Company Profile

• Founded in January 2005
• Corporate Headquarters in Chicago, IL, R&D in New Zealand, Operations and BD office in China and India
• Funding
  – Series B: Qiming Ventures - $US 18M in 2010
• Team
  
  **CEO: Dr. Jennifer Holmgren**
  **CSO/Founder: Dr. Sean Simpson**
  – Over 145 staff
    – Synthetic Biology
    – Analytical
    – Engineering
• IP Portfolio
  – 71 patents granted, 218 patents pending
  – 2 proprietary microbe families
  – 15 synthetic biology families
The LanzaTech Process

Novel gas fermentation technology captures CO-rich gases and converts the carbon to fuels and chemicals

- Gases are sole source of energy
- Production of fuels and chemicals
- Potential to make material impact on the future energy pool (>100s of billions of gallons per year)
- Completely outside of the food value chain
- Biofuel, carbon capture and energy efficiency technology solution
Accessible Feedstocks

- **Pet Coke**
  - Global: ~130M MTA

- **Natural Gas**
  - Global: 184.2T M³

- **Flue Gases**
  - Global: 1.4 B Tons Steel

- **Biomass**
  - Global: >2B MTA

- **Solid Waste**
  - Global: >1B MTA US Alone

**CO₂ + H₂ → CO + H₂**

- **Available**
- **Non Food**
- **High Volume/Low Intrinsic Value**
- **Most Point Sourced**
- **No Need to Develop Dedicated Feedstock Production Infrastructure**

Novel Approach to Biofuels and Chemicals

**Portfolio of Options**

- **Biochemical Conversion**
  - Sugars
    - Fermentation
    - Separation
    - Alcohols, Chemicals

- **Gas Fermentation**
  - Industrial Waste Gases (CO, CO₂/H₂)
    - Fermentation
    - Separation
    - Alcohols, Chemicals
    - Catalytic Conversion
      - Gasoline, Diesel, Jet
      - Alcohols, Chemicals

- **Thermochemical Conversion**
  - Lignin, Cellulose, Hemicellulose
    - Gasification
      - Syngas
        - Fischer Tropsch
        - Alcohol Synthesis
        - Gasoline, Diesel, Jet
    - Fast Pyrolysis
      - Liquid Bio-Oil
        - Catalytic Upgrading
        - Gasoline

- **Lipid Conversion**
  - Algae
    - Oil Extraction
      - Trans-esterification
        - FAME, FAEE
      - Hydrotreating/Hydrocracking
        - Diesel, Jet
  - Natural Oils
LanzaTech Gas to Liquid Platform

Resources
- Industrial CO
- Syngas: Biomass, Coal, Methane
- COG, Chemical H₂
- Power CO₂

Customized Catalysts
- Native
- Synthetic

Engineering Control Chemistry

Product Suite
- C₂
  - Ethanol
  - Acetic acid
- C₃
  - i-propanol
  - acetone
- C₄
  - BDO
  - n-Butanol
  - i-Butanol
  - Succinic acid
- C₅
  - Isoprene
- Other
  - PHB
  - ……

Thermochemical Approaches
- Hydrocarbon Fuels (diesel, jet, gasoline)
- Chemical Intermediates
- Olefins
- Chemicals
On a Fast Path to Commercialization

2008
Pilot BlueScope Steel Mill
15,000 Gallons/Year

2012
Pre-Commercial Operational
Shanghai, China
100,000 Gallons/Year

2013
Commercial
In Design

In Design
USA

Pre-commercial
China
100,000 Gallons/Year
Fast Path to Commercial Scale

- Pre-commercial facility in operation in Shanghai for >8 months meeting and exceeding all its performance targets and milestones
- Capacity 100,000 gallon/year ethanol
- Demo has been approved in China by the NDRC

- Operation of additional 100,000 gallon/year plant with second Chinese Partner, Shougang Group, in Beijing
- Sustainability Assessment of Beijing plant currently underway with RSB.

