

Presented by

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## Gas To Liquid (GTL)

A viable precursor to bio-fuels



# Why Alternative Fuels?

- Jet Fuel (Kerosene) is a good fuel for aviation, e.g.
  - ▶ Good energy content (e.g. 60% better than Ethanol),
  - ▶ Low freeze point ( $< -40^{\circ}\text{C}$ ),
  - ▶ Product is reliable.



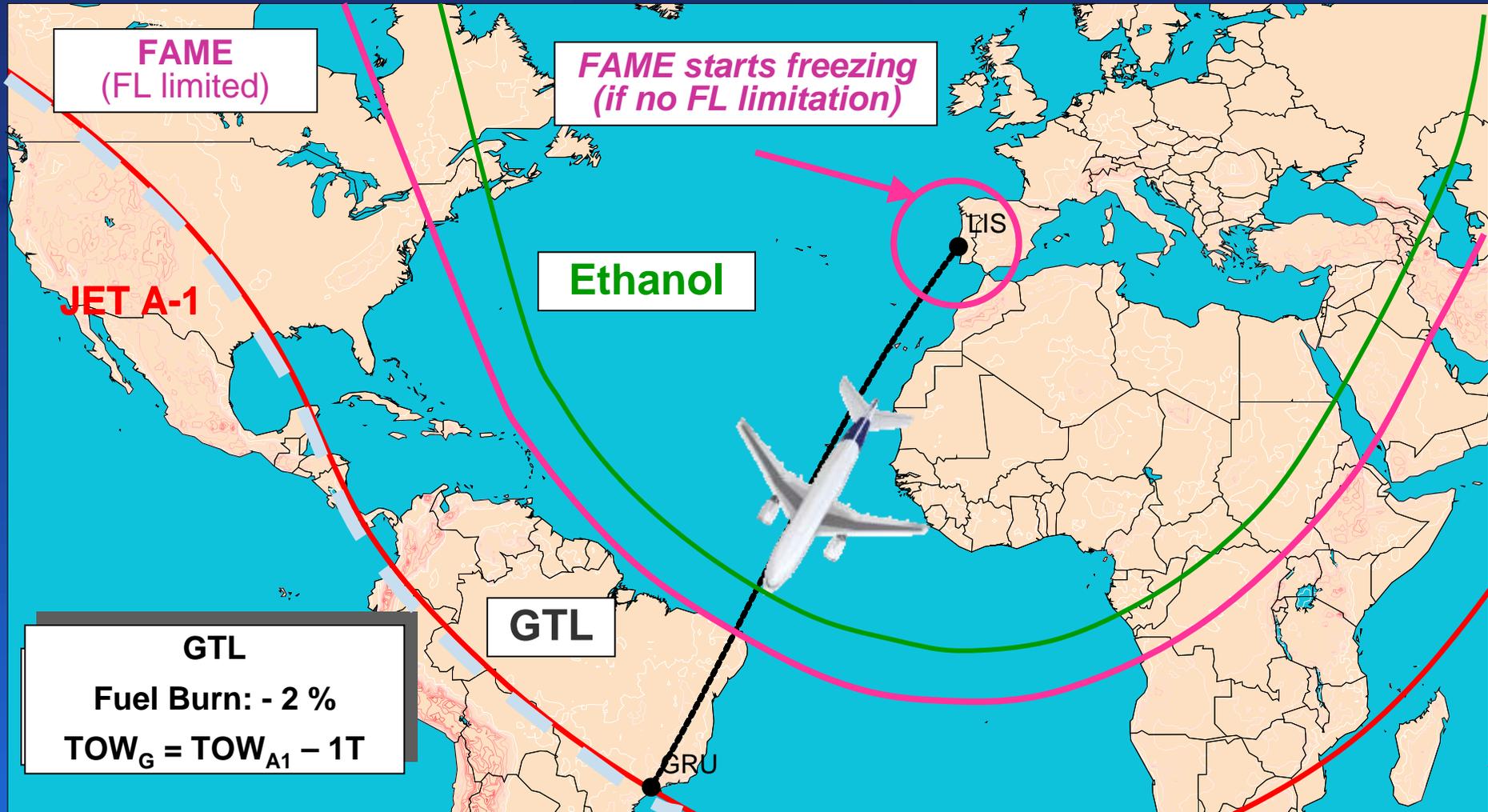
- But:
  - ▶ More and more demand worldwide from all sectors for oil
    - Fuel: can be around 40% cash operating costs of airlines
  - ▶ Requirement and expectation to reduce further environmental impact
    - Local Air Quality & Global Warming.

