



San Joaquin Renewables

NATURAL GAS FROM BIOMASS

Transportation Biofuel Project

Cleaning the air in California's San Joaquin Valley
with BECCS



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Carbon Happens!

Sunshine + water + CO₂ = biomass

It is natural.

It is inevitable.

It is... **HUGE**

Both agriculture and forest growth produce an enormous amount of biomass that is not digestible and is perfect for gasification.

Electrifying transportation will not eliminate carbon. (unless renewable fuels made from carbon are used for that end)



Biogas Potential from technically available organic waste, prepared by Rob Williams, UC Davis

Feedstock	Technically Available Amount	Billion Cubic Feet of Methane	Million Gasoline Gallon Equivalents
Landfill Gas	106 BCF	53	457
Animal Manure	3.4 M BDT	19.5	168
Waste Water Treatment Gas	11.8 BCF	7.7	66
Fats, Oils and Greases	207,000 tons	1.9	16
Municipal Solid Waste (food, leaves, grass)	1.2 M BDT	12.7	109
Municipal Solid Waste (lignocellulosic fraction)	6.7 BDT	65.9	568
Agricultural Residue (Lignocellulosic)	5.3 M BDT	51.8	446
Forestry and Forest Product Residue	14.2 M BDT	139	1,200
FUEL POTENTIAL		351	3,030

Non-digestible organics



Existing Options for Biomass

Incineration with heat recovery for electric power (cogen plants)

- Large water consumption, emissions

Shipping biomass to Japan and other far-flung points

- Highly inefficient and expensive

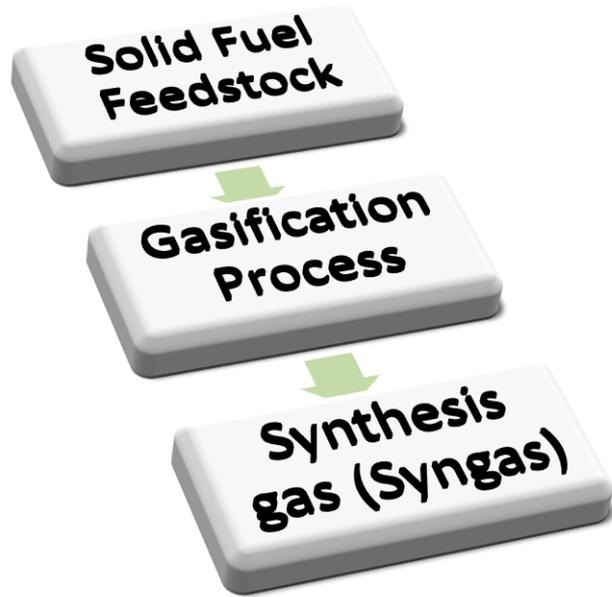
Grinding and soil incorporation:

- Currently being promoted heavily with subsidies
- Decomposition is very slow
- May hurt yields
- Increase in fungus, bacteria, and nematodes
- Larger chunks of wood may hamper replanting and harvest

Open burning of biomass

- Highly polluting – worsening air quality
- Discouraged – soon to be banned in CA

What about conversion to renewable fuel?



CO
H₂
CO₂
H₂O
Methane
Light hydrocarbons

Fueling the Energy Transition™

- Founded in 2005, Frontline BioEnergy has been developing and demonstrating scalable, pressurized gasification, pyrolysis, and integrating many related technologies for renewable energy.

Frontline develops projects and serves others with advanced conversion technologies:

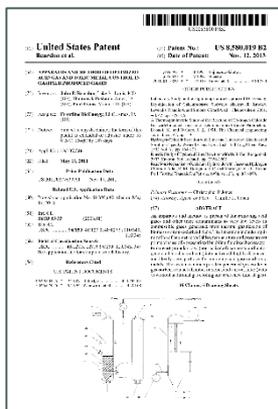
Biomass to biofuels (e.g. biomethane)

Biomass to chemicals (e.g. methanol)

Biomass to electricity



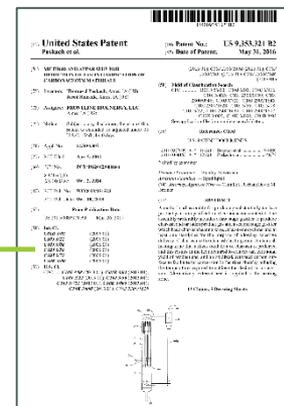
Renewable Energy & Products



PMFreeGas®

High Efficiency Filtration of Produced Gas

- Patents granted in United States, Canada, South Korea, Europe
- Patent pending in several other countries



TarFreeGas®

Minimizes Gasifier-Produced Contaminants

- Patents granted in United States, Canada, China, South Korea, Europe, India
- Patent pending in several other countries



