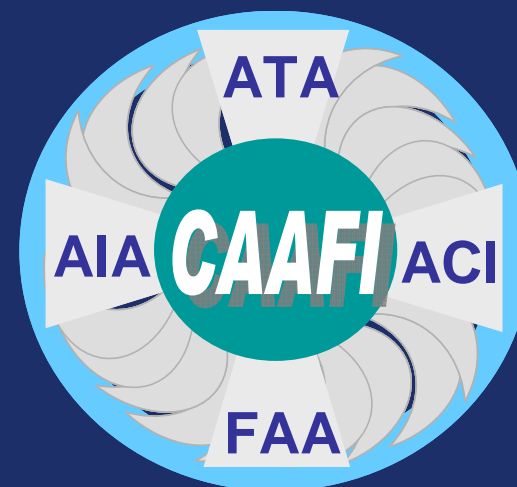


Aviation Alternative Fuels... Characterizing the Options



WWW.CAAFI.ORG

Presented to: ICAO Alternative Fuels Workshop
Session 2: Overview of the Potential Options
for Alternative Fuels
Montreal, Canada

By: Richard L. Altman
Executive Director,
Commercial Aviation Alternative Fuels Initiative
(CAAFI) -

Date: 10 February 2009

Overview of Alternative Aviation Fuel Options

Piet Roets – Sasol – CTL

SynFuels Consortium – GTL

- Mohammed Turki Al Sobai - WOQOD (Qatar Fuel)
- Capt. Chris Schroeder - Qatar Airways
- Phillipe Fonta - Airbus

