

Wood to Wing Envisioning an Aviation Biofuels Industry from Forest Residuals

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Northwest Advanced Renewables Alliance









Catchlight Energy

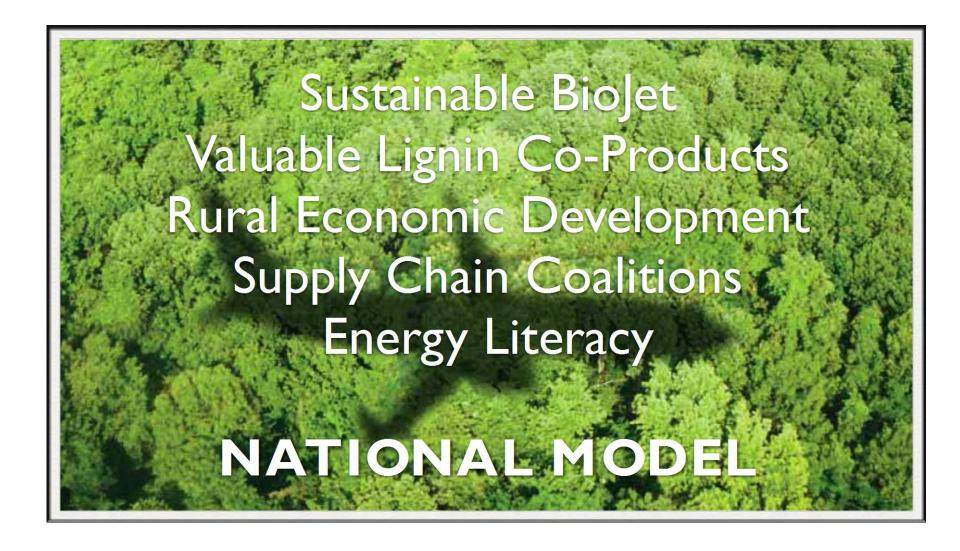
NARA Team



CLH Cosmo Specialty Fiber Facing the Future Gevo, Inc. Montana State University Oregon State University Pennsylvania State Univ Salish Kootenai College Steadfast Management TSInc University of Idaho University of Minnesota **University of Montana University of Washington** University of Wisconsin USFS - Forest Products Lab USFS - PNW Research Sta. **Utah State University** Washington State University Western Washington Univ Weyerhaeuser



