

## Natural Gas to Liquid Fuels (GTL)



**George Boyajian, VP Business Development**

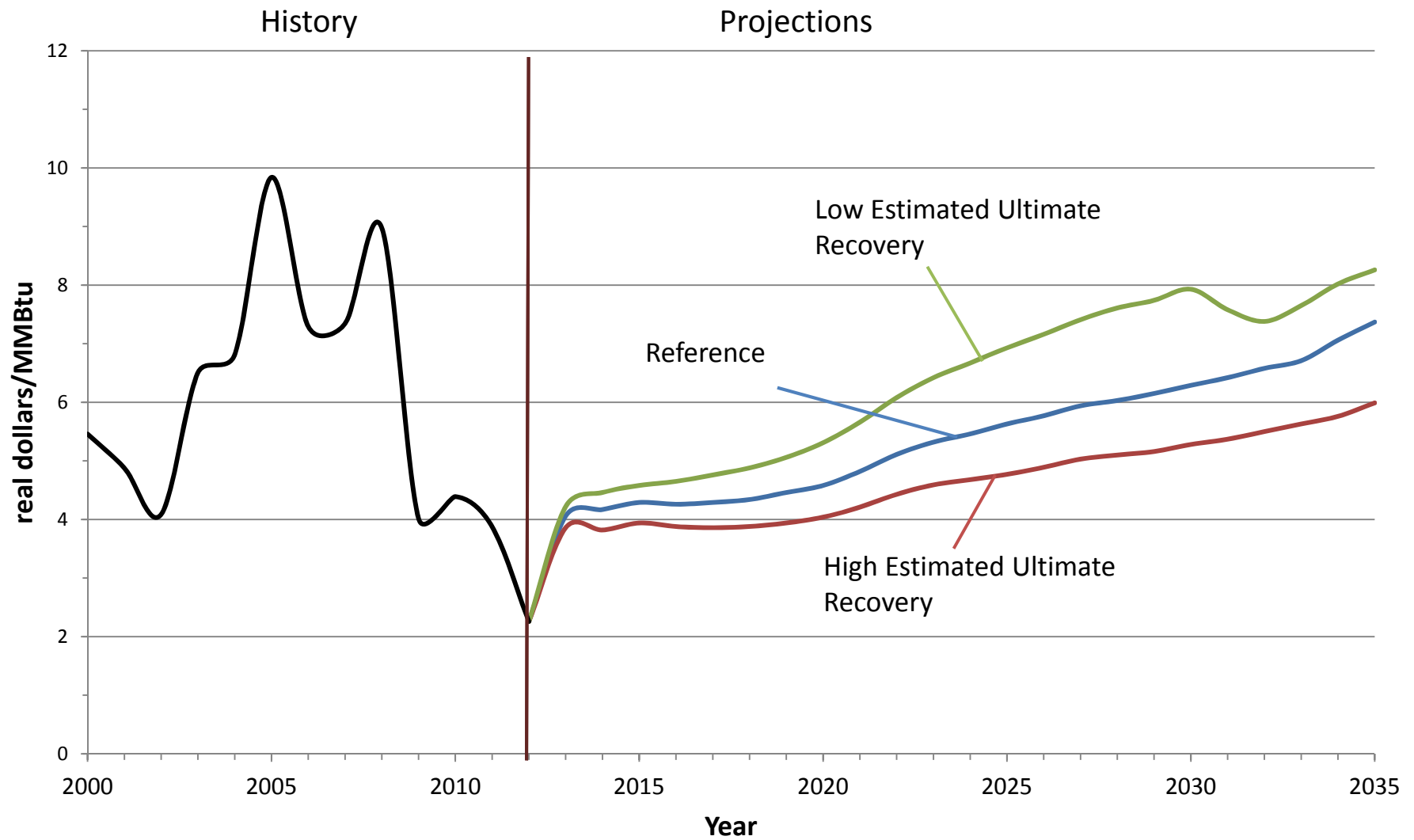
Septemeber 2012

- **US Energy Independence = economic and military security**
- **Jobs**
- **Environment**
  
- **Green Fuels (ethanol, biodiesel, etc.)**
- **Alternative Fuels, Grey Fuels**

## Natural Gas Overview

- Abundant, widespread availability.
  - Natural gas accounts for ¼ of the world’s energy supply.
  - Shale gas has increased worldwide technically recoverable resources by 40%.
- Low and stable price in the US relative to oil price
  - In worst case, expected to remain below \$6/MMBtu until 2022 (\$2010 Henry Hub).
- Provides opportunity to significantly reduce reliance on imported oil while serving as a “bridge fuel” to a green energy economy.
- Cleanest burning fossil fuel.
  - During combustion, 18% fewer life cycle greenhouse gas emissions than petroleum, 27% less than coal on an energy basis.
- Primus uses natural gas as its primary feedstock to produce a variety of fuels and chemicals. Over time, **Primus will integrate the option to use biomass as a feedstock into its process, always producing fuels that are sustainable and petroleum-free.**

Henry Hub Natural Gas Spot Price (2010 dollars)



## Policy Maker & Market Reactions

“The United States now has, at current consumption rates, at least 75 years’ worth of recoverable natural gas. More important, the United States has become the world’s low-cost producer of natural gas...The rise of shale oil is shaping up to be the biggest shift in energy in generations. And its consequences –economic and political-are profoundly beneficial to the United States.”

