Enabling NET ZERO
Meeting the Global Demand for Sustainable Aviation Fuel & Low Carbon Bioproducts
About GranBio

We use residual biomass as feedstock to capture CO₂ from the atmosphere and convert it into low carbon 2G sugar intermediates, biofuels, biochemicals and advanced bio-materials to reduce fossil products dependence and reverse climate change.

GranBio is a cleantech leader and pioneer company with over 200 global granted patents and over 150 patents pending*. The Company builds and operates biorefineries and licenses its proprietary renewable technologies to enable customers to reach their decarbonization and Net Zero emission objectives with the whole green barrel approach.

GranBio also enables production, storage and treatment of various lignocellulosic biomass types as feedstock to biorefineries at large scale.

Unique 2G ethanol & lignin dedicated operating plant
Owner of the two most competitive biomass cracker technologies
+50 people involved in R&D, JDA’s, and strategic alliances
+15 commercial collaborations in nanocellulose to create NetZero renewable materials
Global presence. Plants and research facilities in the United States and Brazil

* Valuation according to Investment Value Criteria: USD1.7 Billion 2021 by PeakValue IP
GranBio has developed one of the world’s largest portfolio of renewable technologies to address the world’s hardest to abate sectors.

Biomass
Forest industry Residues, agricultural wastes, etc.

Thermo-Mechanical Fractionation

GP+®

AVAP®

Chemical Fractionation

AVAPClo®

2G Fermentation

Cellulosic Ethanol

SAF Renewable Diesel

Gasoline Blending

SAF Renewable Diesel

n-butanol

Biochemicals

Proteins

2G Sugars

BioPlus®

NDC®

ButaBio™

Nanocellulose Dispersion Composite

BioMatrix™

Nanocellulose Carrier Powder

Nanocellulose

Tires

Automotive Plastics

Cosmetics

Cement

Adhesives

Building Materials
Our Current Operations in Brazil and USA
Our production and R&D sites support our expansion plan.

BioFlex I – GranBio’s Cellulosic Ethanol Plant in Alagoas, Brazil

Thomaston Integrated Pilot and R&D center in Georgia, USA
GranBio’s widely patented AVAP technology utilizes the “Whole-Barrel” biorefinery approach, addressing different markets from different biomass components.

The AVAP Technology enables a profitable biorefinery in part because it produces a series of valuable products including:

- Low-volume, high-value nanocellulose products (e.g., NDC) together with high-volume commodity liquid fuels at reasonable scale and attractive cost levels
- Biochemicals from 2G sugars
Feedstock Flexibility
Wide-variety of abundant, low-cost feedstock.

Abundant Biomass Feedstock Utilization

- More than 17 different types of biomass have been extensively processed and proven at the AVAP integrated Pilot Plant in Thomaston R&D Center during the last 12 years
- Allows utilization of the wide variety of cellulosic biomass sources available throughout the United State (1-billion tons per DOE)
- Through a separate DOE-funded project, AVAPCO has shown that residual low-cost, woody-biomass alternatives can significantly reduce the price of SAF by up to 30%

Advantages of Woody Biomass

- Established harvesting & delivery industry and infrastructure
- High density provides low transportation cost
- Low sand and dirt content
- Year-round harvesting
- Dense structure & mechanical stability for feeding process equipment
Enabling Net Zero

Key Project Highlights.

1. Capacity
   ~2Mmgal per year of SAF and renewable diesel and 6,600 tons/year of NDC\(^1\)

2. Start-Up Date
   expected Q3 2026

3. Feedstock
   Forest industry residues with agricultural residues campaign

4. GHG Reduction Potential
   Carbon neutral with potential for carbon negative SAF, depending on final facility configuration\(^2\)

5. Location
   Both shuttered and operating pulp and paper mill sites within the US are under consideration

6. AVAP Technology
   Globally patented technology with third-party determination of Freedom-to-Operate. Previously developed and demonstrated at integrated pilot scale

7. ETJ partnership with UOP Honeywell
   Top-tier partner with “make-it-right” process guarantee

8. 100% Replacement SAF Production
   SAF with aromatics will be produced for engine testing to support ASTM approval of ATJ SKA#2 full replacement fuel pathway

9. DOE grant funding
   US$ 80m under a cost-sharing arrangement

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1. A small NDC production campaign of 750 tons will be run during 16-month DOE demo period
2. LCA for various facility configurations and feedstock performed by Michigan Tech
## ENZ Project Schedule

