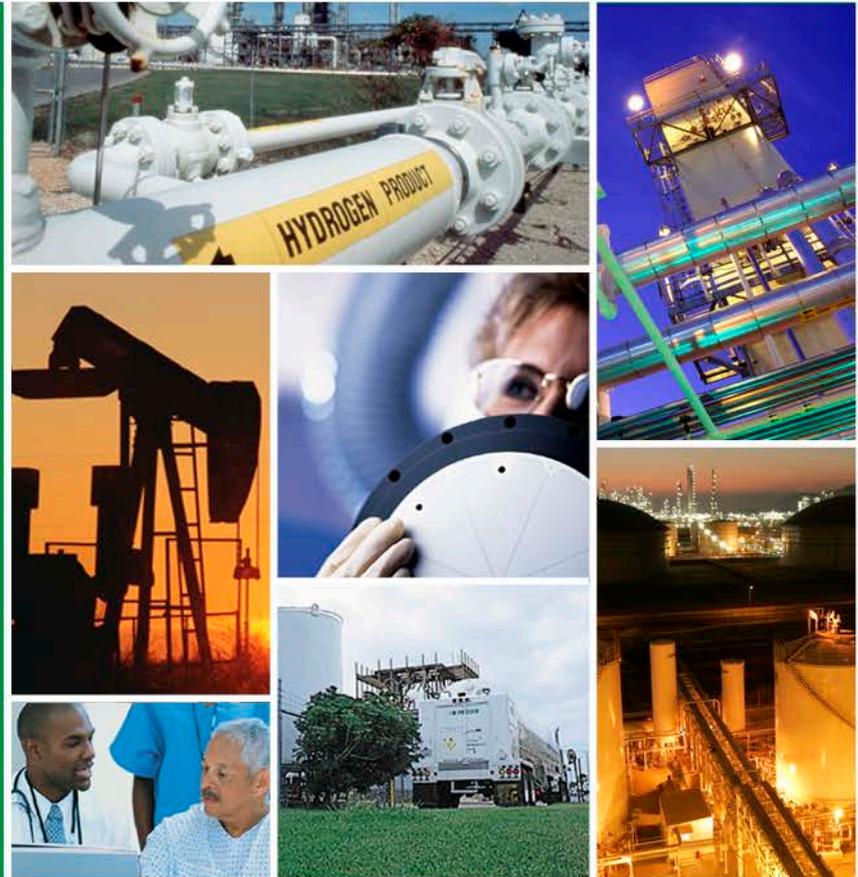


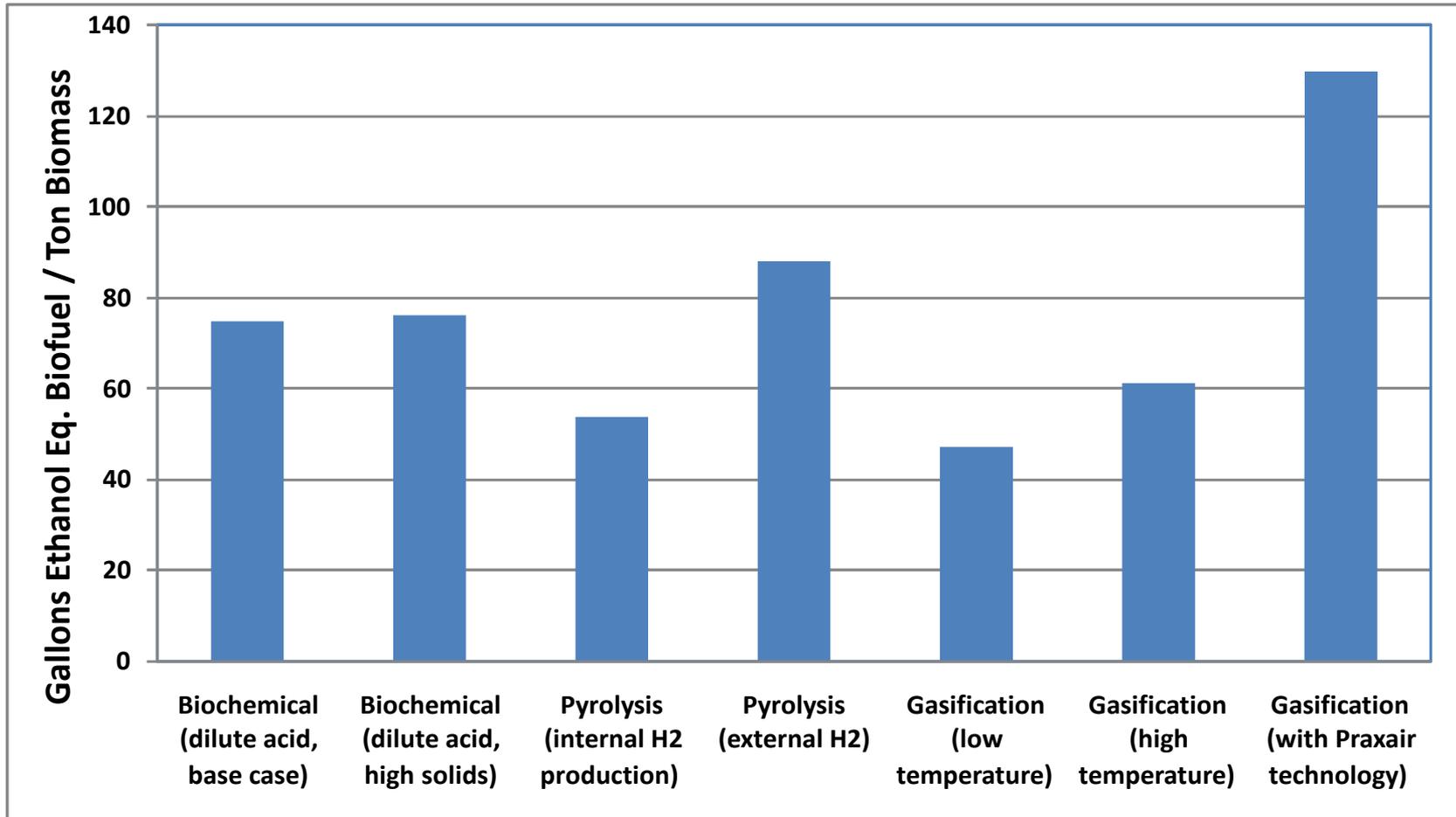
Natural Gas Enhanced Biofuels

Review and Preliminary
Economics

August 16, 2012

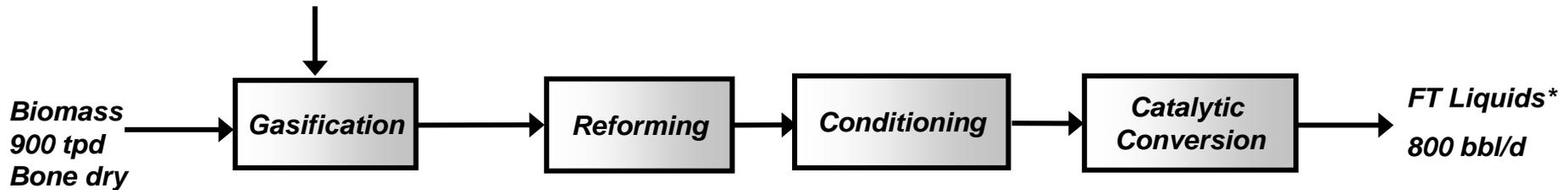


Comparison of Biofuel Production Pathways*



*"Techno-economic comparison of biomass-to-transportation fuels via pyrolysis, gasification and biochemical pathways", Anex R.P. et al., Fuel (2010)

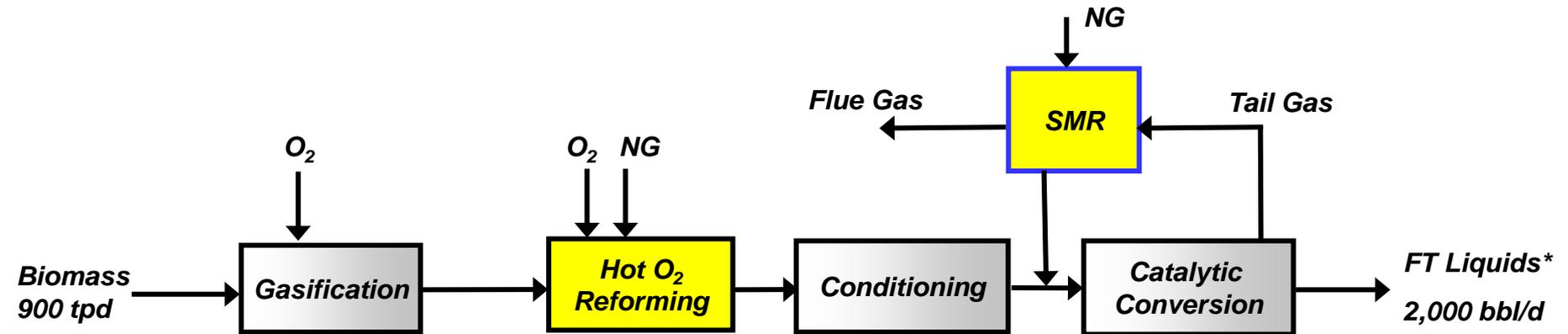
Production Process – Baseline



** 80% diesel, 20% naphtha*

Low biofuel yield makes economic viability challenging

Natural Gas Enhanced Process



* 80% diesel, 20% naphtha

- **Addition of H₂-rich syngas from natural gas**
 - Increases liquids yield per ton of biomass
 - Decreases lifecycle CO₂ emissions – qualified under EPA RFS 2
- **Reduces technical risk**
 - Uses technology proven at scale
 - Adjusting H₂/CO ratio upward is always beneficial
- **Start-up with SMR; higher availability**