Paul Bogers – Shell – BTL/XTL

Bill Wason – CO2 Star, Brazil – Biofuel facility designer

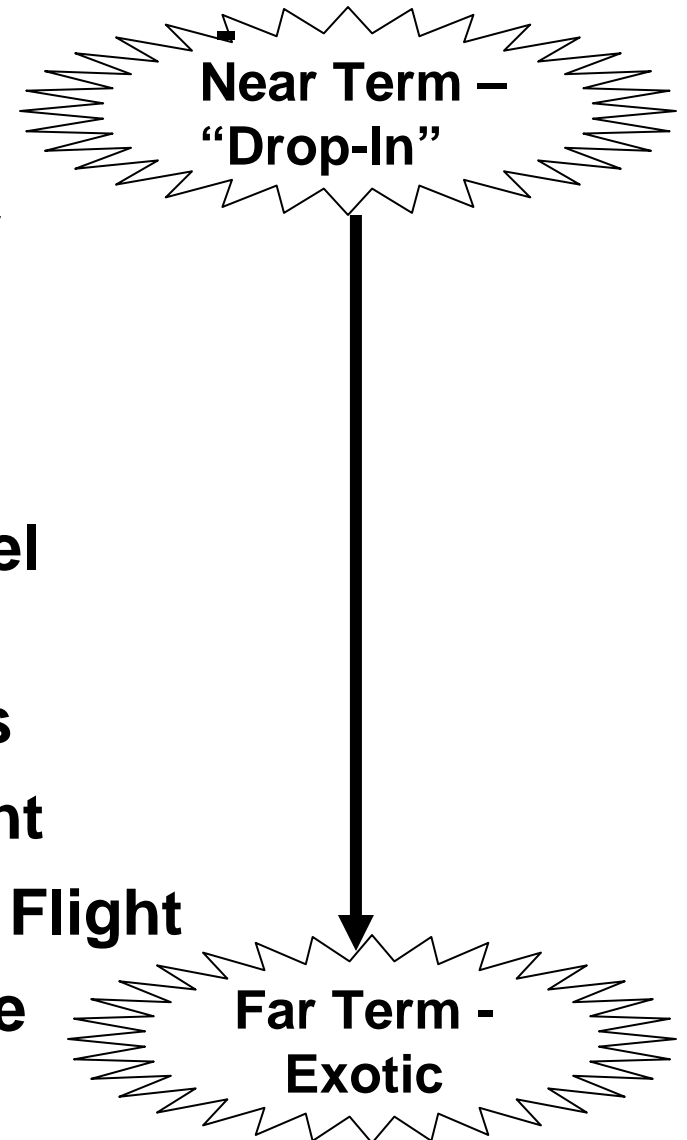
Jennifer Holmgren – UOP – HRJ fuels

Leah Raney – Continental – HRJ Flight

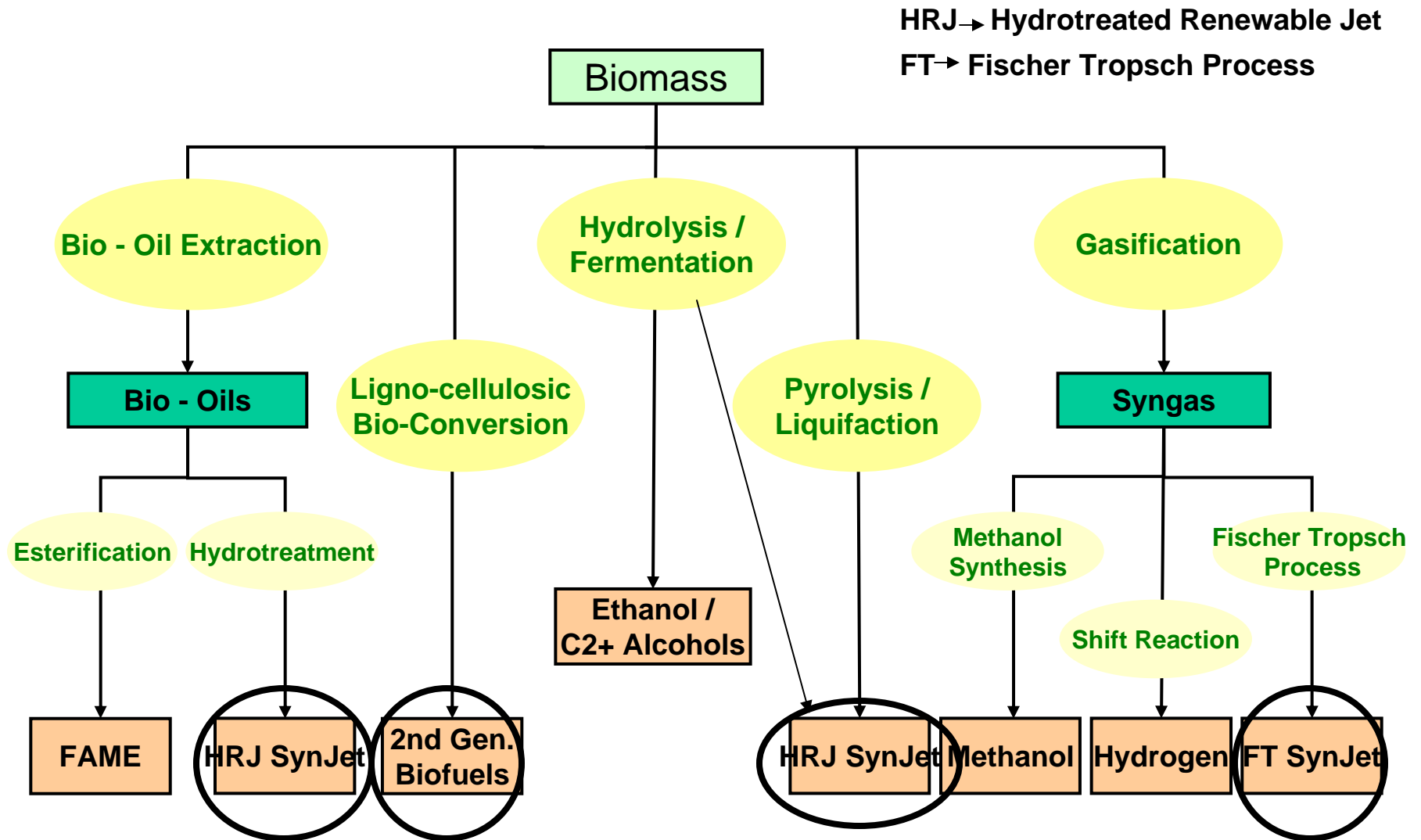
Yasunori Abe – Japan Airlines – HRJ Flight

