

What are “Advanced Biofuels” ??

➤ **Organically sourced**

- Fuel produced from renewable biomass, including crops and crop residue, trees and tree residue, animal waste, forest slash, algae, yard and food waste.
Excluded: ethanol derived from cornstarch.

➤ **Infrastructure-compatible**

- Biomass-derived gasoline, diesel, and jet fuel - "drop-in biofuels" - that can be blended with their petroleum-derived counterparts or used directly in gasoline, diesel, or jet engines.

➤ **Sustainable**

- Meet or exceed environmental and sustainability goals for biofuels production including reduction of greenhouse gas emissions by 50% or more over conventional fossil fuels.

Advanced Biofuels Value Chain

Feedstock

Purpose-Grown Crops: Miscanthus, Switchgrass, Sorghum (not corn)
Ag Residues: Forest Slash, Straw, Bagasse, Food Processing Wastes
Urban / Industrial Wastes - C&D Wood, Paper, Green-waste, Emissions

Pre-Treatment

Hydrolysis: Acid or Base, Super-Critical Fluids, Enzymatic, Organic solvents
Comminution: Milling, Grinding, Pulping, Cavitation, Explosive Pressure
Biological Digestion: Microbial, Fungal, Insect, Animal

Conversion

Microbial Conversion: Bacteria, Fungus, Algae Digestion
Thermal Conversion: Depoly, Torrefaction, Pyrolysis, Gasification, Plasma
Chemical/Kinetic: Piezometry (ΔT), Gravity/Density, Δ Pressure, Hydrolysis

Reforming Refining

Reforming: Biological / Metals Catalysis, PSA, Dewatering, Compression
Refining: Steam Hydrogenation, Molecular Cracking, Decanting-Centrifuge-Distillation, Injection to Petroleum-Sourced Fuels Infrastructure

Final Product

Markets: “Drop-in” Gasoline, Diesel, Heating Oil
Jet and Rocket Fuel
Additives and Blending Products

Thermal Conversion

Thermal

Feedstock	Pre-Treatment	Conversion	Reforming Refining	Products
Biomass	Chip / Grind	Fast Pyrolysis	Catalysis	Fuels and Chemicals
Biomass	Chip / Grind	Allothermic Gasification	Separate Recirculate	Bio-Oil
Sewage, Biomass	Chip / Grind	Indirect CFB Gasification	Separation, F/T to Liquid	Electricity and Fuels
Biomass	O2 and N2 Separation	Oxy-Fired Gasification	Clean / Shift Combine N2	Ammonia, Chemicals
MSW, Organics	MRF Chip / Grind	Gasification & Plasma	Clean-up & Upgrading	Electricity
Any Feed	MRF Chip / Grind	High-Temp Gasification	Clean-up & Upgrading	Fuels and Chemicals
Any Feed	MRF Chip / Grind	Cool Plasma	Clean-up & Upgrading	H2, Electricity
Any Feed	MRF Chip / Grind	Plasma Gasification	Clean-up & Upgrading	H2, Electricity



Companies are shown as examples only.
No recommendations are intended.