> 2X production; 40% more capital

Estimated Project Economics

➤ Feeds & Product Slate

– Feeds

- 900 t/d of bone dry wood
- 11 MM SCFD of natural gas purchased

– Product Slate - 90% of nameplate

- 2,000 bbl/d (84,000 gal/d) – FT liquids
- 14.5 MW of Green electric power sold to grid

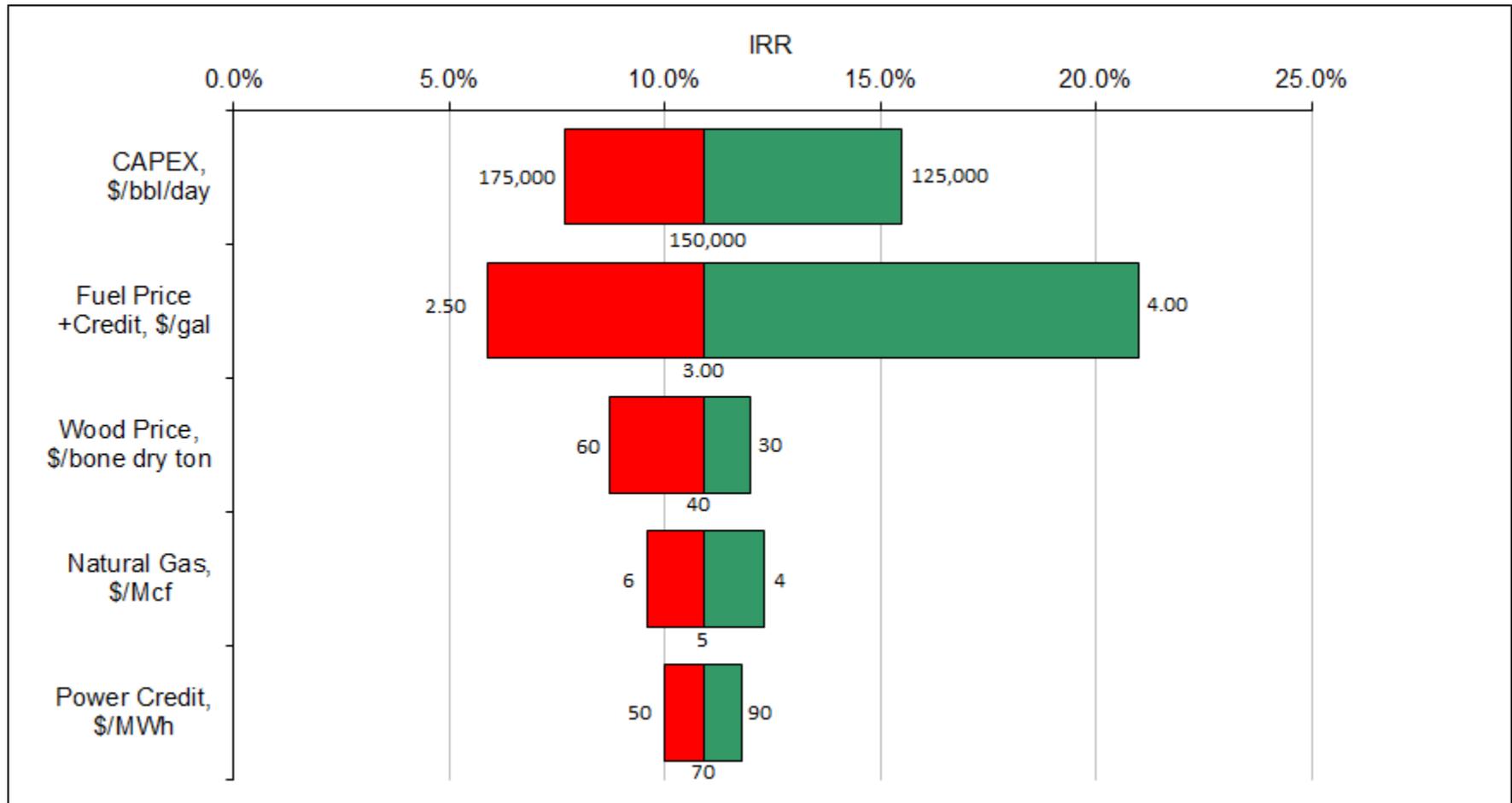
➤ Costs

- CAPEX - \$300MM (\$150,000/bbl/day)
- Wood @ \$40/Bone dry ton
- Natural gas @ \$5.00/MM Btu (HHV)
- Electric power export @ \$70/MWh (premium green power)