# Commercial Aviation Alternative Fuels Options

		TYPE					
		Conventional Jet Fuel ("Kerosene")	Alcohols	Bio Esters	Synthetic Fuels	Hydrogenated Biomass	Cryogenic Fuels
CATEGORY	<u>Non-Renewable (Fossil)</u>	 Jet Fuel			Coal To Liquid (CTL) Gas To Liquid (GTL) 		Liquefied Natural Gas 
	<u>Renewable</u>	35% lower energy content 	Ethanol ... 	Fatty Acid Methyl Esters (FAME), ... 	Biomass To Liquid (BTL) 	Hydrogenated Vegetable Oils 	Liquid Hydrogen  Low energy content per unit volume, Availability, Infrastructure

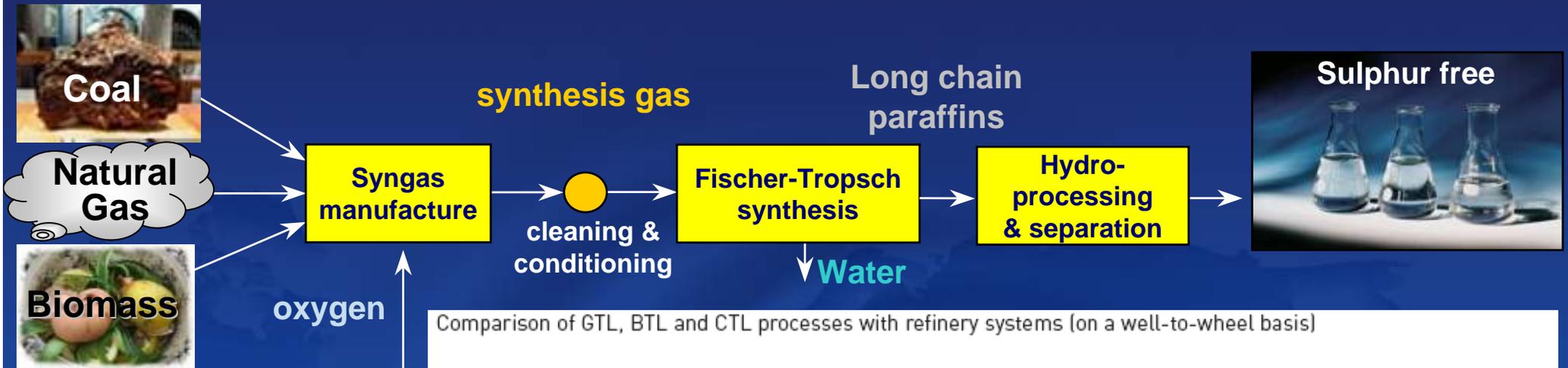
# Alternative Fuels illustrated: JET A-1 = Base