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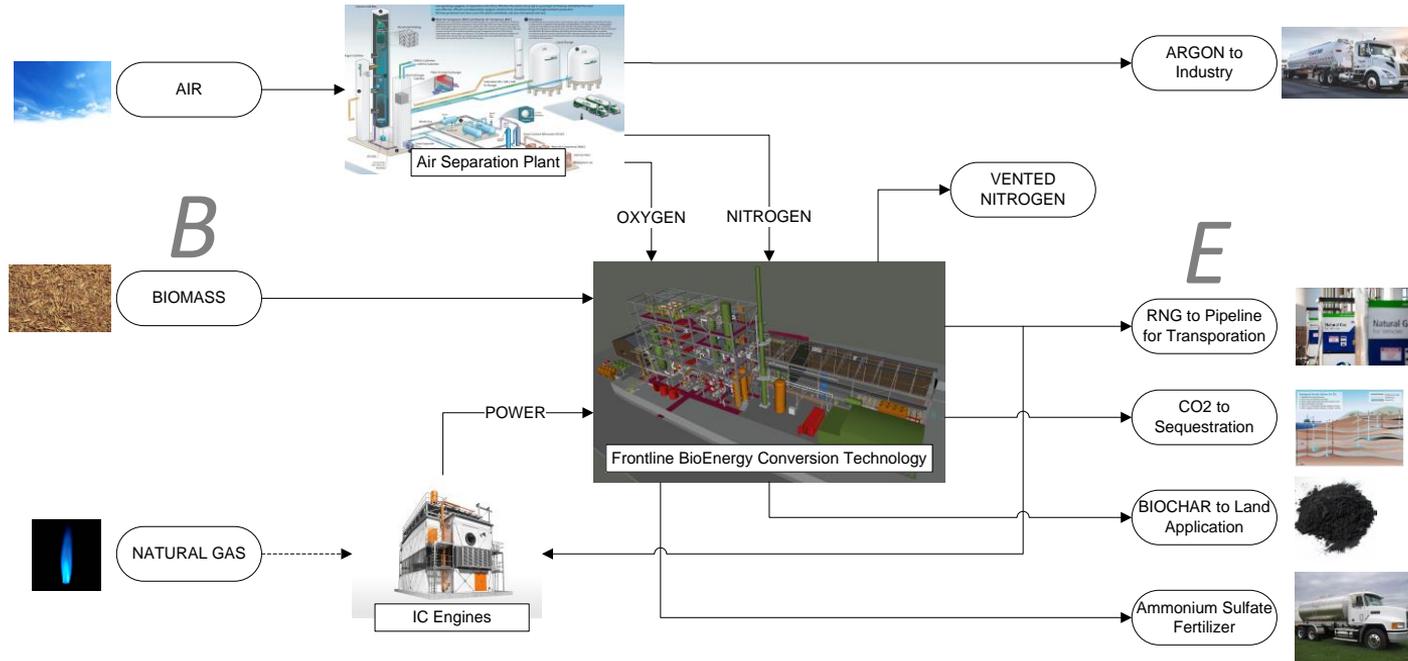
NATURAL GAS FROM BIOMASS



Renewable Energy & Products

BING[®] Process

Biomass Energy with Carbon Capture and Storage



CCS



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Project Facts

- Will be of the first **Biomass Energy with Carbon Capture and Storage (BECCS)** projects in California
- Will create 125 jobs in economically disadvantaged communities
- Will provide an air quality benefit equivalent to eliminating the NOx emissions from 2,400 diesel trucks



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Project Facts

- Annually, the project will:
 - consume 400,000 tons/year of ag waste
 - consume no water
 - produce 22,000 tons per year of ammonium sulfate 40% fertilizer
 - produce 29 million gasoline-gallon equivalents of pipeline-quality renewable natural gas (RNG)
 - produce 50,000 tons/year of biochar
 - Produce 5,000 tons/year of liquid argon using renewable power
 - safely store approximately 400,000 tons/year of CO₂ in a class VI geologic sequestration well
- Project Status:
 - EPA D3 RIN pathway approved by EPA (May, 2020)
 - Executed feedstock agreements
 - Executed site purchase agreement
 - Executed offtake agreements
 - All permits drafted
 - Funding secured

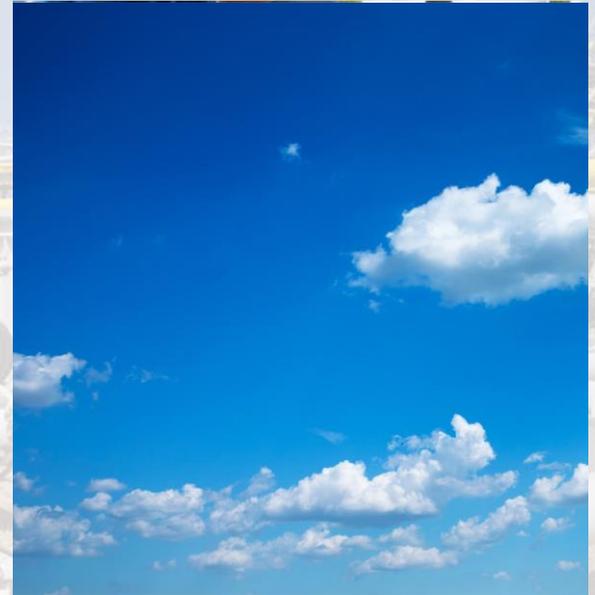


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Simply put...