Brian Goodall – Sapphire – HRJ Algae

Fayette Collier – NASA - Far Term



Aviation “Drop-in” Fuels Near to Mid Term

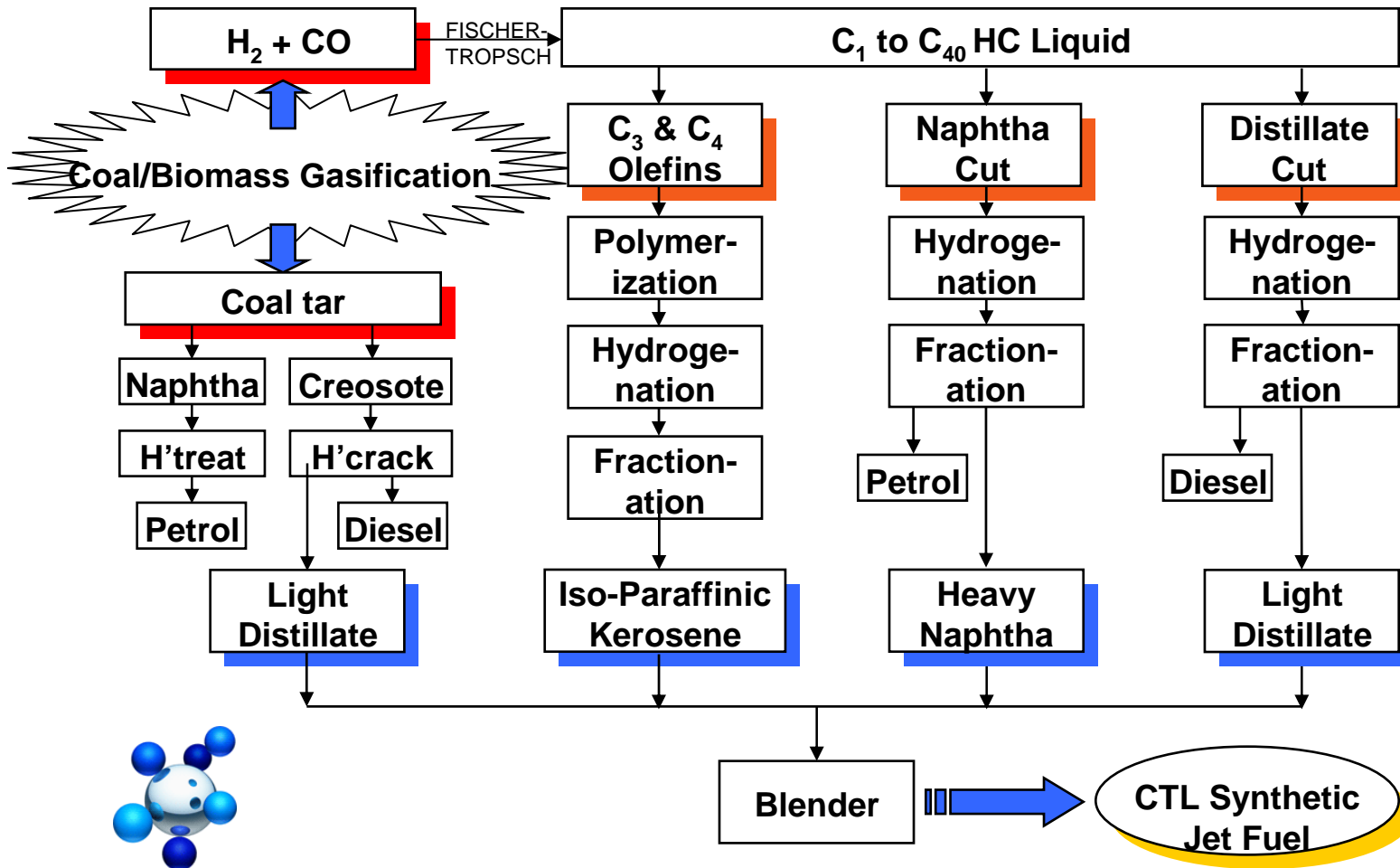


○ Present “Drop-in” Options Examined by CAAFI Sponsors/Stakeholders for carbon positive Aviation Fuels