-Fareed Zakaria, The Washington Post, March 29, 2012

“One trend we aim to invest behind is the shift in market interest from conventional to unconventional oil and natural gas assets...”

-KKR & Co. Inc., website

“We have a supply of natural gas that can last America nearly 100 years.”

- President Obama, 2012 State of the Union Address.

- **Primus Green Energy, Inc. has a proven system that converts biomass and/or natural gas to gasoline.**
- This is a “drop-in” fuel, usable directly in gasoline engines without any modification or adjustment, for which infrastructure is already readily available.
- Bechtel design its first 25 million gallon per year commercial plant.
- Primus has raised \$61 mm from IC-Green, a division of Israel Corporation.

## **Robert Johnson CEO**

- **CEO of three biofuel companies: Mascoma (S-1 filed), BC International Corporation (acquired by BP) and Promethegen.**
- **Prior to 1998 he was a senior investment banker (Dain Rauscher Wessels, Lehman Brothers) where he completed over 100 transactions totaling over \$3 billion in the private placements**

## **Eli Gal, Phd CTO**

- **Expert in coal and biomass gasification processes, air pollution control, cleantech, water treatment and chemical processes, 14 years with **GE Power Systems**, 16 years additional consulting**

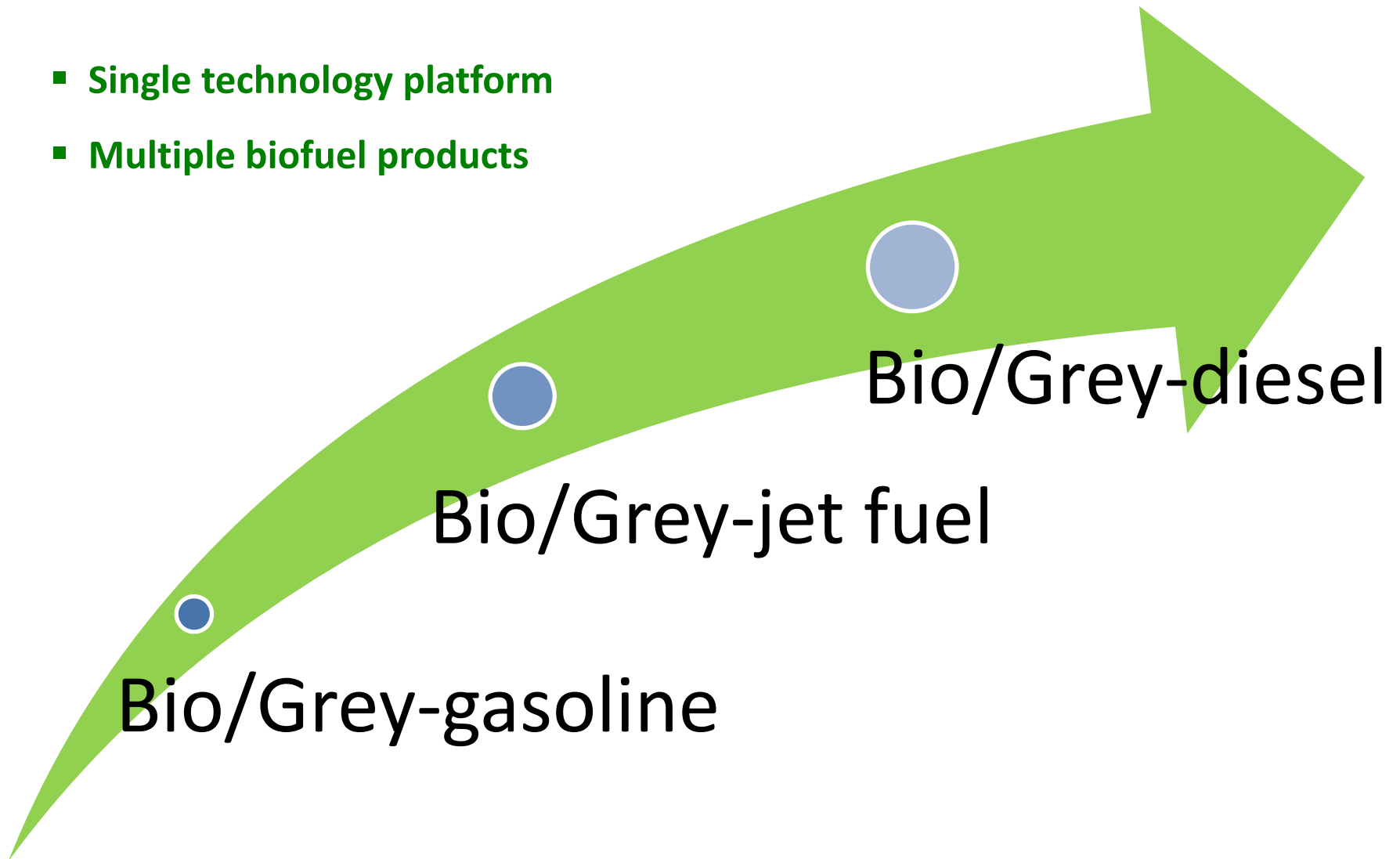
## **Howard L. Fang, Phd, Vice President, R&D**