Co-locating LanzaTech’s Technology Steel Mill brownfield sites reduces land footprint, improves economics and reduces construction time.
GHG Savings: Well to Wheel Life Cycle

LanzaTech Steel Mill Gas to Ethanol

50-70% GHG reduction over Petroleum Gasoline

- Based on LCA analyses performed in cooperation with Michigan Technological University and the Roundtable for Sustainable Biomaterials

LanzaTech Biomass Residue to Ethanol

75-85% GHG reduction over Petroleum Gasoline

- Based on LCA analyses performed in cooperation with Michigan Technological University and the Roundtable for Sustainable Biomaterials

GHG footprint is 50-70% smaller than the footprint of petroleum fuels

GHG footprint is 75-85% smaller than the footprint of petroleum fuels
Creating Value through Diversification

<table>
<thead>
<tr>
<th>Industry</th>
<th>Partners/Projects</th>
<th>End User/Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>posco, BAOSTEEL, SIEMENS</td>
<td>virgin atlantic</td>
</tr>
<tr>
<td>Oil/Natural Gas</td>
<td>HARSCO, JINDAL, CHINASTEEL</td>
<td>BOEING</td>
</tr>
<tr>
<td>Coal</td>
<td>IndianOil, PETRONAS</td>
<td>Mitsui, PETRONAS</td>
</tr>
<tr>
<td>Biomass</td>
<td>HNCC, <a href="http://www.ykjtcn.com">www.ykjtcn.com</a></td>
<td>INVIsta</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Freedom Pines Biorefinery</td>
<td>LCY, INVISTA</td>
</tr>
</tbody>
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LanzaTech
Alcohol to Jet (ATJ) Pathway

A novel route to synthetic jet fuel
## LanzaTech US Government Jet Fuel Projects

<table>
<thead>
<tr>
<th>Transportation</th>
<th>Defense</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$3 M</strong></td>
<td><strong>$500 K</strong></td>
<td><strong>$4 M</strong></td>
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### OBJECTIVE
- Accelerate ASTM certification
- Investigate near, long-term integration & deployment opportunities
- Reduce cost of alcohol-derived fuel by lowering ethanol production costs
- Develop hybrid fermentation/catalytic route from biomass-derived syngas to jet fuel & chemicals

### RESOURCE
- Steel mill gases
- Gasified lignin residues
- Steel mill gases
- Gasified corn stover, wood chips, switchgrass

### ALCOHOL CONVERSION
- Swedish Biofuels fully-synthetic ATJ
- Swedish Biofuels SPK & fully-synthetic ATJ processes
- PNNL/Imperium ethanol to jet
- PNNL 2,3-BDO to butadiene

### PARTNERS
- LanzaTech
- Swedish Biofuels
- PNNL
- Imperium
- Michigan Tech
- LanzaTech
- Swedish Biofuels
- Michigan Tech
- LanzaTech
- PNNL
- NREL
- Imperium
- Michigan Tech
- Delaware
- Boeing
Project Objective: develop a cost-effective hybrid conversion technology for catalytic upgrading of biomass-derived syngas to jet fuel and chemicals to meet the price, quality and environmental requirements of the aviation industry.
Freedom Pines Biorefinery, Soperton, GA

Maintenance, Offices, & Warehouse

Demonstration Plant

Biomass Handling

Gasifier

125 dtpd Infrastructure in Place
Freedom Pines Process

- LanzaTech fermentation of biomass syngas
- Handles diverse feedstocks
  - Forest or ag residues, energy crops such as grasses
  - Suitable for mixed feedstocks
  - Enables optimization of harvesting and logistics
- Logging residues from Georgia pine
- New energy crop: giant miscanthus
  - Up to 12 feet tall
  - Up to 20 bushels/acre
  - Propagates without seeding
  - Harvested in winter to minimize water content and nutrient withdrawal
  - Well-suited to region around Freedom Pines
A Sensible Path…

Waste for Energy

Aligns:
- Industrial Growth
- Energy Security
- Energy Efficiency

Allows:
- Land
- To Produce Food
- For People