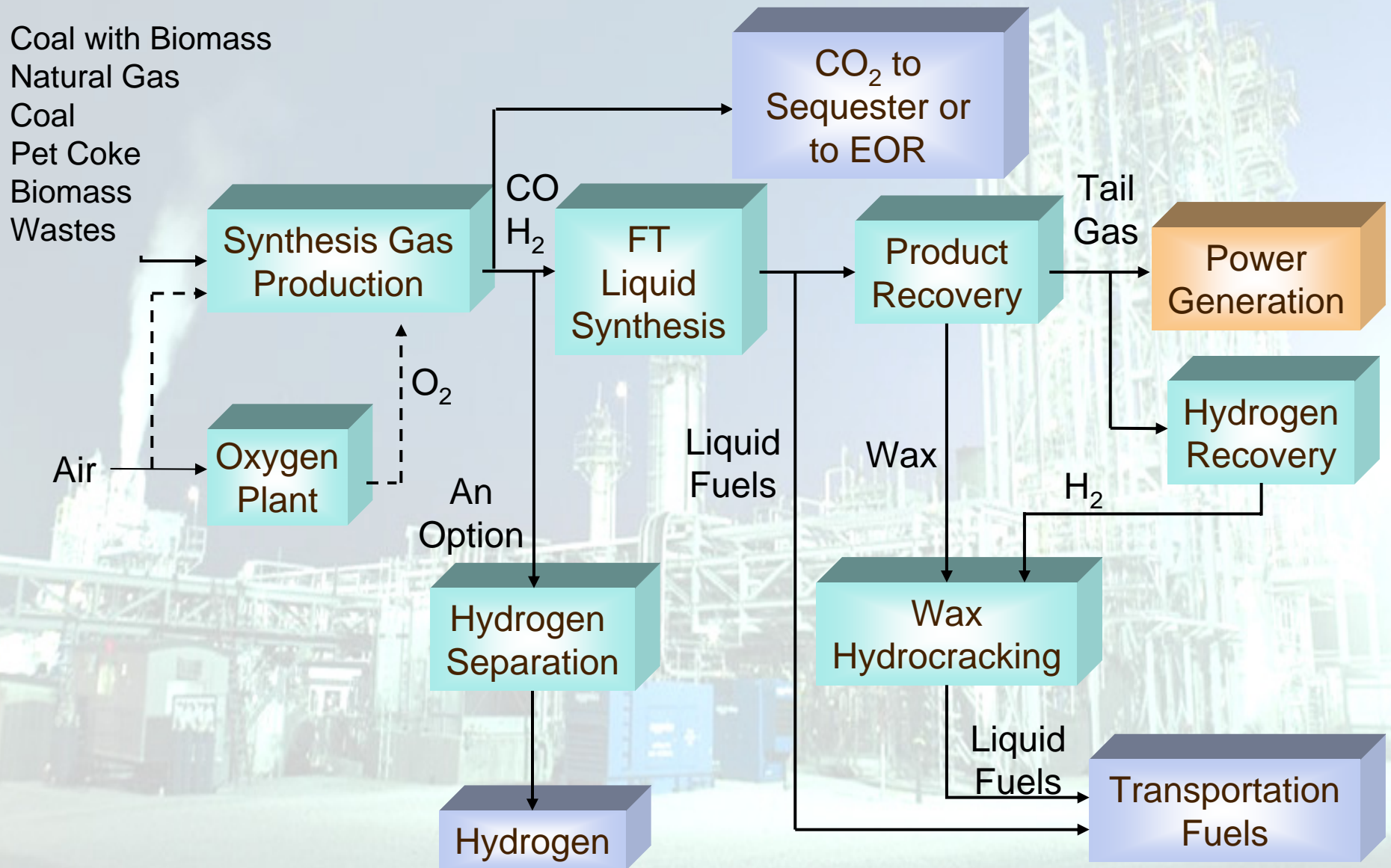
Compliments AirBP – 4/08 Future Fuels Conference, London, England (framework only)

Coal/Bio to Liquid via Fischer Tropsch Process

Approach dates back to 1920's



Fischer Tropsch Product, Co-product Opportunity



SynFuels Consortium Formed November 07'



Investigates synthetic fuel effects on:

