



Aviation Fuels Update 2009

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Why is this topic so very important?

- The “Status Quo” has changed.
- We need to understand the current situation so that we can find a future solution for the piston aviation industry.

The “Status Quo”...

- **Leaded aviation fuel (100LL) will go away**
 - **Global economic, political, and regulatory pressure**
- **The situation in North America is dramatically different than the rest-of-world**
 - **Large installed base of legacy (100LL) aircraft**
- **U.S. Military logistics strategy is focused around a single fuel supply stream for all vehicles – Jet Fuel**
 - **50/50 Synthetic Blend JP-8 (Jet-A1)**
 - **Commercial jet aviation will likely follow**



Engine and Fuel Evolution

Engine and Fuel Evolution

Continuous Combustion



**Kerosene
(Distillate)**



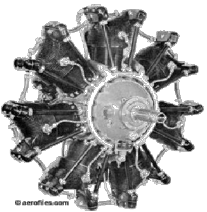
**Jet Fuel
(Hydro-processed)**



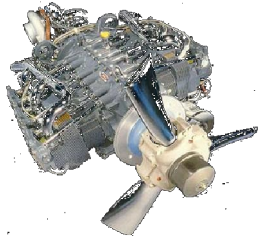
Increased Performance,
Reliability & Safety

Remove TEL & identify alternates
and
retain Performance, Reliability & Safety

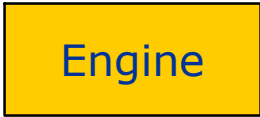
Periodic Combustion



**Gasoline
(Distillate)**



**Avgas
(Alkylate)**



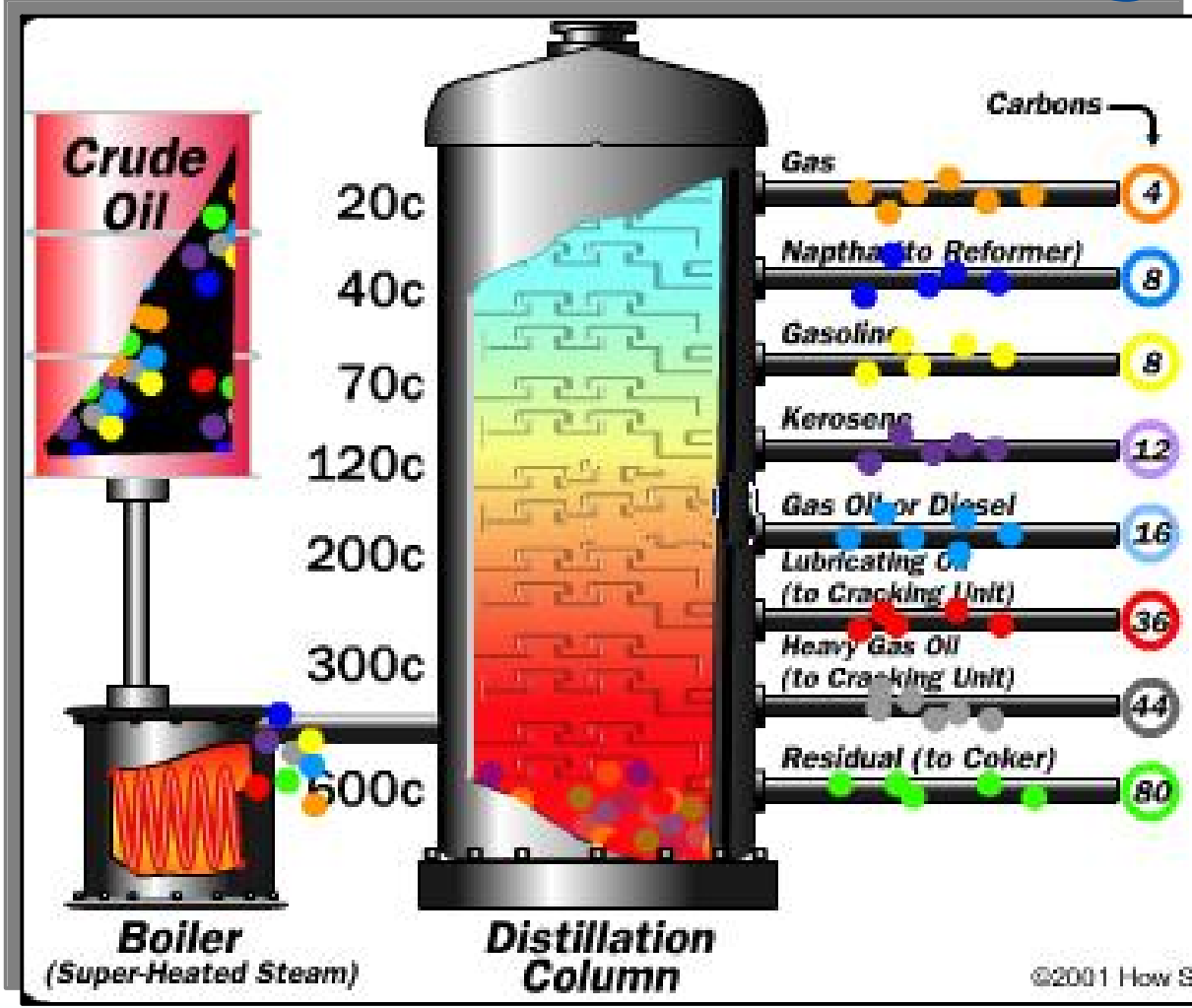
Past

Present

Future?