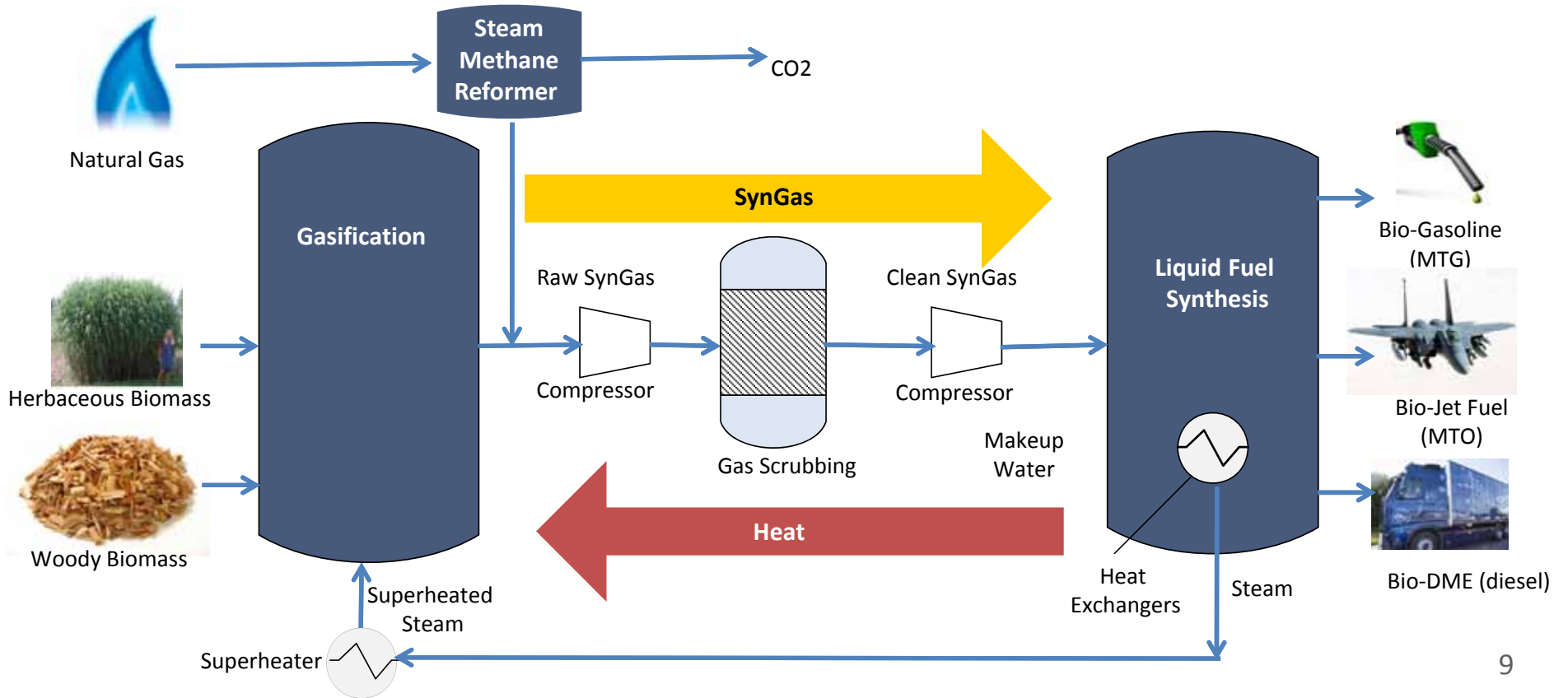
- **30 years of experience with **Exxon Mobil, BP and Cummins Engines****