- The global environment**
- Local air quality**
- Fuel burn**

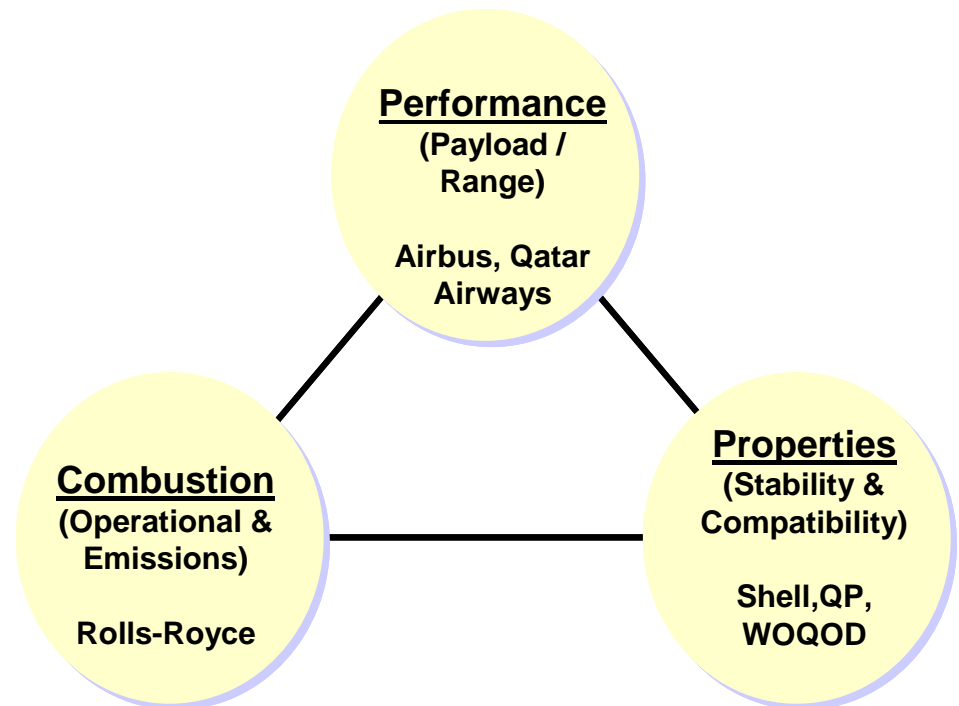
Graphics Adapted from Paul Bogers, Shell

SynFuels Consortium Formed November 07'

Speakers Include:

- **Qatar Airways** – customer's view, corporate social responsibility
- **Qatar Fuels (WOQOD)** manufacturer's view of a world-scale GTL project
- **Airbus** – Producer of A380 testbed for first flight
- **Shell** – options and challenges in the wider alternative fuels continuum

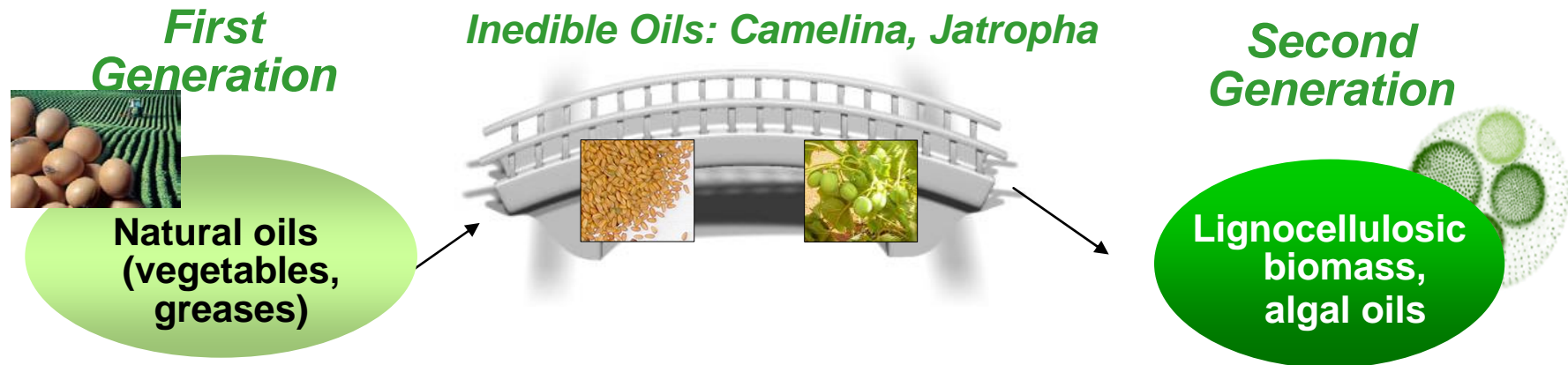
Graphics Adapted from Paul Bogers, Shell