Northwest Advanced Renewables Alliance











Why Aviation Fuels

















www.safnw.com

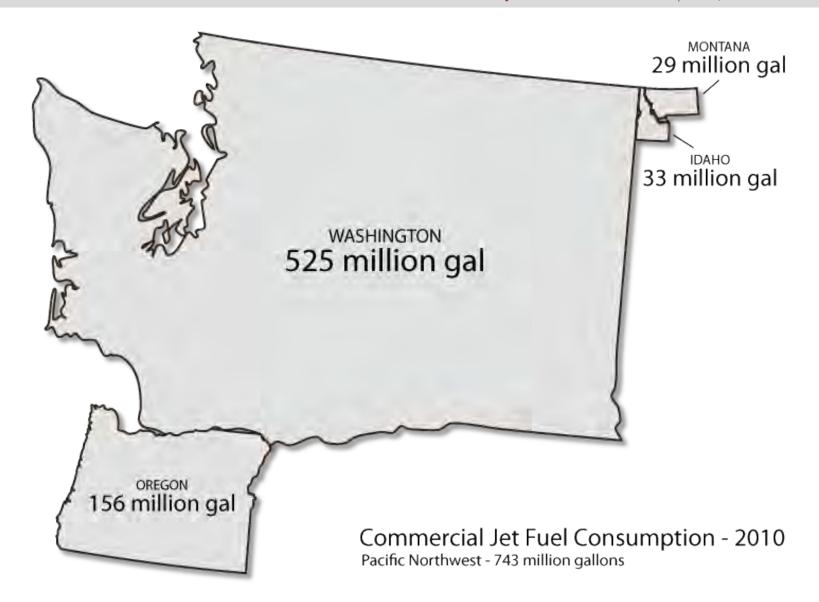








Regional Commercial Aviation Fuel Consumption



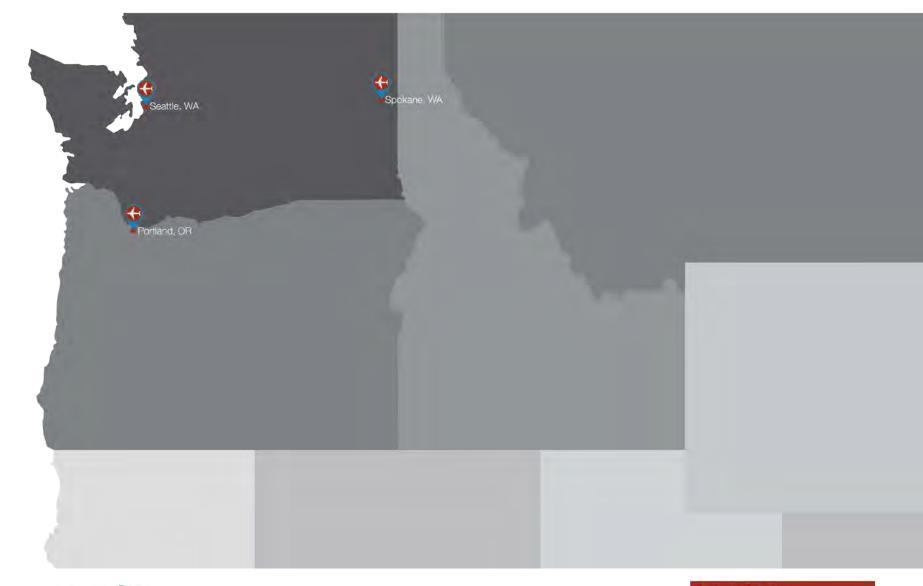








Market Demand Centers

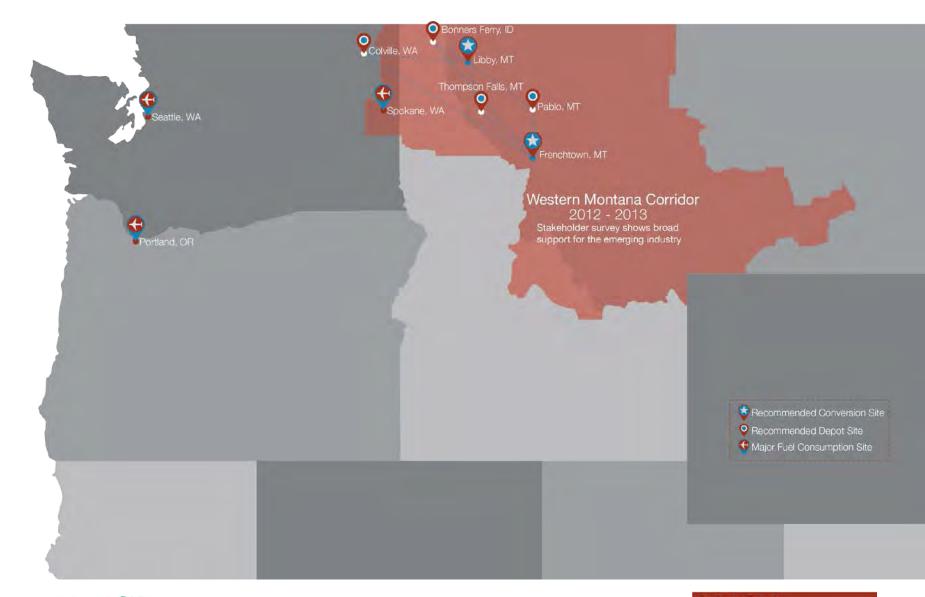








Western Montana Corridor (WMC)

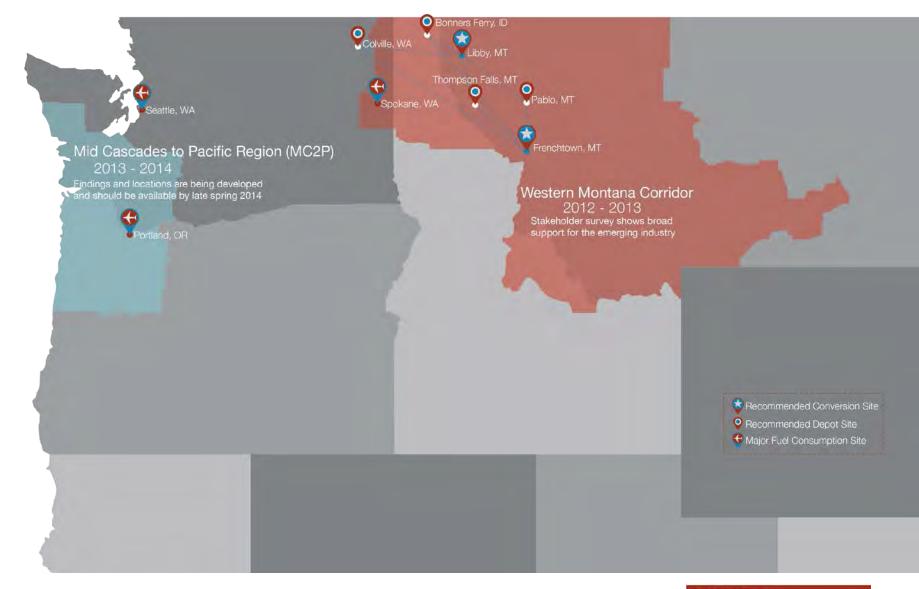








Mid Cascade to Pacific (MC2P)