### Phase 1
- **Development**
  - Finalize cost share financing
  - Finalize off-take contracts
  - Hire staff

### Phase 2
- **Execution**
  - Permitting
  - Detailed Engineering
  - Procurement
  - Construction

### Phase 3
- **Operation**
  - Commissioning
  - Start-up
  - Ramp-Up
  - Operation at steady state
  - Product Sales

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
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</thead>
<tbody>
<tr>
<td>2023</td>
<td>Development</td>
<td>Execution</td>
<td>Operation</td>
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<tr>
<td>2024</td>
<td>Finalize cost share financing</td>
<td>Permitting</td>
<td>Commissioning</td>
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<tr>
<td>2026</td>
<td>Finalize off-take contracts</td>
<td>Detailed Engineering</td>
<td>Start-up</td>
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<tr>
<td>2027</td>
<td>Hire staff</td>
<td>Procurement</td>
<td>Ramp-Up</td>
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<tr>
<td></td>
<td></td>
<td>Construction</td>
<td>Operation at steady state</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Product Sales</td>
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Third-Party Life Cycle Analysis: Net Zero AVAP SAF

Current LCA modeling by Michigan Tech shows AVAP-enabled SAF from forest biomass is capable of NET ZERO and carbon negative emissions, even at ENZ demo scale.

Life Cycle Emissions
\[ \text{gCO2e/MJ} \]

- Conventional Jet Fuel: 89
- ETJ- Corn Grain (USA): 91
- ETJ- Corn Grain (USA) w/ Carbon Capture: 57
- ETJ- Sugar Cane (Brazil): 31
- HEFA- Tallow: 23

*Critical parameters include heat integration, forest biomass type, and excess electricity to grid from combined cycle biomass power production.

Low Carbon 2G Sugars for Biochemical Conversion
GranBio’s 2G sugars offers significant advantages over first generation sugars in terms of carbon foot-print (that will enable a market premium) and production cost (resulting from low-cost residual biomass).

**AVAP 2G Sugars “Cradle-to-Gate” Carbon Intensity**

- The GHG emissions (g CO2eq/kg sugar) from AVAP 2G sugar production using forest residuals are 95% less than corn dextrose sugars\(^{(1)}\)

<table>
<thead>
<tr>
<th></th>
<th>Biomass (Feedstock)</th>
<th>Biomass (Boiler Fuel)</th>
<th>Chemicals</th>
<th>Electricity Credit</th>
<th>Total AVAP Sugars</th>
<th>Total Corn Dextrose Sugars (Literature Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential (g CO2eq per kg sugar)</td>
<td>60</td>
<td>15</td>
<td>58</td>
<td>-88</td>
<td>45</td>
<td>900</td>
</tr>
</tbody>
</table>

Notes: (1) LCA performed by Michigan Tech;
SAF Market Drivers
Market timing is unique: worldwide regulatory mandates & consumers’ decarbonization objections are driving a strong SAF demand of 450 million tons per year by 2050.

Global Aviation long-term goal to Net Zero CO2 emissions

Global SAF Mandates

2022 US SAF Grand Challenge Goals

3B gallons annually
By 2030

35B gallons annually
by 2050

2023 EU SAF Mandate (ReFuelEU)

Minimum share of supply of sustainable aviation fuels

Several SAF technologies are competing to be the key pathway

SAF can be obtained through different production methods and associated technologies. Currently, HEFA (refining oils into SAF through hydrogen) is leading the pack – but cannot meet future demand needs due to feedstock limitations.

Sources: Commercial Aviation Alternative Fuels Initiative (CAAFI). Business press. ICF
Increasing Shift from Petrochemicals to Biochemicals

Today 95% of all manufactured goods are made from fossil-fuel derived petrochemicals. Demand for more sustainable chemical products is increasing as product manufacturers are faced with environmental and societal pressures.

**Petrochemical Industry Trends**

- The chemicals industry represents 4% of global CO₂ emissions and is also the largest industrial consumer of hydrocarbons worldwide, utilizing them as process feedstock and for process energy.
- Many multi-national chemical companies have stated commitments to achieve NET ZERO by 2050.

**Biochemicals Solutions**

- Biochemicals produced from bio-based feedstocks are estimated to replace 43% of petrochemicals by 2050.
- New manufacturing approaches based on bio-based feedstocks offer a pathway for a large portion of the chemical system to become a “carbon sink”, absorbing more CO₂ than is produced.
GranBio’s Proven Biochemicals from AVAP 2G Sugars
AVAP sugars have been converted to a variety of biochemicals with performance equivalent to dextrose.