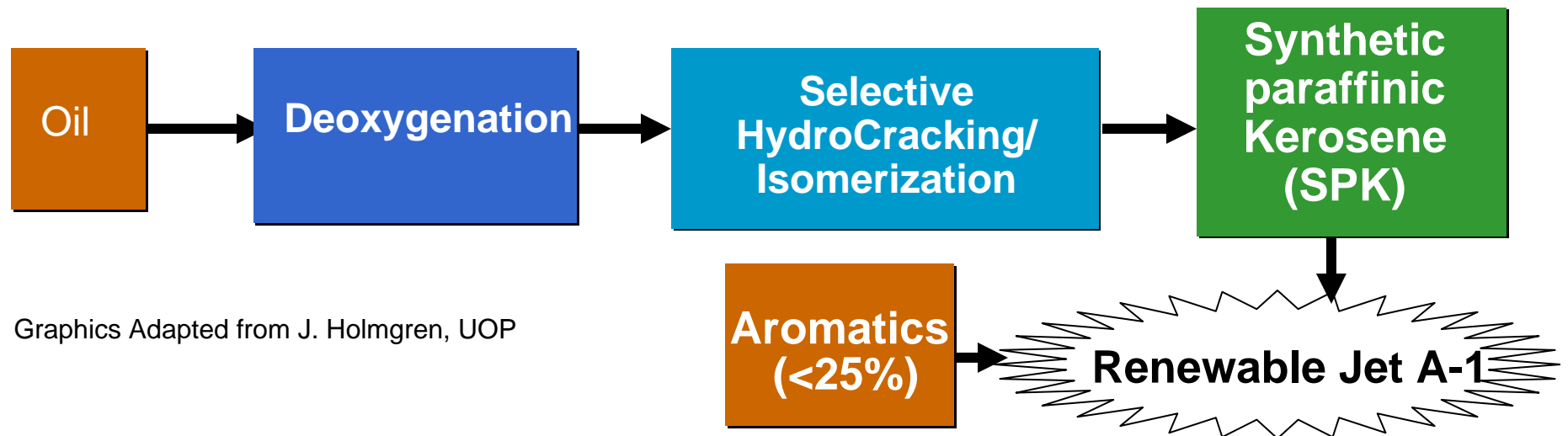
- comprehensive research
- knowledge transfer via the QSTP network
- parametric study of synthetic fuels portfolio not just FT or GTL

Hydrotreated Renewable Jet (HRJ) Processes

Bridging the BioJet Generations.....