## **George Boyajian, Phd, Vice President, Business Development**

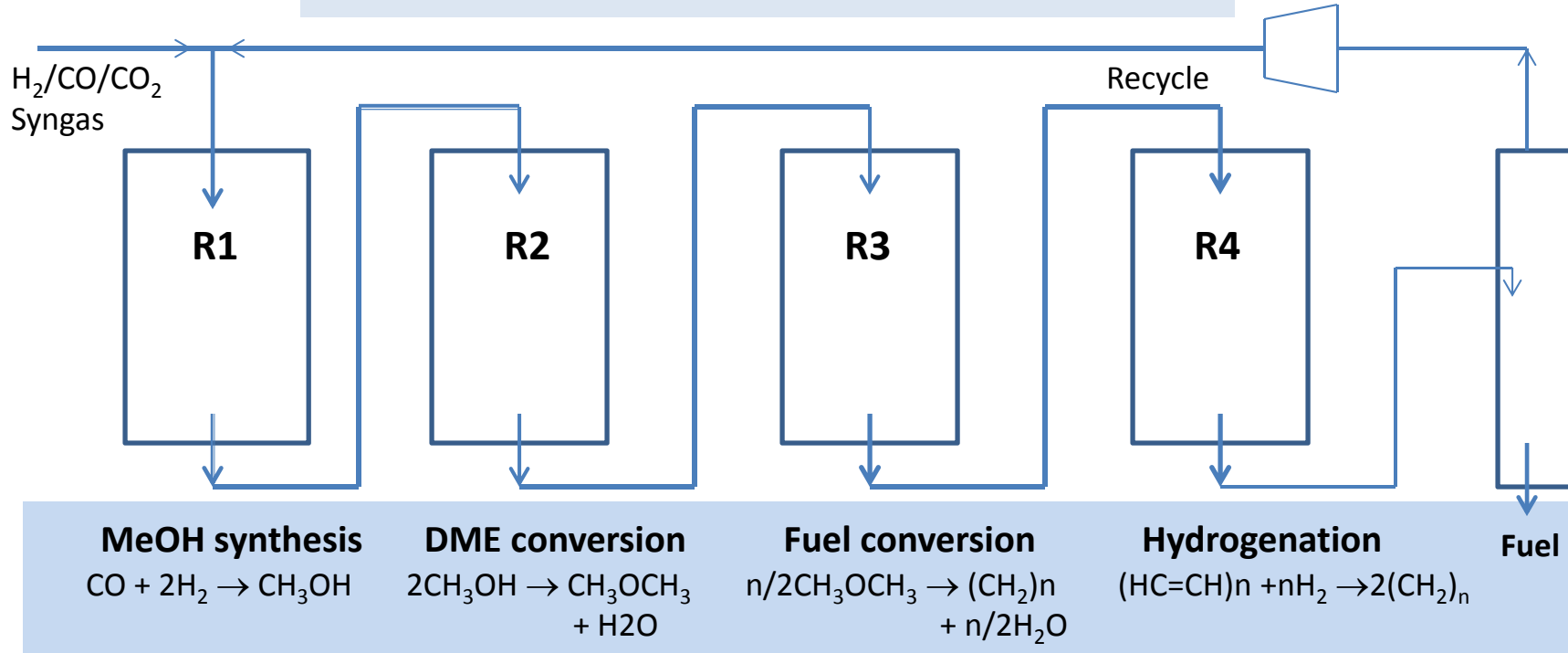
- **18 years technology executive, built and sold last venture to **GE Healthcare****

- **Single technology platform**
- **Multiple biofuel products**



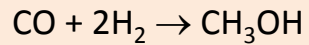


## STGH (Syngas-to-Gasoline + Hydrotreatment)

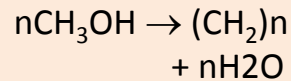


## STJH (Syngas-to-Jetfuel + Hydrotreatment)

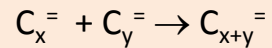
### MeOH synthesis



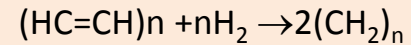
### MTO



### Olefin oligomerization



### Hydrogenation



Analysis Category	Primus Gasline Nov/Dec 2011 Independent Labs' Analysis <sup>(1)</sup>
D-1319: Composition	✓
D-3606-07: Benzene	✓
D-240: Energy Content	✓
D-5191: Vapor Pressure	✓
Octane	93
D-130: Corrosion	✓
D-525: Stability	✓

<sup>(1)</sup> As measured by Core Laboratory & Inspectorate, Nov/Dec 2011

- Primus gasoline is a **highly competitive “drop-in” biofuel for gasoline**

	Fossil Fuel Gasoline	Ethanol	Bio-Diesel	Primus Gasolines
<b>Dependency on food-related crops</b>	None	High	Medium	None
<b>Energy density (MJ/gallon)</b>	132	89	126	132
<b>Cost per gallon</b>	\$3.10	\$2.23	\$3.00	\$2.50 (\$1.60**)
<b>Uses</b>	Drop-in	Fuel oxygenate	Substitute for diesel	Drop-in blend or substitute for gasoline
<b>Lifecycle Carbon Dioxide Emissions</b>	24.3 lbs/gallon	14.6 lbs/gallon	5.84 lbs/gallon	4.86 lbs/gallon

\*\* Ethanol equivalent gallon based on 1.5x energy content ratio of gasoline vs. ethanol

Breakeven Price Combinations (0% IRR)		
Gasoline Price per Gallon	Implicit Crude Oil Price per Barrel (WTI) 2000-2010	Natural Gas Price per MMBtu
\$2.00	\$60-65	\$2.29
\$2.50	\$75-81	\$4.75
\$3.00	\$90-97	\$7.22
\$3.25	\$97-105	\$8.46
\$3.50	\$105-113	\$9.69

