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## Revolutionizing Sustainable Aviation: Investing in the Future with BioButanol and Hydrogen at The Community BioRefinery

### *Introduction*

Aviation is a major contributor to global carbon emissions, accounting for 2% of CO<sub>2</sub> emissions and 12% of transportation-related CO<sub>2</sub> emissions. As we aim for net-zero carbon emissions by 2050, the aviation industry is under immense pressure to transition to more sustainable practices. Sustainable Aviation Fuel (SAF) stands out as a pivotal solution to this challenge, promising significant reductions in greenhouse gas emissions. The Community BioRefinery (CBR) is leading this transformation, pioneering next-generation biofuels such as bio-butanol and hydrogen. This article explores CBR's groundbreaking approach and invites investors to be part of the future of sustainable aviation.

### *Historical Context*

To appreciate the importance of this work, it is useful to look back at two key figures in aviation fuel development: Sir Frank Whittle and Chaim Weizmann.

- **Sir Frank Whittle (1907-1996):** An English aviation engineer and inventor, credited with developing the jet engine and pioneering aviation fuel necessary for jet propulsion. His work laid the foundation for modern jet aviation and influenced the evolution of aviation fuel. Whittle's interest in alternative fuels began during the early development of the jet engine when he recognized the need for high-energy fuels that could withstand extreme conditions. His work during World War II and subsequent years set the stage for modern aviation fuel research, influencing the design and development of biofuels that would come much later. Whittle's legacy in fuel innovation provides a historical context for CBR's modern advancements in bio-butanol and hydrogen.
- **Chaim Weizmann (1874-1952):** A Belarusian-born chemist known for developing the Acetone-Butanol-Ethanol (ABE) fermentation process during World War I. Weizmann's background as a chemist and his innovative work in bacterial fermentation led to the production of acetone, butanol, and ethanol from renewable plant starches. His contributions were crucial for the British war effort, particularly in providing the sustainable aviation fuel (SAF) of the day for airplanes, which played a significant role in enhancing the high performance and efficiency of the fighter aircraft during the war.

The ABE fermentation process, initially discovered in the early 20th century, produces bio-butanol. Weizmann's advancements made bio-butanol a viable alternative to fossil fuels, crucial during WWII for producing high-energy fuels for high performance, piston driven engines. The British Royal Air Force (RAF) required large quantities of acetone for the production of cordite, a smokeless propellant used in munitions. Butanol, a byproduct of the process, found its use in various industrial applications, including as a fuel for jet engines. The high energy content and stability of butanol made it a valuable component in the development of fuels that could meet the

rigorous demands of early jet propulsion technology. Weizmann's work laid the groundwork for the development of biofuels, including bio-butanol, which CBR is advancing today.

## **Sustainable Aviation Fuel (SAF): An Overview**

SAF is an alternative fuel, either petroleum jet fuel blended with a renewable alcohol, or, one that is 100% derived from non-petroleum feedstocks that significantly reduces emissions from air transportation. The alcohol level of a derived blend can be blended with conventional jet fuel in varying proportions, with blend limits typically between 10% and 50%.

### **Key Benefits of SAF:**

- **Engine and Infrastructure Compatibility:** Can be used in existing aircraft and infrastructure.
- **Reduced Emissions:** Up to 94% reduction in greenhouse gas emissions depending on the feedstock and technology.
- **Flexibility:** Produced from various renewable feedstocks, including municipal solid waste, woody biomass, fats, greases, oils, and other organic materials.

## **The Community BioRefinery's Vision and Innovations**

CBR is the oldest biofuel R&D company in the United States, dating back to the early 1980s. Unlike many biofuel companies focused on ethanol, CBR has pioneered the development of bio-butanol, a superior biofuel with significant advantages over ethanol. With the correct investment, CBR is prepared to “go commercial”.

### **CBR's Circular Economy and Sustainability:**

- Cultivating plants sustainably
- Extracting essential nutrients
- Converting sugars into valuable products
- Recycling and reusing waste materials
- Treating and reusing water

This comprehensive approach ensures that every part of the plant is utilized, maximizing resource use and minimizing waste.

## **Bio-Butanol: An Ideal Next-Generation Advanced Biofuel**

CBR's focus on bio-butanol sets it apart from other biofuel producers. Bio-butanol has several advantages over ethanol, including higher energy content, lower volatility, and better compatibility with existing fuel infrastructure, making it an ideal candidate for SAF.