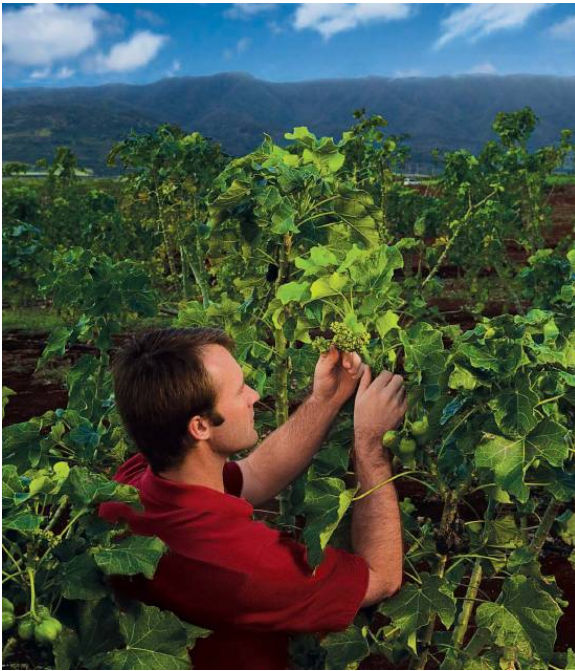
Using Conventional Refining Technology



Graphics Adapted from J. Holmgren, UOP

Hydrotreated Renewable Jet Feedstock Options

Now: Jatropha



- Grows on marginal lands
- Doesn't compete with food

Soon: Salt Water Tolerant Plants



- Doesn't use fresh water
- High oil content

Future: Algae



- Doesn't compete with food or fresh water
- Very high oil content

Three Successful HRJ Biojet Flight Programs*

* Visuals Complement J. Holmgren, UOP



Feedstock:
Jatropha oil

- Successful ANZ Flight Demo
Date: December 30 2008



Feedstock:
Jatropha and algal oil

- Successful CO Flight
Demo Date: Jan. 7 2009



Feedstock: Camelina,
Jatropha and algal oil

- Successful JAL Flight Demo
Date: Jan. 30 2009



Fermentation Process for Jet Fuel

Fermentation-derived Hydrocarbons



Non-food sugar-containing feedstocks

- Sugarcane
- Sweet sorghum
- Cellulosic sugars

Feedstock Processing & Steam/Electricity Generation

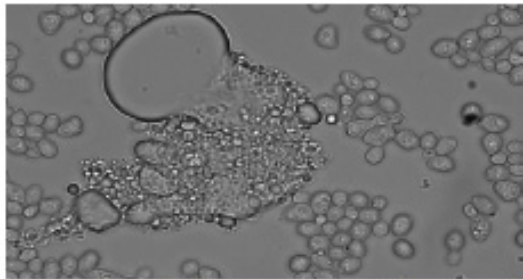
Surplus energy exported to grid

Fermentation

Separation

Finishing

Cost-competitive & sustainable diesel and jet fuel blending components



Microbes Engineered to Excrete HC



Energy Efficient Centrifugation separates hydrocarbons from broth

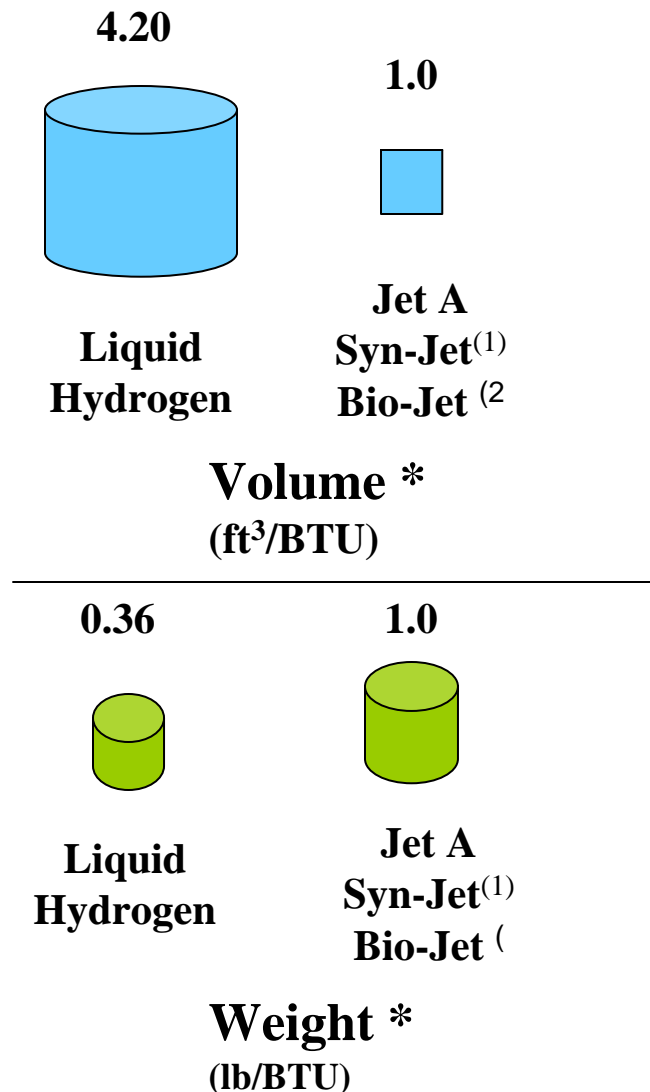
Mature, low temperature/pressure process converts intermediate into final product

Aviation Fuels – Hydrogen Long Term?