**Ethylene**
- Market Size: $140 billion/yr US$; CAGR +6%
- Applications: PE polymers; building block for many downstream chemicals and materials
- Producers: Large oil and chemical companies, using natural gas or naphtha from crude oil

**Succinic Acid**
- Market Size: $0.5 billion/yr US$; CAGR +7%
- Applications: Chemical building block used in the manufacture of polymers, plasticizers, and pharmaceuticals
- Producers: Global chemical companies, using hydrogenation of maleic anhydride derived from crude oil

**Lactic Acid**
- Market Size: $4 billion/yr US$; CAGR +9%
- Applications: Polylactide (PLA) polymers, a sustainable and renewable plastic that competes with PET and others
- Producers: Cargill, Corbion, ADM

**Butanediol (BDO)**
- Market Size: $7 billion/yr US$; CAGR +9%
- Applications: Polytetrahydrofuran and polybutylene terephthalate; performance polymers; engineering plastics
- Producers: BASF and many Asia players, using crude oil; Cargill plant in USA will use corn sugar fermentation to BDO

**n-Butanol**
- Market Size: $3.5 billion/yr US$; CAGR +5%
- Applications: Solvents; building block for acrylates and methacrylates, coating resins, and butyl carboxylates
- Producers: Fragmented market; conventionally produced from hydroformylation/hydrogenation of propylene

Source: GranBio (internal)
BioPlus Nanocellulose for Tires
GranBio has developed and scaled a drop-in nanocellulose product (NDC™) that reduces the fuel consumption and increases the renewable content of tires.

BioPlus Nanocellulose Advantages

▪ Replacement for reinforcing carbon black and silica currently used in tire rubber compounds which have sustainability, rolling resistance and processing challenges
▪ Low rolling resistance / high fuel economy
▪ Renewable: most abundant polymer in nature
▪ Patented lignin-coated form is a UV absorber & anti-oxidant to displace petrochemical based products used for these functionalities in tires
▪ High processability
▪ Low GHG emissions associated with production

Nanocellulose Dispersion Composite™ (NDC) Advantages

This solid rubber masterbatch product allow tire manufacturers to easily dose precise, highly dispersed nanocellulose into rubber compounds during manufacturing.

▪ Drop-In
▪ No compounding process or equipment modification required
▪ Dust-free handling of nanomaterials
▪ Easily cut, weighed, and dosed
▪ Highly concentrated pre-dispersion of discrete nanoparticles / prevents agglomeration that can deteriorate performance

Tire rolling resistance accounts for up to 30% of a vehicle’s fuel consumption and CO2 emissions
### Example Performance in Rubber

Performance in truck tire formulation with 20% NC in place of carbon black:

<table>
<thead>
<tr>
<th>Property</th>
<th>Change with 20% NC</th>
</tr>
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<tbody>
<tr>
<td>Dispersion Quality</td>
<td>Maintained</td>
</tr>
<tr>
<td>Fuel Economy</td>
<td>+20%</td>
</tr>
<tr>
<td>Stiffness</td>
<td>Maintained</td>
</tr>
<tr>
<td>Strength</td>
<td>Maintained</td>
</tr>
<tr>
<td>Abrasion Resistance</td>
<td>Maintained</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>Maintained / Slightly improved</td>
</tr>
<tr>
<td>Light weighting</td>
<td>~1%</td>
</tr>
</tbody>
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NDC Development Trajectory

- 2015: BioPlus Nanocellulose Pilot Line Start-Up
- 2016: Nanocellulose Sampling to Birla Carbon
- 2017: NDC Laboratory Development
- 2018: JDA Signed between GranBio & Birla Carbon
- 2019: $7.3M grant for SAF & Nanocellulose Masterbatch Pilot from DOE
- 2020: Batch Pilot Trials
- 2021: Continuous Pilot Trials
- 2022: P3Nano Scale-Up Grant
- 2023: USDA Wood Innovations TEA Grant

2 NDC patents granted and 26 pending globally

$80 million grant for SAF & NDC Demo Plant
Commercial Rollout Schedule & Targets

The construction of the first commercial scale plant will lead to a broader rollout. The business plan envisions 10+ plants to be built over the next 15 years.

Plant commissioning schedule

SAF Production
MMgal/year

NDC Production
Ktons/year

2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040

2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040