- We create value from biomass
- We don't use any water
- We create jobs
- We clean the air



Uses of RNG



RNG as direct transportation fuel

- Replaces diesel-fueled trucks

RNG for traditional and advanced biofuel plants

- Replacing fossil natural gas lowers CI of produced biofuel
- SMR's can make renewable hydrogen with negative CI

RNG for EV charging stations

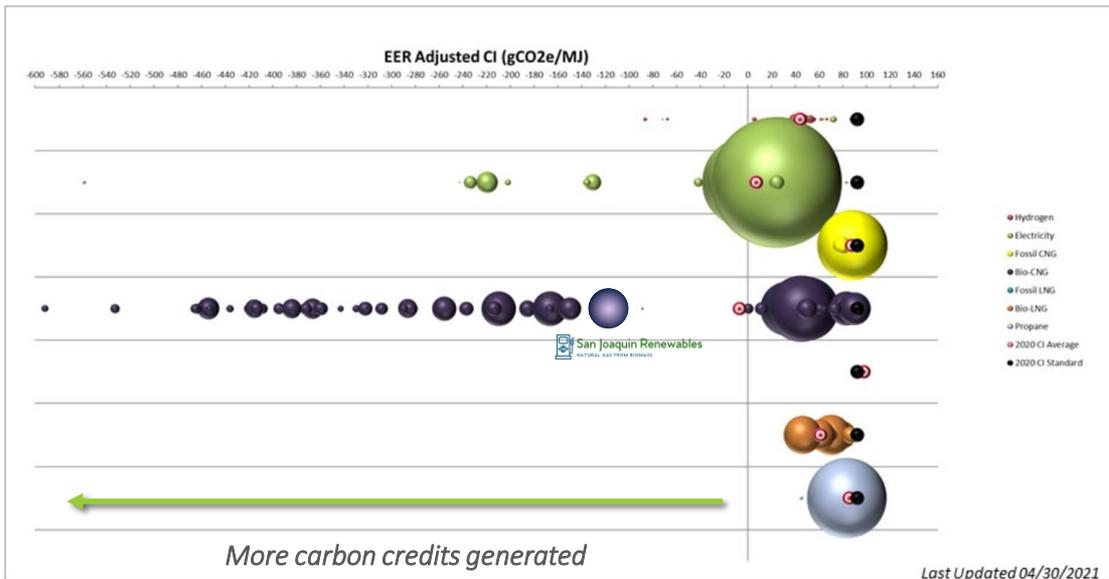
- RNG fuels engines or fuel cells

Anything else natural gas is used for!

- Cooking, heating, etc.

Size and Carbon Intensity Values of Non-Liquid Fuel Pathways

2020 Volume-weighted Average Carbon Intensity by Fuel Type for Non-Liquid Fuels



This figure provides perspective on the performance of actual quantities of fuel consumed in California. Each sphere represents a certified fuel pathway, the size of the sphere represents the reported volume of the fuel in 2020, while its position on the horizontal axis indicates the carbon intensity of that fuel.

The alternative fuel's CI value is divided by its Energy Economy Ratio (EER) in order to obtain the EER-adjusted CI value, representing the emissions which occur from the alternative fuel per MJ of conventional fuel displaced.

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Each marker represents an individual certified fuel pathway carbon intensity (CI), adjusted by the Energy Economy Ratio (EER). The length of each bar indicates the range of carbon intensity that may be achieved by a fuel pathway. The wide range of carbon intensities is due to the lifecycle emissions methodology of the LCFS, variations in feedstock types, origin, raw material production processing efficiencies, and transportation all contribute to an individual producer's fuel pathway CI. All valid CI values shown here are certified including the legacy, Tier 1, Tier 2, and Lookup Table Pathways.

Frontline's BING™ pathway is not yet approved by the California Air Resources Board.

