



NARA

Techno-Economic Evaluation of Renewable Jet Fuel from Softwoods: The NARA Greenfield Integrated Biorefinery Process

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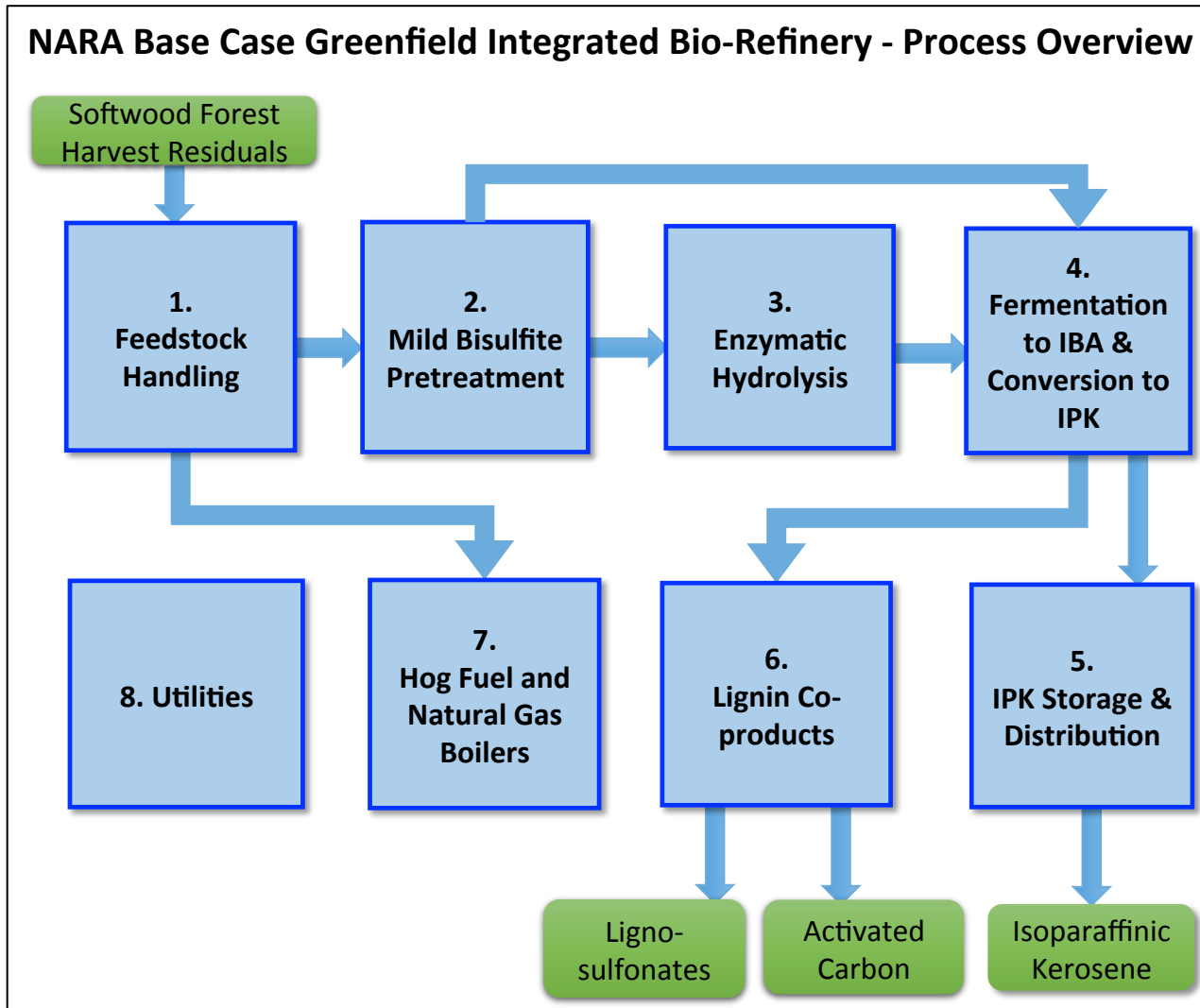
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Embassy Suites, Crystal City

- Commissioned to assemble detail from all the relevant conversion teams, design an integrated, full-scale Nth plant facility, estimate all Capex, Opex, Revenue, and perform a DCF-ROI analysis
- Estimated process parameters, yields, inputs, etc, from all process steps
- Integrated all steps into overall process flow.
- Built ASPEN mass and energy balance to define materials and energy.
- Obtained cost estimates for capital equipment, installation, facility costs.
- Obtained data for operating costs.
- Assembled into a Discounted Cash Flow analysis

IBR Process Flow Overview



IBR Base Case Key Specifics

- Hypothetical siting in Longview, WA, (best location)
- Feedstock is 846,000 BDST/yr. softwood forest harvest residuals, (2,200 BDST/day)
- Facility output is:
 - 35,700,000 gal/yr. isoparaffinic kerosene (jet biofuel)
 - 196,224 tons/yr. lignosulfonates
 - 66,192 tons/yr. activated carbon
- Full scale, greenfield, Nth plant, not pioneer or demonstration scale
- 30-year facility life, 10% discount rate, MACRS depreciation, 100% equity financing, solve for minimum selling price of IPK to get zero NPV.

- Total Capital Investment; \$1,100 MM
- Annual Operating expense; \$248 MM/yr.
- Revenue:
 - Lignosulfonates: \$39 MM/yr.
 - Activated Carbon: \$99 MM/yr.
 - Isoparaffinic Kerosene: \$261 MM/yr. (to achieve 10% IRR)
 - IPK MSP total is: **\$7.31/gal IPK**
 - Petro-jet projection: \$2.56/gal IPK
 - RINs projection: \$2.46/gal IPK
 - Needed additional: \$2.29/gal IPK
- Conclusion
 - Current projected prices for IPK and RINs would only return ~3.6% IRR. Need a total “biofuel premium” of about \$4.75/gal IPK to achieve 10% IRR.

Comparison to other pathways

- DOE BETO MYPP NREL TEAs are the most up-to-date, fully developed biofuels TEAs.
- For woody feedstock to hydrocarbons (gasoline and diesel), using current state of technology, the NREL **MSP values** are; (per/GGE)
 - 2013 Woody feedstock via biologic conversion of sugars to hydrocarbons: \$12.97
 - 2015 Woody feedstock via Fast Pyrolysis to hydrocarbons: \$6.47
 - 2015 Woody feedstock via catalytic conversion of sugars to hydrocarbons: \$7.29
- NARA Softwood to IPK similar at MSP \$7.31/gal IPK
 - *However, state of technology more advanced for many NARA process steps*

- Thank you for your time today
- Questions?