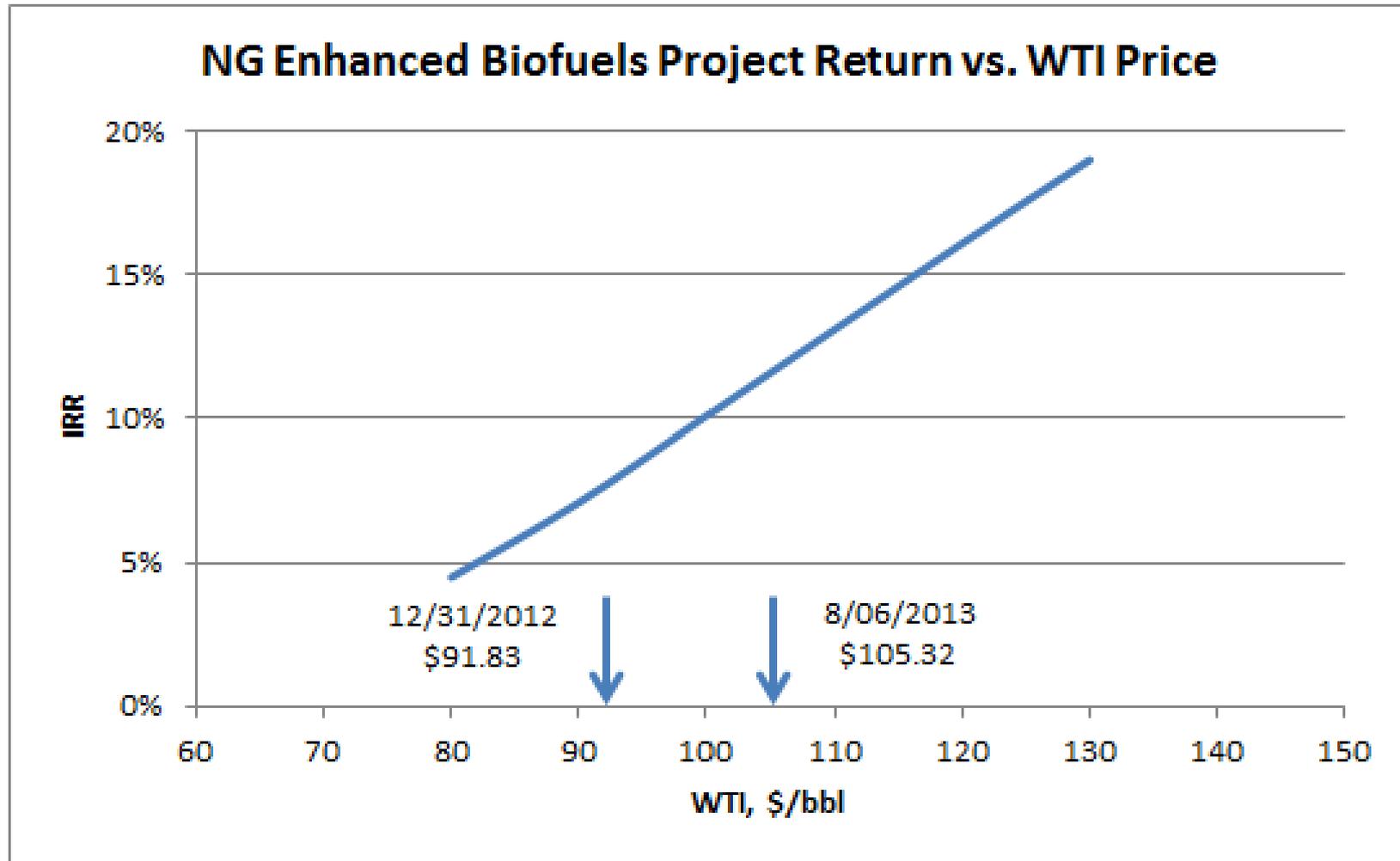
➤ Financial Assumptions

- Income tax rate @ 30%
- 100% equity financed
- 10 year economics

Projected IRR



IRR as a Function of Oil Price



Based on the following correlation relating diesel prices to WTI

$$Y = 0.029(X) + 0.022 \text{ where: } Y - \$/\text{gal refinery diesel price; } X - \$/\text{bbl WTI price}$$