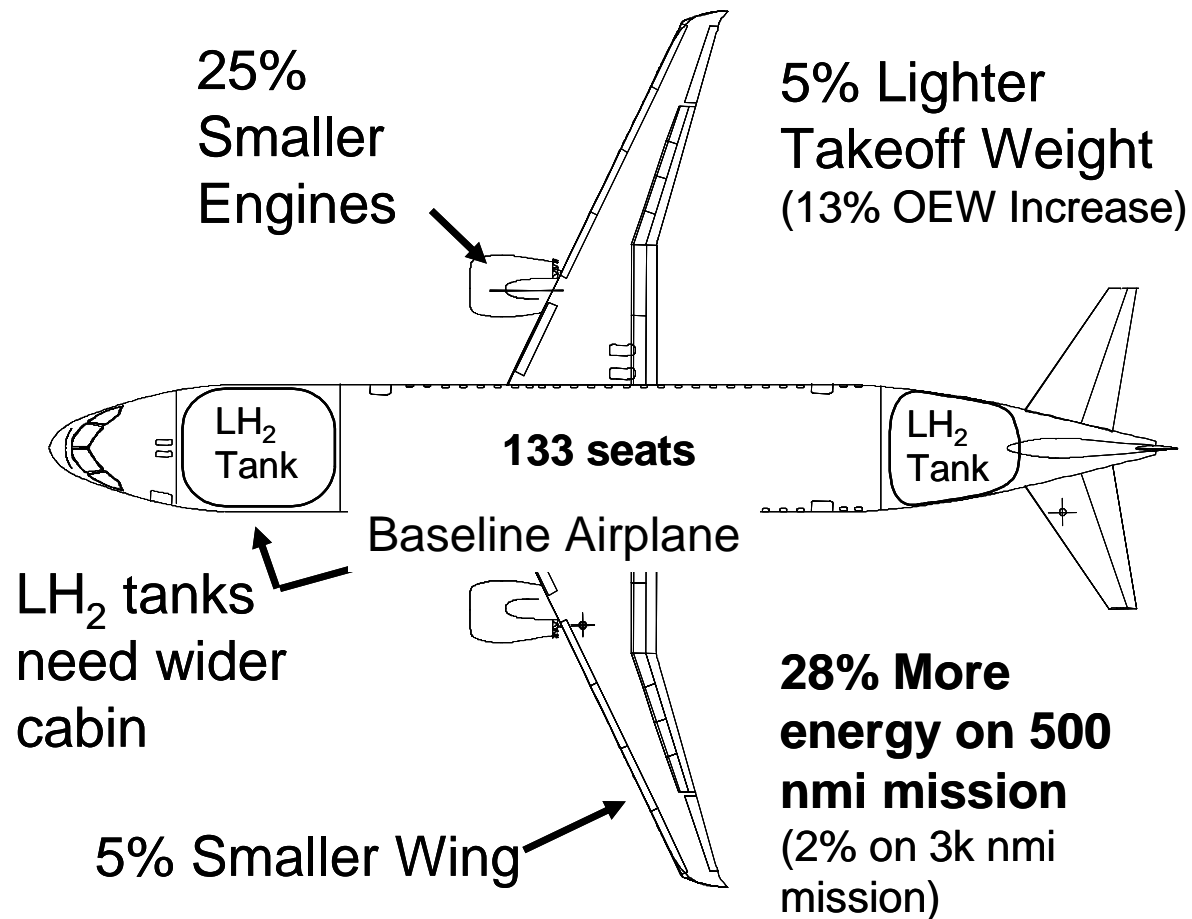
Very Clean burning, but....

- Requires new airport infrastructure (fueling, gates, taxiways)
- Currently CO2 intensive production owing to energy use for Hydrogen production
- New aircraft designs required for missions

** *Analysis Dave Daggett – The Boeing Company, 1.0 = Drop in for current aircraft*



Hydrogen Fuel Implications to Current Designs



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