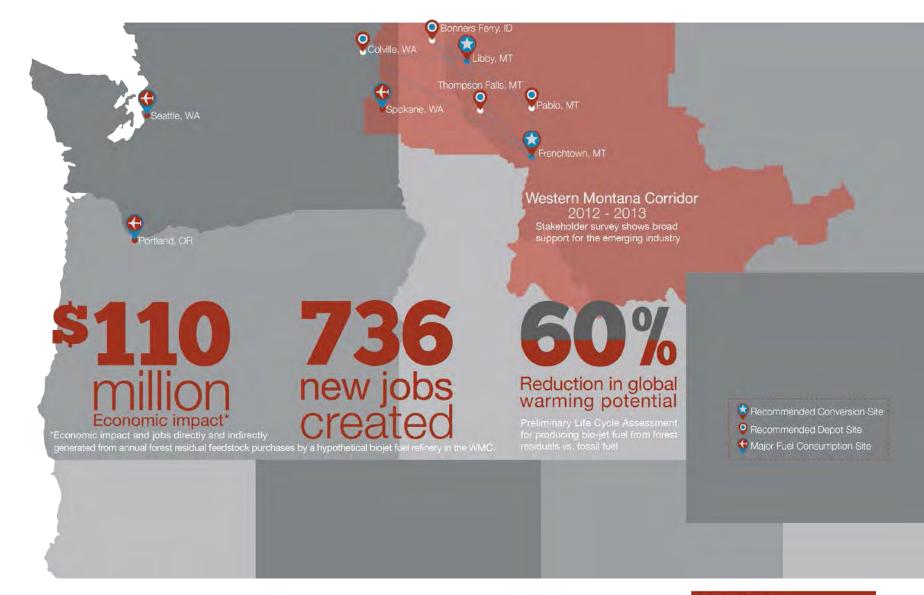








Overall Impact in WMC









Our **INDUSTRIAL CROP** – Forest Residues



Our Target Feedstock



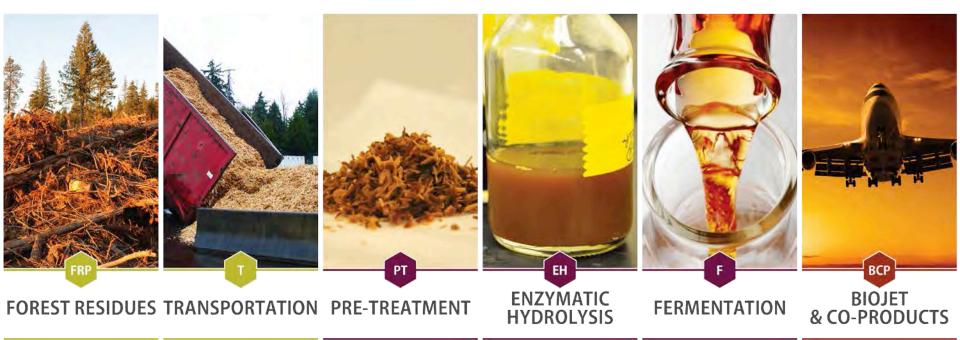








IMPROVE: Step-by-Step Efficiencies



IMPROVEMENTS THROUGHOUT THE SUPPLY CHAIN





NARA TEA Status: Approach

TEA Approach

Based on NREL
TEA of Biochem Cellulosic Ethanol
NREL/TP-5100-47764

Significant Changes to Inputs

- Revised CapEx
- Revised OpEx
- Four Production Scenarios
- Multiple "initial" versions

Contributors

- Catchlight Energy
- Gevo
- TSI (Tom Spink, Inc)
- Weyerhaeuser



Process Design and Economics for Biochemical Conversion of Lignocellulosic Biomass to Ethanol

