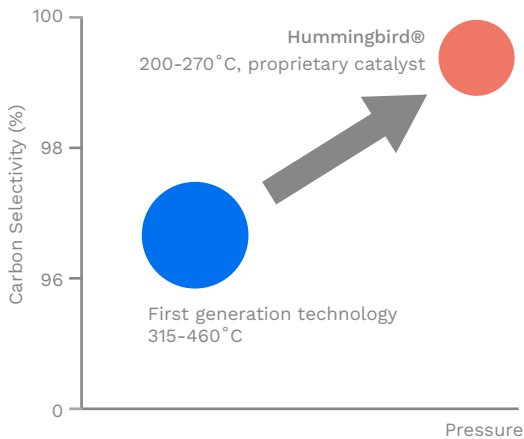


# Boost the Value of your Ethanol

Hummingbird® technology offers ~2% greater Carbon selectivity compared to First Generation technologies resulting in a higher ROI



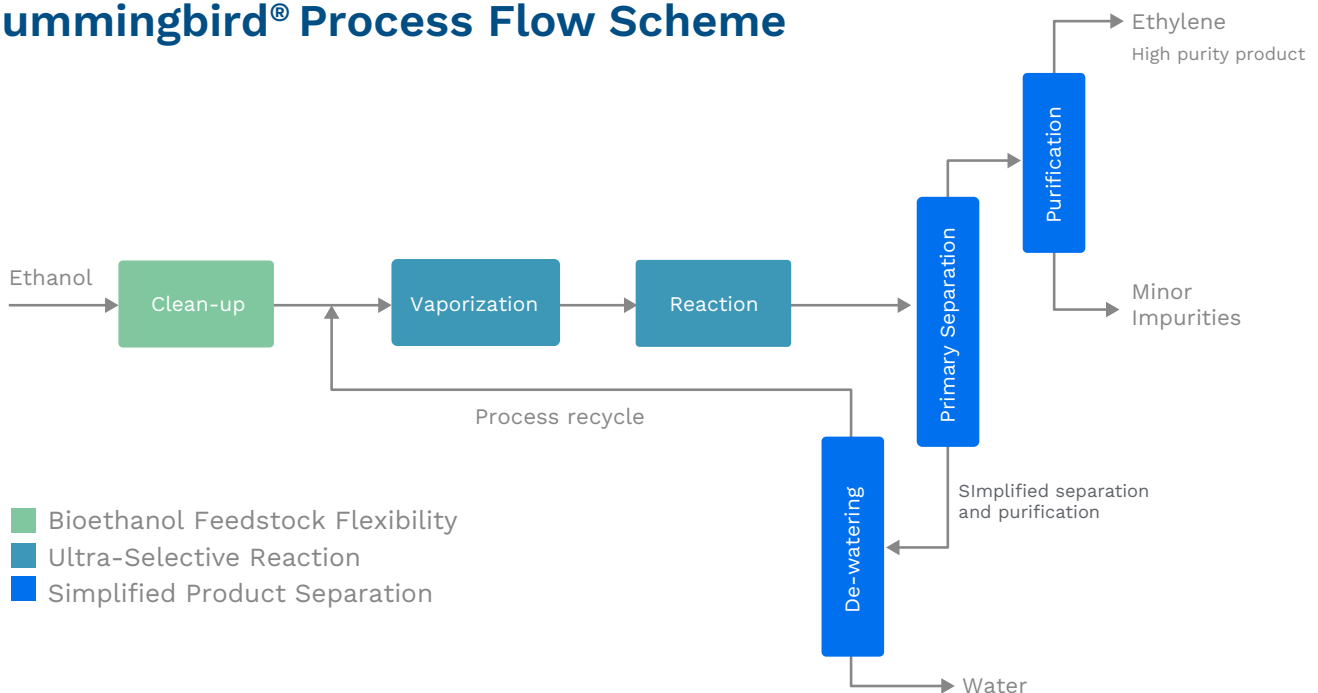
## Sustainable Ethylene Production

The Hummingbird® technology is a second generation, low-cost process for dehydrating ethanol to ethylene. The technology uses a proprietary heteropolyacid (HPA) supported catalyst, operating at a lower temperature, higher pressure, and higher selectivity than first generation processes. The Hummingbird technology features enhanced ethanol feedstock flexibility. Hummingbird produces polymer grade ethylene with over 99% selectivity.

## Benefits of Hummingbird technology

- Higher Selectivity
  - No C2 Splitter
  - No Fired Heater
  - No Caustic Wash Tower
  - No Stripping Column
- Increased Revenue
  - Lower CAPEX
  - Robust Design
  - Feedstock Flexibility

## Hummingbird® Process Flow Scheme



- Bioethanol Feedstock Flexibility
- Ultra-Selective Reaction
- Simplified Product Separation

# Sustainable Aviation Fuel - Alcohol-to-Jet



## Advantages

- An ASTM certified SAF production pathway
- Ethanol feedstock flexibility – ability to process multiple ethanol grades
- Ultra selective reaction converting >99% of carbon in feedstock to fuels
- On-stream product flexibility with ability to vary ratio of SAF and renewable diesel as per demand
- High reduction in carbon footprint as compared with conventional jet fuel production.

## Application

An ASTM certified technology pathway producing sustainable aviation fuel (SAF) as is a drop-in replacement for conventional jet fuel. As per current approvals, a blend of up to 50% AtJ SAF is permitted – however, approvals to allow for up to 100% AtJ SAF are underway.

## Technology Ownership

The LanzaJet ATJ™ technology for producing SAF is an integrated technology licensed by LanzaJet that combines Technip Energies' proprietary Hummingbird® ethanol to ethylene technology and LanzaJet's ethylene to jet technology.

## References

2024: 10 million gallons/year - Freedom Pines, Georgia, USA

**A commercially proven, sustainable technology with >99% carbon efficiency that converts low-carbon, bioethanol into sustainable aviation fuel (synthetic paraffinic kerosene) and renewable diesel in a continuous process.**

The first step of the integrated technology is a simple and low-cost ethanol dehydration step to produce ethylene using a proprietary catalytic process that can process a variety of ethanol grades. In the second step, the ethylene is oligomerized through a catalytic process to produce up to 90% sustainable aviation fuel (SAF). The balance is renewable diesel (with flexibility to alter the ratio of the products) which is separated from SAF through fractionation.