(as of April 30, 2021)

Source: California Air Resources Board:
<https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>



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Feedstocks

Orchard Wood Waste

- 300,000 dry tons/year



Pistachio shells

- 40,000 dry tons/year



Almond shells

- 40,000 dry tons/year



Walnut shells

- 20,000 dry tons/year



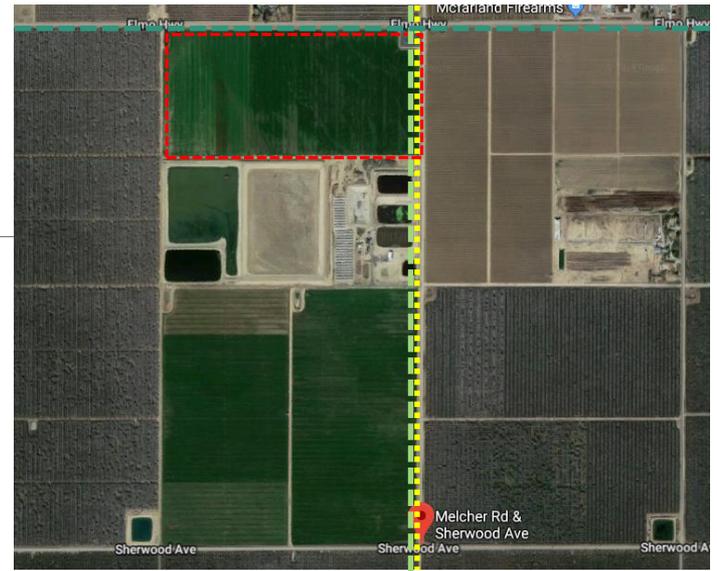
Project Site

80 acres in the heart of the biomass zone

Directly on Southern California Gas transmission pipeline and lower pressure distribution line

Directly on Pacific Gas and Electric high voltage transmission line

Directly over the Vedder Sand deep saline aquifer





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Permitting



California Environmental Quality Act

- Holistic look at environmental impact
- Final drafting



San Joaquin Valley

AIR POLLUTION CONTROL DISTRICT

Air permit

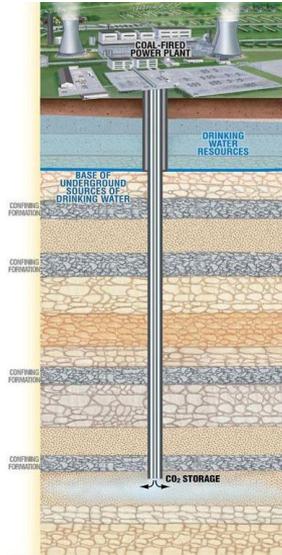
- Emissions estimates, monitoring requirements
- Final drafting



Class VI well permit (EPA)

- Protecting underground sources of drinking water
- Submitted

Class VI Well for CO₂ Sequestration



Regulated by US EPA's Underground Injection Control (UIC) Region 9

Regulations govern:

- Site characterization and pre-injection logging and testing;
- Area of Review (AoR) modeling and corrective action
- Well construction and operation
- Financial responsibility demonstrations
- Testing and monitoring during the injection and postinjection phases
- Well plugging and site closure, including non-endangerment demonstrations
- Emergency and remedial response.

Extensive geology studies have been performed, site appears suitable.

- Application for San Joaquin Renewables has been submitted

Well will also comply with California CCS protocol to qualify for LCFS carbon credits

San Joaquin Renewables Project Air Quality Impact

by the numbers:

RNG Production

	Pile Burning Emissions		SJR Max Emissions ton pollutant /yr	Reduction	Reduction
	lb pollutant/ dry ton biomass	ton pollutant /yr		tons /yr	
PM _{2.5}	10.5	1,670	10	1,660	99%
NOx	3.9	624	10	614	98%
CO	132.6	21,004	100	20,904	99.99%
Non-Methane VOC	3.0	469	10	459	98%
Methane (CH ₄)	10.0	1,584	1	1,583	99.9%

RNG Use in Transportation

	Estimated Diesel Tailpipe Emissions		Estimated CNG Tailpipe Emissions		Reduction	Reduction
	lb/ truck•yr	Emissions from fueled trucks ton/yr	lb/ truck•yr	ton/yr	tons /yr	
PM _{2.5}	50.1	68	0.5	0.7	67.5	99%
NOx	3751.0	5,064	375	506	4,557	90%
CO	3205.4	4,327	160	216	4,111	95%
NM-VOC	96.8	131	24	33	98	75%

San Joaquin Renewables Project Potential Air Quality Impact

OVERALL:

	Pile Burning Reduction	Tailpipe Reduction	TOTAL Reduction
	tons /yr	tons /yr	tons /yr
PM _{2.5}	1,660	67	1,727
NO _x	614	4,557	5,172
CO	20,904	4,111	25,015
NM-VOC	459	98	557
CH ₄	1,583	-276	1,307



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Renewable Energy & Products

Questions?

For more info or to contact us, visit:

www.sjrgas.com

www.frontlinebioenergy.com