Microbial Conversion

Microbial



Feedstock

Pre-Treatment








Conversion

Reforming Refining

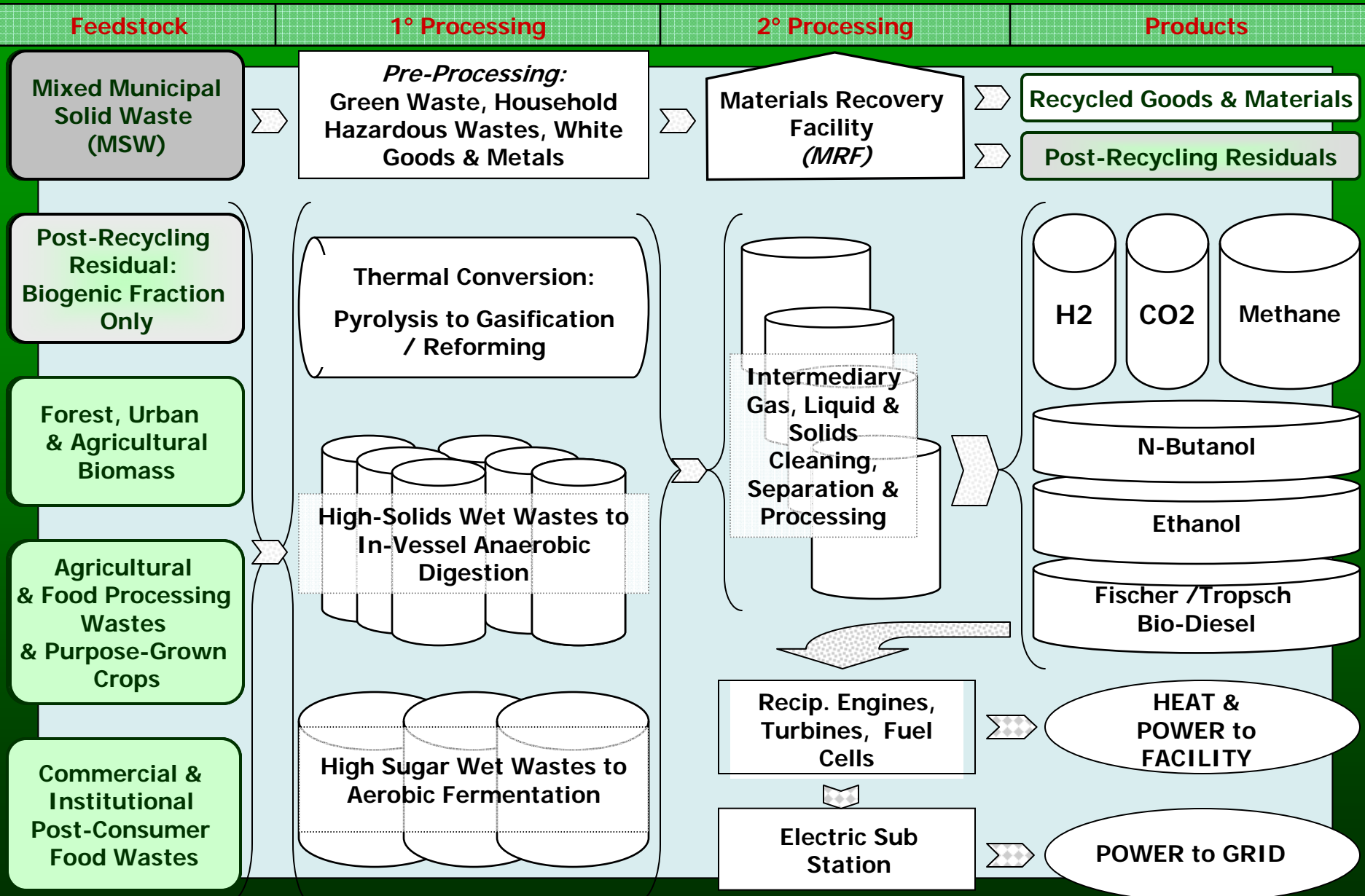
Products

Sugars	GMO Yeast	Ferment	Oil/water Separation	Farnesene
Cellulosic Biomass	Enzymatic Hydrolysis	Ferment	Distillation	Ethanol, other Fuels
Sunlight, Nutrients	GMO Algae	Algal Growth	Oil Upgrading	Biodiesel, other fuels
Biomass	GMO Bacteria	Bacterial Digestion	Separation Dehydration	N-Butanol
Landfilled Organics	In-Situ AD & Gas Extraction		Clean-up Compress	Pipeline Methane
Biomass	Acid Hydrolysis	AD	Separation-Dehydration	Fuels and Chemicals
Methane	One-Step Nano-material Based Biological / Metallic Catalysis			Fuels and Chemicals
Manure	Slurry	AD	Condition Compress	Fuel or Pipeline

