OUR TEAM









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OCTOBER 2020

POTENTIAL FOR BIOENERGY AND BIOCHEMICAL INDUSTRY IN GEORGIA



SOUTHEAST HAS THE WORLD'S LARGEST *'CONTIGUOUS SUSTAINED' FOREST*

- Forest biomass inventories have more than doubled from 1953 to present

 - Little to no change in planted acres
 Forest resources in the Southeast continue to grow
 Market declines in paper usage, growth in pulp, tissue & lumber
- Wood supply chain infrastructure in place

 - Harvesting processes and equipment exist today
 Harvesting can proceed year-round (inventory stored in the field)
 Industry capable of moving large additional amounts of wood
 Wood largely avoids competition with food / feed crops



BIOFUELS FOR POWER & TRANSPORTATION



- Biofuels today
 - Pellets: Used for power generation in Europe
 - Ethanol, Butanol, Bio-oil (Bio-crude), Biointermediates, Renewable Diesel: Blended into liquid fuels
 - Syn Gas: Burned for power or as feedstock for conversion to fuels / chemicals

Several early stage wood to biofuels projects are currently in development

- Ensyn and partners in Canada and US, Canfor / Licella in Canada, Clariant Sunliquid®
- Integrated economics are not favorable at present Biofuels exist today where mandates and/or tax incentives are in place
 - Technologies generally work, mandates to incentivize investments exist (e.g. RFS, LCFS)
 - Significant regulatory challenges negatively impact economics and thus limit interest

What about chemicals / biomaterials?

Volumes needed are orders of magnitude lower than fuels demand

The need for low-cost biofuels and bioproducts from sustainable resources is intensifying



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Technical solutions exist today at demonstration level





Current state to achieve biofuels at scale?

- <u>Thermochemical</u> processes: showing increasing promise in prototype projects
- <u>Biochemical</u> conversions: recent plant closings suggest operating costs and capital requirements have to-date negatively impacted competitive economics
- <u>Wood to sugars</u> (+ lignin coproducts): longer-term solution
- Wood to <u>biointermediates</u> (e.g. bio-oil / bio-crude) require downstream conversion to biofuels
- <u>Rule of thumb</u>: If the solution does not have positive economics with zero cost biomass, it's unlikely to scale commercially





CLOSTRIDIA TO FERMENT SYNTHESIS GAS PRODUCED FROM CELLULOSIC BIOMASS BY ESTABLISHED GASIFICATION TECHNOLOGIES, INTO A RANGE OF ADVANCED BIOPRODUCTS



We target drop-in fuels, fuel additives, and chemical building blocks with a \$14Bn US market.

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ABOUT NEW TECHNOLOGIES

Considering a vision for a **future bio-economy** in Southeast GA:

- Feedstocks (Wood waste, Municipal Solid Waste, forest residues, mill residues and more)
- **Products** (bio-fuels, bio-chemicals, bio-crude, bio-plastics, Carbon offsets, Biochar)



INCORPORATION INTO USEEIO

numI-> Number of industries numC-> Number of commodities/goods numE-> Number of environmental indicators





We can:

- Change % of substitution of current industry by new bio-product
- Identify the Climate Change Impacts (through GHG) for the new commodity/good (biofuels) and for the economy in a future where this industry exists