### **Advantages of Bio-Butanol:**

- **Energy Density:** Bio-butanol has a higher energy content than ethanol, making it a more efficient fuel. The energy density of bio-butanol is approximately 29.2 MJ/L (megajoules per liter), compared to ethanol's 21.1 MJ/L. This higher energy density means that bio-butanol can provide more power per unit volume, improving fuel efficiency and performance in aviation applications.
- **Comparison to Kerosene:** Kerosene, traditionally used as the basis for jet fuel, has an energy density of around 35 MJ/L. While bio-butanol's energy density is slightly lower than that of kerosene, it is significantly higher than ethanol. This similarity in energy density to kerosene makes bio-butanol a

suitable alternative for aviation fuel, offering comparable performance and efficiency. Additionally, like kerosene, bio-butanol has a low freezing point and high combustion stability.

- **Blend Compatibility:** Bio-butanol can be blended with traditional jet fuels at higher ratios without requiring significant modifications to engines or infrastructure. Unlike ethanol, which can only be blended in small proportions with gasoline due to its higher oxygen content, bio-butanol's chemical properties allow it to mix seamlessly with existing fuels. This compatibility reduces the need for costly infrastructure changes and engine modifications, making the transition to bio-butanol as a SAF more feasible and economically viable.
- **Reduced Emissions:** Bio-butanol has lower greenhouse gas emissions compared to conventional jet fuels. Studies have shown that the lifecycle CO<sub>2</sub> emissions of bio-butanol can be up to 85% lower than those of traditional fossil fuels, depending on the feedstock and production process used. This reduction in emissions is crucial for the aviation industry to meet its sustainability goals and reduce its overall carbon footprint.

## Engine Requirements for Using SAF

Jet engines require fuels with high energy density, low freezing points, and stable combustion properties to operate efficiently and safely. The fuel must also be compatible with existing infrastructure and engine materials to prevent corrosion and wear. Bio-butanol meets these requirements due to its favorable chemical properties:

- **High Energy Density:** Provides the necessary power for long-haul flights.
- **Low Freezing Point:** Ensures fuel remains liquid at high altitudes where temperatures are extremely low.
- **Stable Combustion:** Maintains consistent performance and efficiency, crucial for engine reliability.

## Advanced Bioreactor Technology

CBR's bio-butanol production process involves advanced bioreactor technology that continuously produces bio-butanol and hydrogen. This innovative approach enhances efficiency and ensures a steady supply of high-quality bio-butanol for use in SAF.

- **Continuous Flow Production:** Allows for consistent production rates and improved yield efficiencies, reducing downtime and operational costs.
- **Validation and Verification:** Independently validated and verified by third-party engineering firms, confirming the quality and consistency of CBR's bio-butanol.

## Comprehensive Utilization of Agricultural Feedstocks

The Community BioRefinery addresses the critical "Food vs. Fuel" debate by ensuring that its biofuel production process does not compromise food resources. Instead, CBR's innovative approach maximizes the recovery of food components from feedstocks *first* to create vertically integrated food products, nutraceuticals, and a variety of bio-based products.

### Food and Nutraceutical Recovery:

- **Pure Plant Protein Isolates:** High-purity plant protein isolates containing all essential branched-chain amino acids needed in the human diet.
- **Resistant Starch:** Beneficial for digestive health and used in various food products.
- **High oleic oils**

### Bio-Based Products:

- **Biodegradable Plastics (PLA and PHA):** Environmentally friendly alternatives to traditional plastics.
- **Green Electricity:** Fuel sources from bioreactors used to power fuel cells, producing renewable green electricity, enabling the production facilities to be energy self-sufficient.

#### **Biofuels:**

- **Bio-Diesel and Bio-Jet Fuel:** Derived from agricultural feedstocks and containing zero petroleum, providing a renewable alternative to traditional fossil fuels.

#### **High-Quality Aquaculture Feed:**

- **Aquaculture Feed:** Supports sustainable aquaculture practices by converting plant-based feedstocks into high-quality fish feed.

#### **Hydroponic Vegetables and Berries:**

- **Hydroponic Vegetables and Berries:** Grown using nutrients extracted from feedstocks, benefiting from the internal heat source and organic fertilizer produced within the system.