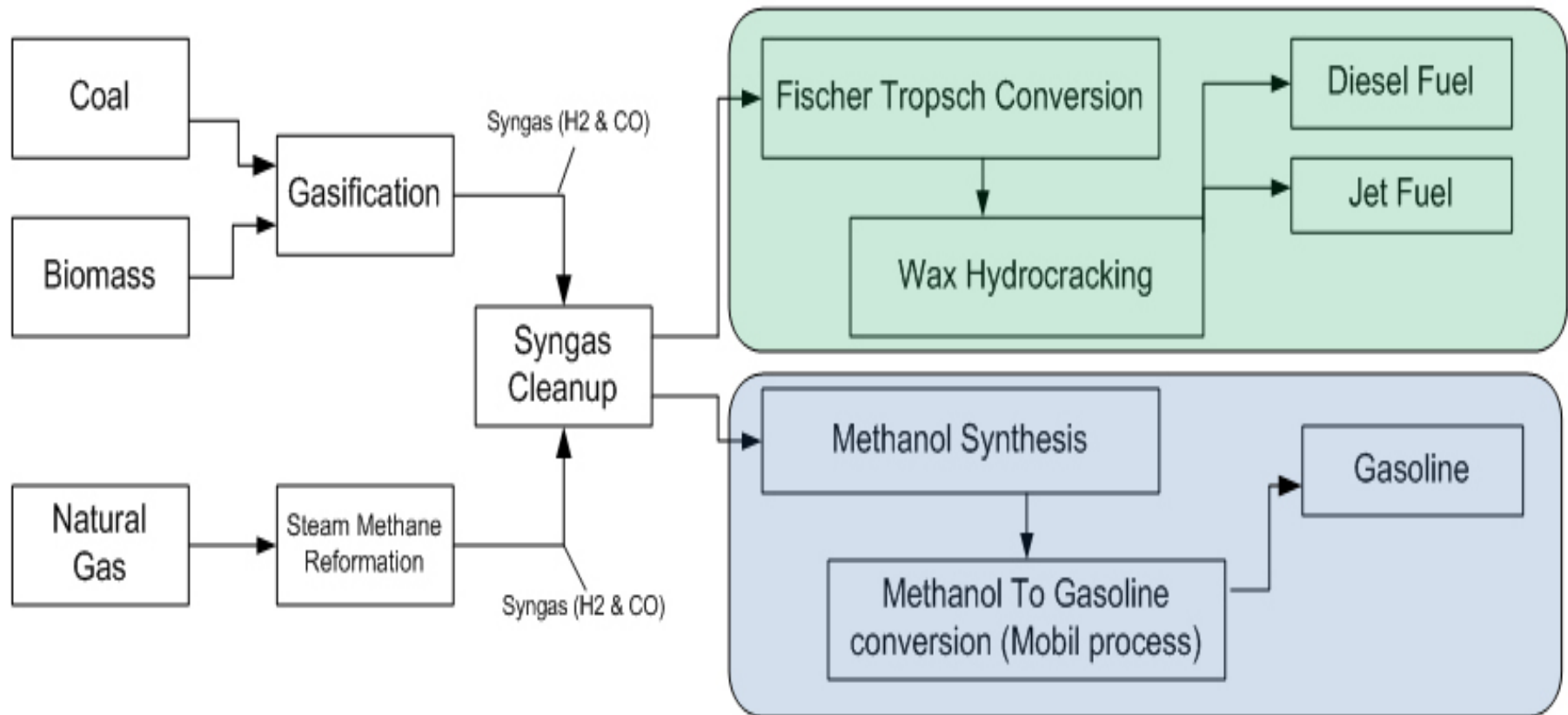
### Advantages of the Primus STG+

- Cost competitive today using natural gas feedstock with no gov't subsidies.
- Lower GHG footprint than jet from crude.
- Four reactors in one recycle loop. No need for methanol condensation and evaporation.
- High product yield of 30% yield achieved to date, expected to reach 35%. (Yield is from syngas with H<sub>2</sub>/CO ratio of 2.1).
- High quality premium 93 octane gasoline (with superior stability, lower corrosion and lower vapor pressure), toluene and xylene.

### Advantages of the Primus STG+ (continued)

- Potential for low cost production at relatively small scale compared to other GTL technologies (MTG and FT). Cost optimization work is being conducted with support from Bechtel team.
- Process integration lowers operating costs.
- Process yields one or two products vs. Fischer-Tropsch's 6 – 7.