## Operational Effects

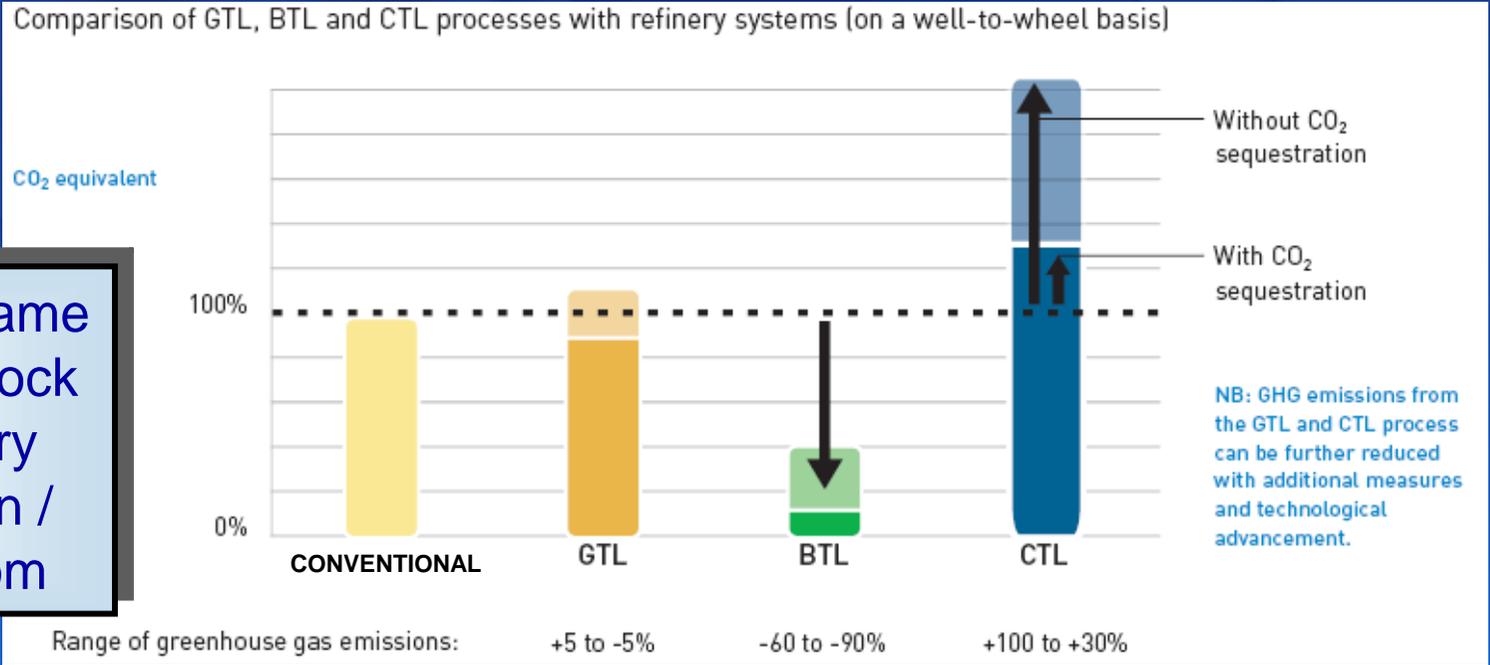


*Mission: 80% Payload, 150 NM Diversion, 5% Reserves*

# Synthetic Fuels for Commercial Aviation (XTL)



End product is the same regardless of feedstock and has no memory of where the carbon / hydrogen came from



Source: ASFE 2007

(Bosch, Daimler Chrysler, Renault, Shell, Sasol Chevron, Volkswagen)



# GTL as a path towards 2<sup>nd</sup> Generation BTL Jet Fuel

- **Gas To Liquid (GTL) Synthetic Jet Fuel**

- ▶ is to be available in significant quantities in the near future at certain locations (e.g. Qatar),
- ▶ is attractive for local air quality,
- ▶ should be equivalent in life cycle CO<sub>2</sub> to current jet fuel,
- ▶ has same characteristics as future Biomass To Liquid (BTL) synthetic jet fuel.



- **GTL is therefore a good precursor to 2<sup>nd</sup> Generation BTL**

- ▶ Cash in local air quality benefits as early as possible
- ▶ Preparing for emergence of a wider slate of synthetic fuels

# 1<sup>st</sup> test flight of a commercial aircraft with GTL - Feb. 1<sup>st</sup>, 2008



# Fuel and Aircraft for Feb. 1<sup>st</sup>, 2008 Flight

- **GTL Fuel supplied by Shell:**

- ▶ GTL fuel blended with conventional kerosene at Shell Technology Centre in Thornton, UK in January 2008
  - Around 40% GTL for this first test to stay within usual conventional kerosene properties
- ▶ GTL fuel blend delivered to Airbus UK Filton facility
  - Airbus and Rolls-Royce acceptance end January 2008

# A380 MSN 004 Feb. 1<sup>st</sup>, 2008 GTL Flight



- ▶ powered with 4 Rolls-Royce Trent900 engines
- ▶ Engine 1 tested
- ▶ 11 Tonnes of GTL blend in Engine 1 feed tank
- ▶ Engine 1 feed tank fuel system also on test

# A380 MSN 004 Feb. 1<sup>st</sup>, 2008 Flight

- **3-hour Test Flight from Filton, UK to Toulouse, France**
  - ▶ Check aircraft Fuel System indications on ground
  - ▶ Take-off from Filton, UK, Engines at max power
  - ▶ Check engines parameters at different flight levels
  - ▶ Check aircraft Fuel System indications in flight
  - ▶ Engine transients at maximum altitude
  - ▶ Check Engine 1 relight characteristics
  - ▶ Engine transients in descent
  - ▶ Check engine parameters in holding conditions
  - ▶ Landing in Toulouse, France

# First Commercial Aircraft Flight with GTL Fuel

All Tests Positive: NO Unknown Unknowns

## TESTS

– Materials, Engine, Aircraft systems

- GS Engine Ground Start
- AD Engine Accels / Decels
- GF Gravity Feeding
- WS Engine Windmilling Start

FL 400

FL 300

FL 200

FL 100

FILTON



TOULOUSE

Touch & Go

Max Take-off

11:30 GMT

Landing

14:20 GMT



# Next steps...

- Actively support generic synthetic fuels approval for commercial aviation via agreed industry protocols
  - ▶ ASTM & DEF-STAN
- Additional testing and investigation within the Qatar-led consortium to fully quantify GTL's impact on:
  - ▶ Local air quality & global environment,
  - ▶ Aircraft performance.



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# Alternative fuels Roadmap