Dilute-Acid Pretreatment and Enzymatic Hydrolysis of Corn Stover

D. Humbird, R. Davis, L. Tao, C. Kinchin, D. Hsu, and A. Aden National Renewable Energy Laboratory Golden, Colorado

P. Schoen, J. Lukas, B. Olthof, M. Worley, D. Sexton, and D. Dudgeon Harris Group Inc. Seattle, Washington and Atlanta, Georgia

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Technical Report NREL/TP-5100-47764 May 2011

Contract No. DE-AC36-08GO28308

Download: http://goo.gl/6CYDB





NARA TEA Status: Approach

TEA Approach

Based on NREL
TEA of Biochem Cellulosic Ethanol
NREL/TP-5100-47764

Base Case

- Feedstock Preparation (sorting, storage)
- Calcium Bisulfite Pretreatment
- On-Site Enzyme Production
- Standard IBA/IPK Production
- Multi-Fuel Boiler Burn Lignin

Contributors

- WY Engineering Design Woodyard
- TSI Pretreatment
- Gevo IBA/IPK



Process Design and Economics for Biochemical Conversion of Lignocellulosic Biomass to Ethanol

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Current Status

NARA A2J IPK = 2-3x Petroleum Jet Prices

depending on RIN value

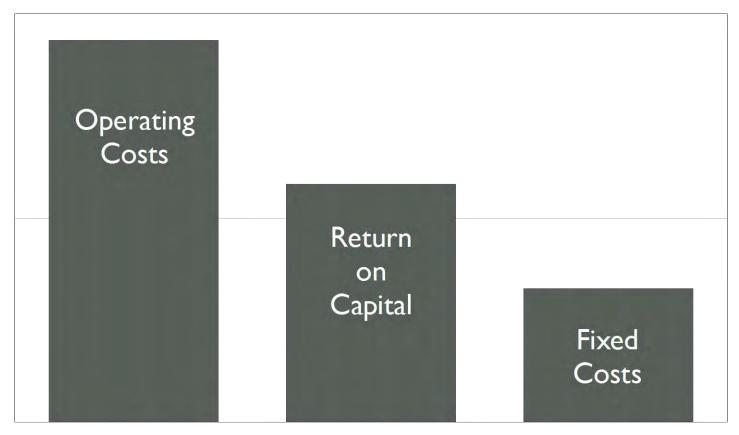
Case 3.4 - Assumptions

Integrated Biorefinery - 770M BDT/yr
Feedstock - ground slash piles - NARA FS-10
Greenfield CapEx Entire Facility
Commercial Feedstock Costs
Burn Lignin + Rejects
Today's NG Prices