**Indirect Conversion Synthetic Fuels Manufacturing Processes**



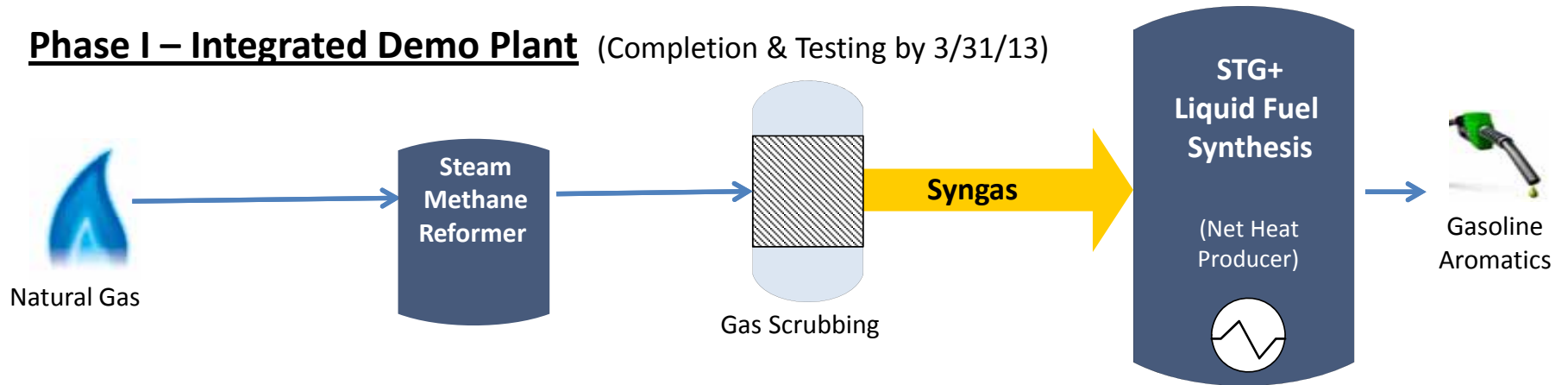
	<b>Yield Jet</b>	<b>Yield (syngas %)</b>	<b>Cost Capex</b>
<b>FT</b>	<b>20%</b>	<b>15%</b>	<b>100%</b>
<b>STG+</b>	<b>70%</b>	<b>32%</b>	<b>80%</b>

Factor/Process	Primus	Haldor Topsøe	ExxonMobil
Feed Flexibility	Bio, coal, NG	NG, coal	Methanol
Product Flexibility	Gasoline, aromatics, jet fuel	Gasoline	Gasoline
Durene Reduction	Integrated	Separate	Separate
Complexity (Major Steps)	Syn Gas, STG+	Syn Gas, TIGAS, Durene reduction	Syn Gas, Methanol, MTG, Durene reduction
Scale Flexibility	Small to large	Small to large	Limited to Methanol plant size
Catalyst Sourcing	Multiple	In-house	Combined
Integration Economies	Highly integrated	Unknown	Low, separate plants
Footprint	Small	Medium	Large

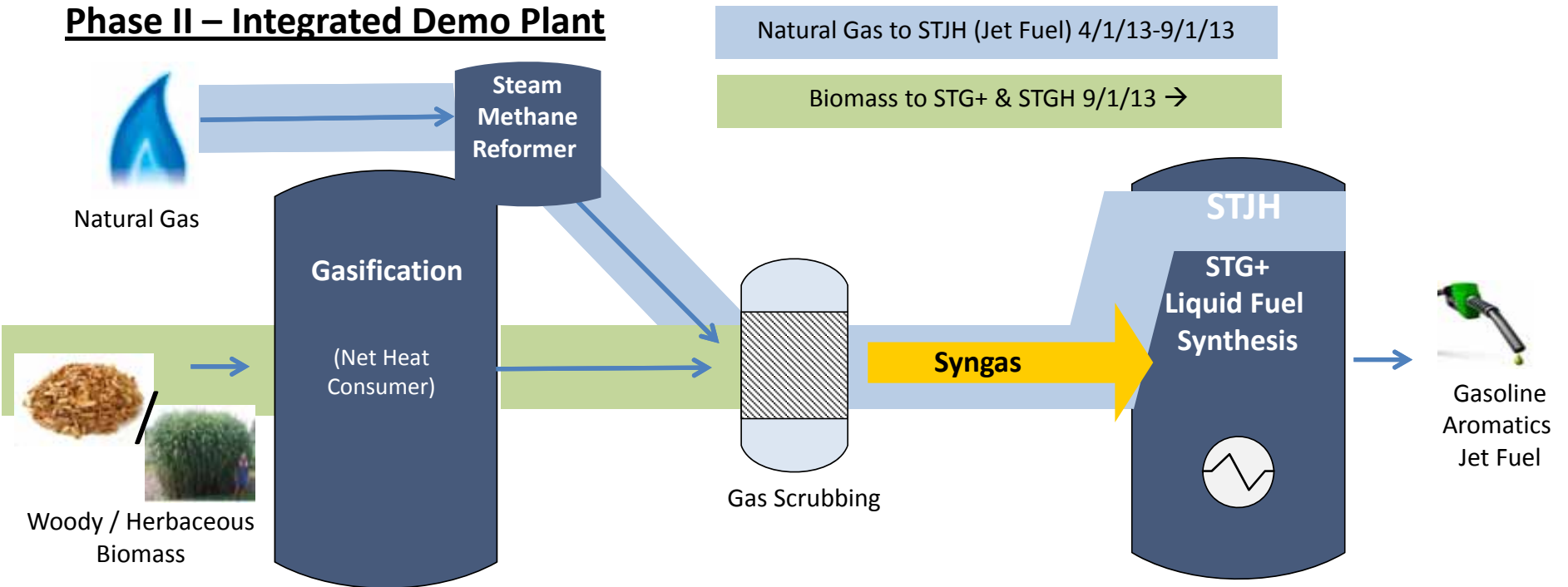
CAPEX / OPEX Ranking Outlook for “Drop-in” Gasoline