### **Technological Advancements and Community Impact**

CBR's technological innovations include a cold process, closed system with zero waste, and the ability to isolate pharmaceutical-grade elements. These advancements enable the production of superior products while maintaining environmental integrity.

#### **Community Impact:**

- **Decentralization and Local Development:** Unlike traditional large-scale refineries, CBR's model is decentralized, allowing for the establishment of local biorefineries. This approach reduces transportation costs and emissions, fosters local economic development, and generates many well-paying jobs.

### **Global Implications**

The potential for CBR's model to be replicated globally is significant. By providing a blueprint for sustainable, decentralized production, CBR can help address global challenges such as food security, energy independence, and climate change. This global reach mirrors the impact Whittle had on the aviation industry, positioning CBR as a transformative force in the biofuel sector.

### **Tangible Evidence of Success**

CBR has demonstrated proof of concept and success through various pilot and demonstration projects and independent engineering validations:

- **Case Studies:** Documented successful implementation of bio-butanol production in several pilot projects, showcasing the efficiency and scalability of the technology.
- **Pilot/Demo Project Results:** Positive outcomes from pilot projects that have tested and validated the production process and product quality.
- **Independent Validations:** Third-party engineering firms have rigorously tested and confirmed the quality and consistency of CBR's bio-butanol, ensuring it meets the stringent requirements for SAF.

### **Risk Management**

Addressing potential risks and implementing strategies to mitigate them is crucial for investor confidence:

- **Technological Risks:** Continuous work in R&D to stay ahead of technological advancements and mitigate obsolescence.
- **Regulatory Risks:** Maintaining compliance with current regulations and anticipating future changes by engaging with regulatory bodies.
- **Market Risks:** Diversifying product offerings and establishing strategic partnerships to secure market presence and reduce dependency on a single market segment.
- **Operational Risks:** Implementing robust quality control measures and maintaining flexible production processes to adapt to unforeseen operational challenges.
- **Financial Risks:** Ensuring financial stability through sound fiscal management, securing multiple funding sources, and maintaining a strong balance sheet.

### A Hypothetical

Consider this: The Department of Energy has issued its “Grand Challenge” to come up with ways for 300 *billion* gallons of SAF to be on hand by the year 2050. A nominal Community BioRefineries facility can produce 3 *million* gallons of bio-butanol each year. Therefore, by the year 2050 (in this scenario), Community BioRefineries will need to have sufficient facilities in the U.S. and elsewhere to produce 30 *billion* gallons of bio-butanol to provide the minimum 10%\* renewable alcohol for the 300-billion-gallon requirement/goal. That will require 10,000 CBR facilities to satisfy that single requirement. (\* per the Renewable Fuels Act mandate.)

Considering the rigorous training in traditional business strategies that Harvard Business School graduates experience, one must ponder: how many of these graduates would truly seek to execute an ‘exit strategy’ from a CBR investment?

\* Applying CBR’s bio-butanol as depicted in the hypothetical above requires stretching its bio-butanol production to the max just to satisfy that single goal. What becomes lost in the discussion is that, with the correct biomass components, CBR has the capability to make a 100% complete SAF/bio-jet fuel internally and on-site, just not on the billions of gallons scale.

### Conclusion

Sir Frank Whittle's legacy in aviation fuel development is defined by his ability to improve fuel formulations, enhancing performance and reliability. Chaim Weizmann's contributions to the ABE fermentation process further exemplify the critical advancements in biofuel technology. The Community BioRefinery carries forward this legacy in the biofuel industry, utilizing every component of agricultural feedstocks to produce a diverse range of high-value products. Through its innovative and sustainable approach, CBR is poised to become the new standard in the green economy, much like Whittle and Weizmann were in their times. As the world shifts towards more sustainable practices, the Community BioRefinery's model offers a compelling vision for the future of energy and resource utilization.

**Investment Opportunity:** The Community BioRefinery seeks accredited investors who want to be part of the group building the American green economy, echoing the legacy of those who built the industrial foundation of the nation. By investing in CBR, stakeholders will contribute to a sustainable future, supporting the development of advanced biofuels, eco-friendly products, and local economic growth. Join us in this transformative journey and help shape the green economy of tomorrow.

To learn more, see us at: [www.communitybiorefinery.com](http://www.communitybiorefinery.com)

This missive was created by Vincent James, CBR’s CTO and Scott Hewitt, CBR’s CEO.

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