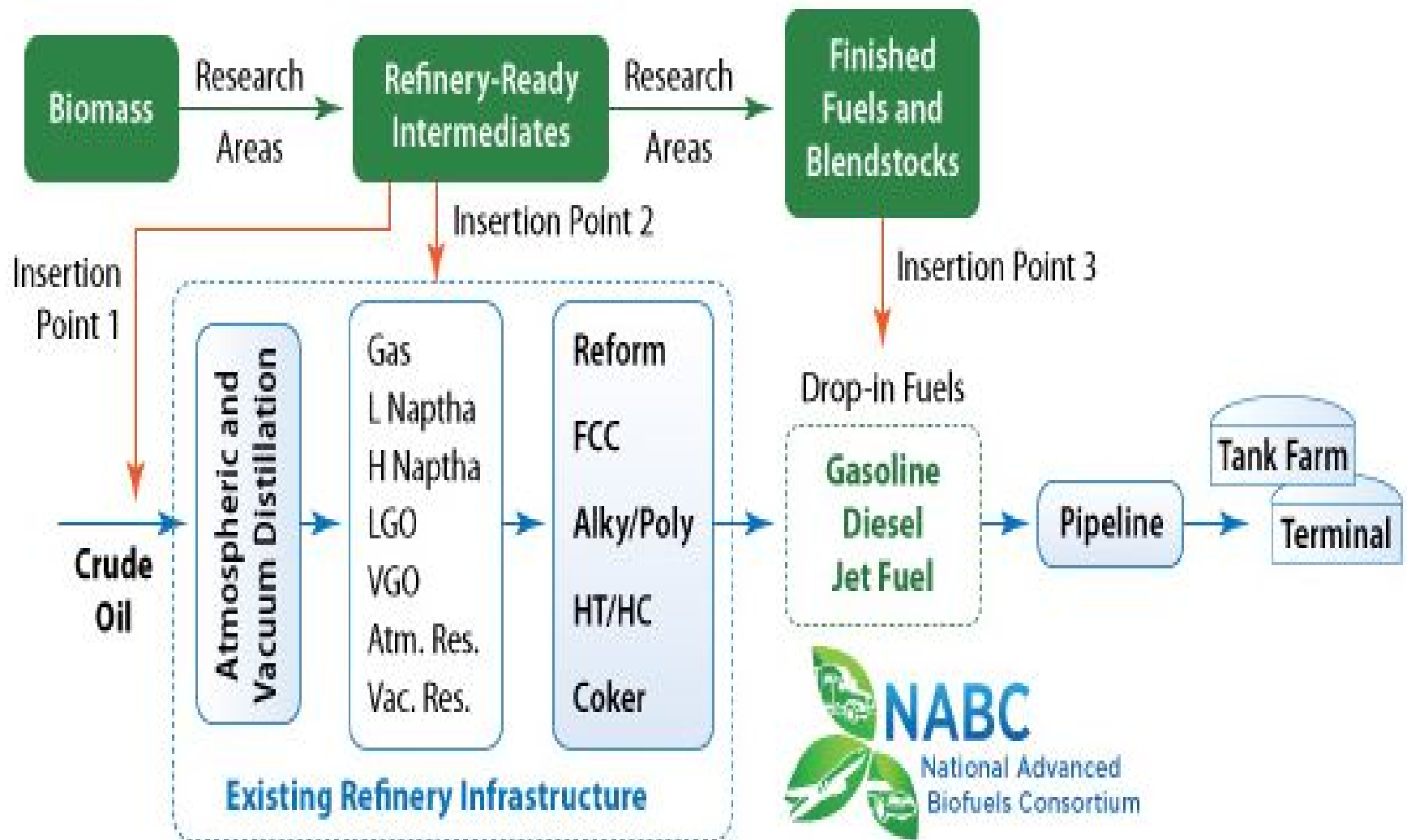
Sub-Process Specialists

Sub-Process	Feedstock	Pre-Treatment	Conversion	Reforming Refining	Final Products
	Cellulosic Biomass	Enzymatic Hydrolysis			Produce specialized enzymes and catalysts for hydrolysis of biomass
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	Cellulosic Biomass	Microbial Catalysis			Biological Catalysts
	Cellulosic Biomass	Cellulator FiberZyme			Add-on to existing ethanol / biodiesel plants to integrate cellulosic feedstock
	Cellulosic Biomass	ShockWave			Physical disruption of cell walls to improve hydrolysis, digestion, fermentation
	Cellulosic Biomass	Harvesting			All forms of Biomass Feedstock Management from Ag and Forest Sources
	Liquids and Slurries	Centrifuge, Reverse/O			All forms of separation and decanting

Integrated Biorefinery

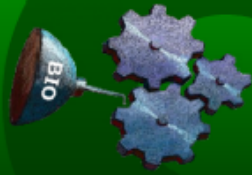


Biofuels Injection into Refinery Infrastructure



NABC: For open distribution

Source: www.nabcprojects.org



on matters of waste conversion for resource recovery

Teru Talk

by Michael Theroux

(pronounced "Terú")

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