Primus < HT TIGAS < EM MTG < FT

**Phase I – Integrated Demo Plant** (Completion & Testing by 3/31/13)



**Phase II – Integrated Demo Plant**



## Demo Plant – Hillsborough, NJ, USA

- Phase 1: Natural gas to gasoline
- 12.7 gal/hr (100,000 gallons/yr)
- Expected Completion 1Q/13
- Milestones for success (2 months)
  - Production of gasoline that meets or exceeds product specifications
  - Confirmation of commercial plant design parameters including:
    - continuous nameplate production for 1 month
    - yield, carbon efficiency
    - reactor capability
    - catalyst behavior
    - composition control under various operating conditions
    - perform independently witnessed and verified tests for lenders'/investors' due diligence purposes

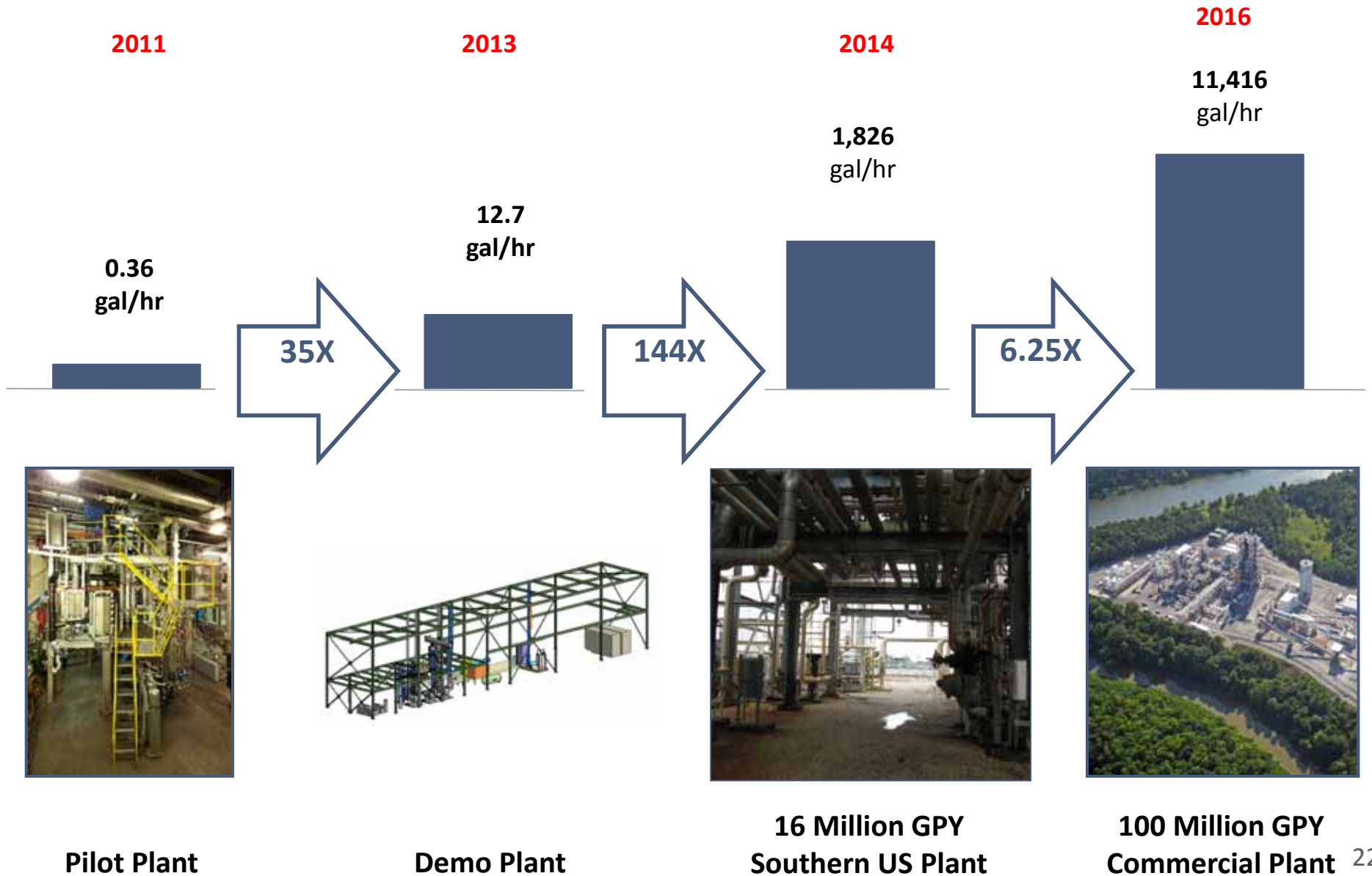


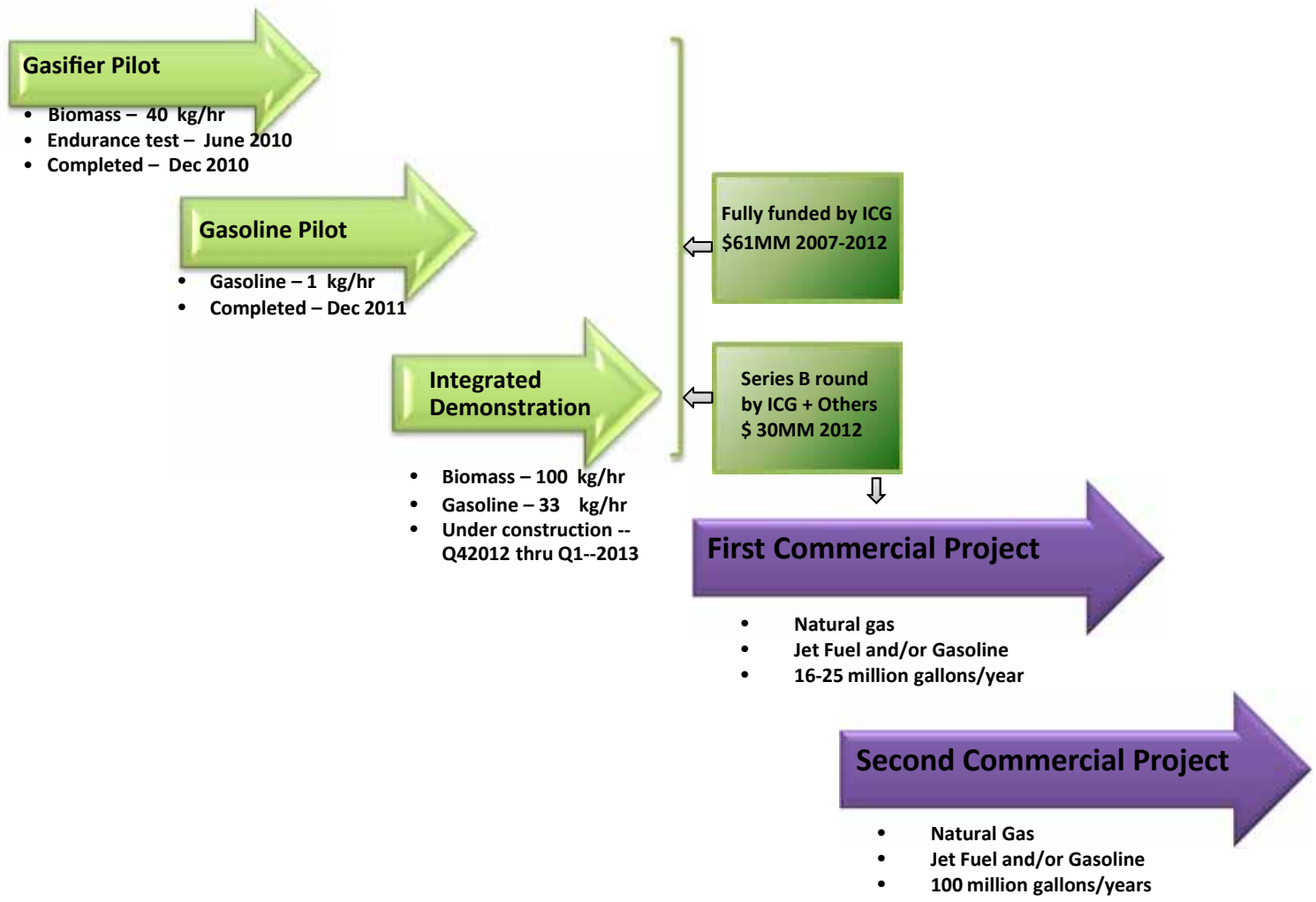
First Commercial Plant – Louisiana, USA

- PGE will purchase an existing syngas plant, as basic for site; reduces capital cost and construction time
- Extensive infrastructure and pipelines, adjacent to refineries
- Production: 16-25 million gallons of fuel
- Jet fuel production will be for major US airline
- Will be able to switch between jet fuel and 93 octane gasoline production by changing catalysts, no equipment changes



Successfully Scaled for Commercial Production







[www.primusge.com](http://www.primusge.com)

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**Thank You**