillion Btu/yr.
- Current U.S. energy use is 98 quadrillion Btu/yr. and is expected to grow to 135 quadrillion Btu/yr.
- Biomass can not meet all of our energy needs, but it can provide a major contribution.

Well-to-Wheels Petroleum Energy Use



On-site production of hydrogen from ethanol for use in a hydrogen fuel cell vehicle uses less petroleum than any other near-term (2015) option including a highly efficient hybrid electric ethanol (E85) vehicle. Central production of hydrogen from biomass gasification for use in a hydrogen fuel cell vehicle uses the least petroleum.

Well-to-Wheels Greenhouse Gas Emissions



Fuel cell vehicles powered by hydrogen produced from cellulosic ethanol emit only 90 grams per mile of greenhouse gas emissions on a well-to-wheel basis, ~ 20 % less than an ethanol high efficiency vehicle.

Summary

Bio-derived liquids to hydrogen is an important near-term pathway having the potential to replace gasoline as a light duty vehicle fuel.

Near-Term, distributed hydrogen production from bio-derived liquids may be the most viable renewable hydrogen pathway.

By 2017, DOE's goal is to produce and deliver hydrogen from bio-derived liquids for less than $3 per gallon gasoline equivalent.

Production Technical Team Research Reviewers

Kevin Nguyen
Chevron Energy Technology Company

Maria E Curry-Nkansah
British Petroleum

Nikunj Gupta
Shell Hydrogen

Lead:
Steven Schlasner
ConocoPhillips

Robert Lucchesi
ExxonMobil Research & Engineering

Co-Lead:
Roxanne Garland
DOE