NARA TEA: Costs Components – BioJet ONLY



Major Contributions to Fuel Costs





Northwest Advanced Renewables Alliance

DEVELOPMENT SITES: Suitability Criteria



GREENFIELDS

Non-industrial sites

Wildlife habitats

Agricultural land

Resource land

Ecological value

GRAYFIELDS

Existing industrial sites

No assumed contamination

Community blight

BROWNFIELDS

Existing industrial sites

Real or perceived contamination

Community blight

Human health hazard

Owner liability

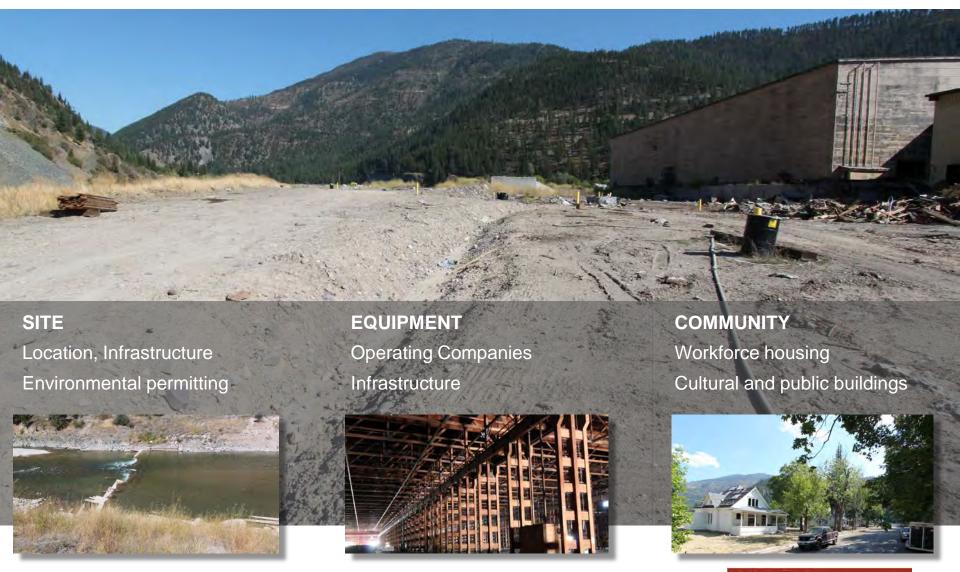








DEVELOPMENT SITES: Existing Assets





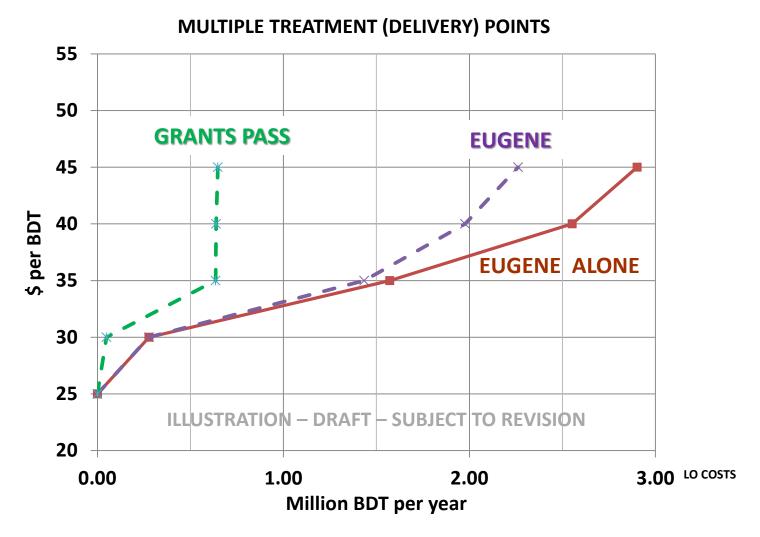




Community Assets via Stakeholder Involvement



PROJECTED BIOMASS SUPPLY EXAMPLES



SOFTWOOD BIOMASS DELIVERED TO EUGENE + GRANTS PASS AT VARIOUS PRICES ALL LANDS



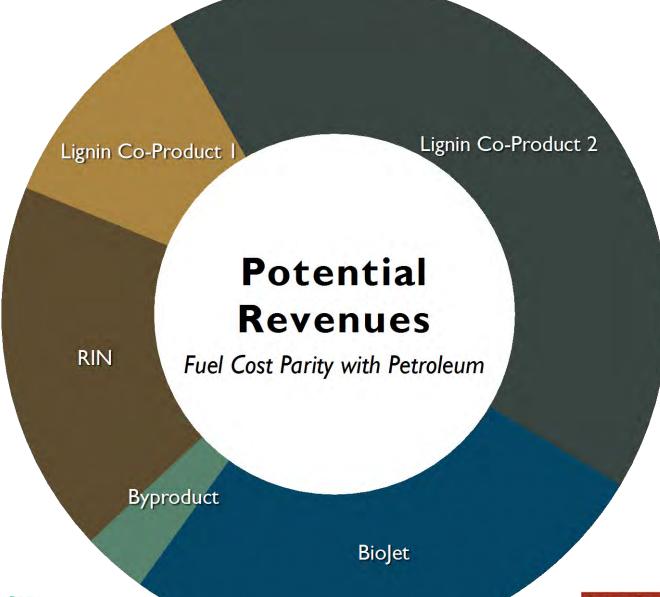








ONE Potential Co-Products Scenario











2014 - Lessons Learned

Reduce Capital Costs –
 Existing Facilities
 Shuttered Mills

- 2. Diversify Markets Value Chain with Non-Fuel
- 3. Build Value Chain Economic Environmental





- Refine Technical Pathway –
 Yield-Yield
 Reduce CapEx
 High Vol and High Value Co-Products
- 2. Optimize Logistical Pathway Forest Operations and Transportation
- 3. Commercialization –
 Stakeholder Involvement
 Education Programs





Acknowledgements

TEA Analysis

Gevan Marrs – WY Tom Spink – TSI Bob Wooley – Gevo Dwight Anderson – CLE

Supply Chain

Natalie Martinkus – WSU Todd Beyreuther – WSU Todd Morgan – U Montana Erik Berg – U Montana

Co-Products

Tom Spink – TSI Dave Fish – WY

Feedstock Engineering

John Sessions – OSU Gevan Marrs – WY Kevin Boston – OSU Dwight Anderson – CLE

Feedstock Economics

Darius Adams – OSU Greg Latta – OSU Todd Morgan – U Montana Peter Gray - WSU





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