High performance aviation engines were made possible because of the concurrent development of high performance aviation fuels.

Basic Fossil Fuel Processing



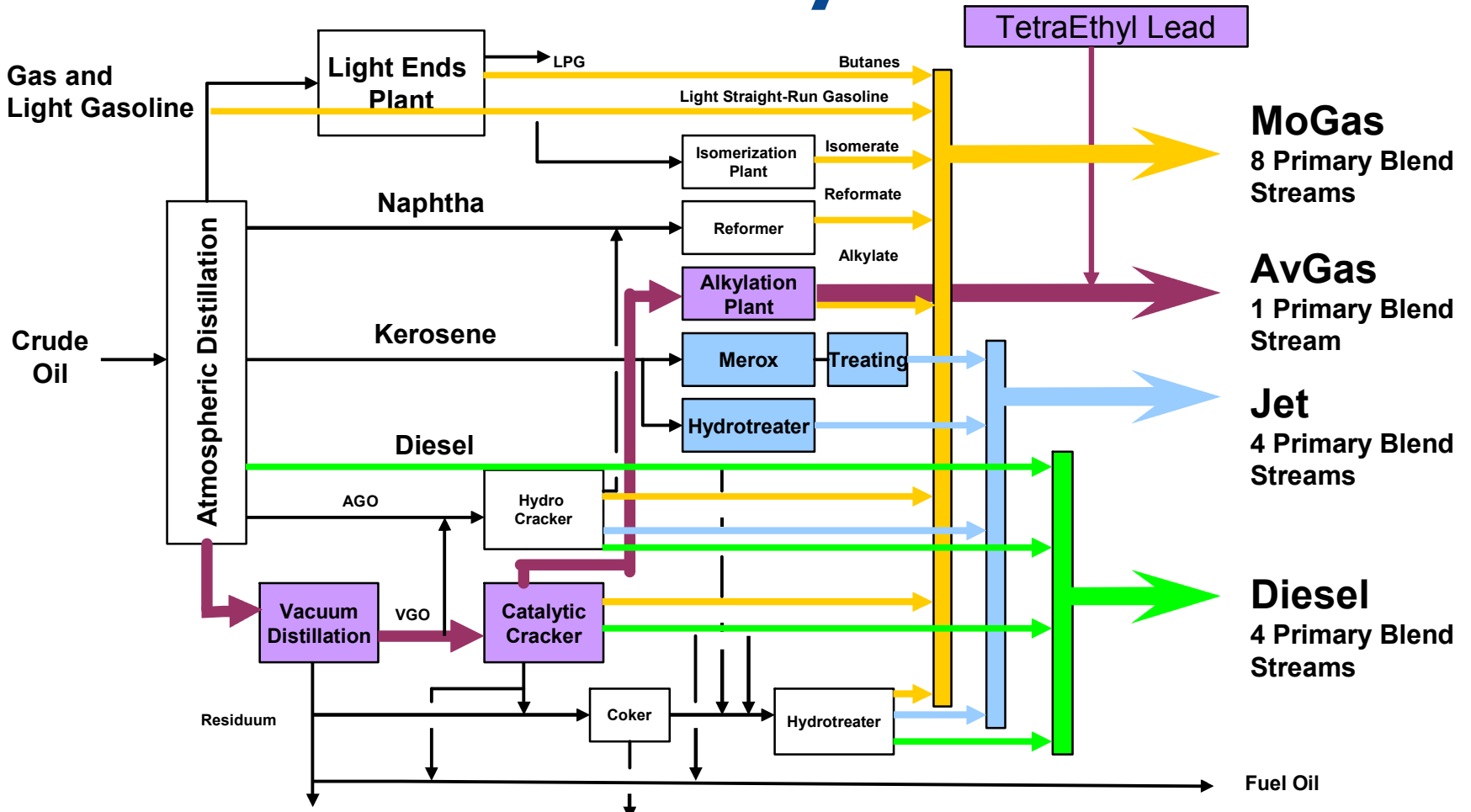
**Higher Flammability
Lower Density**

**Lower Flammability
Higher Density**

©2001 How S

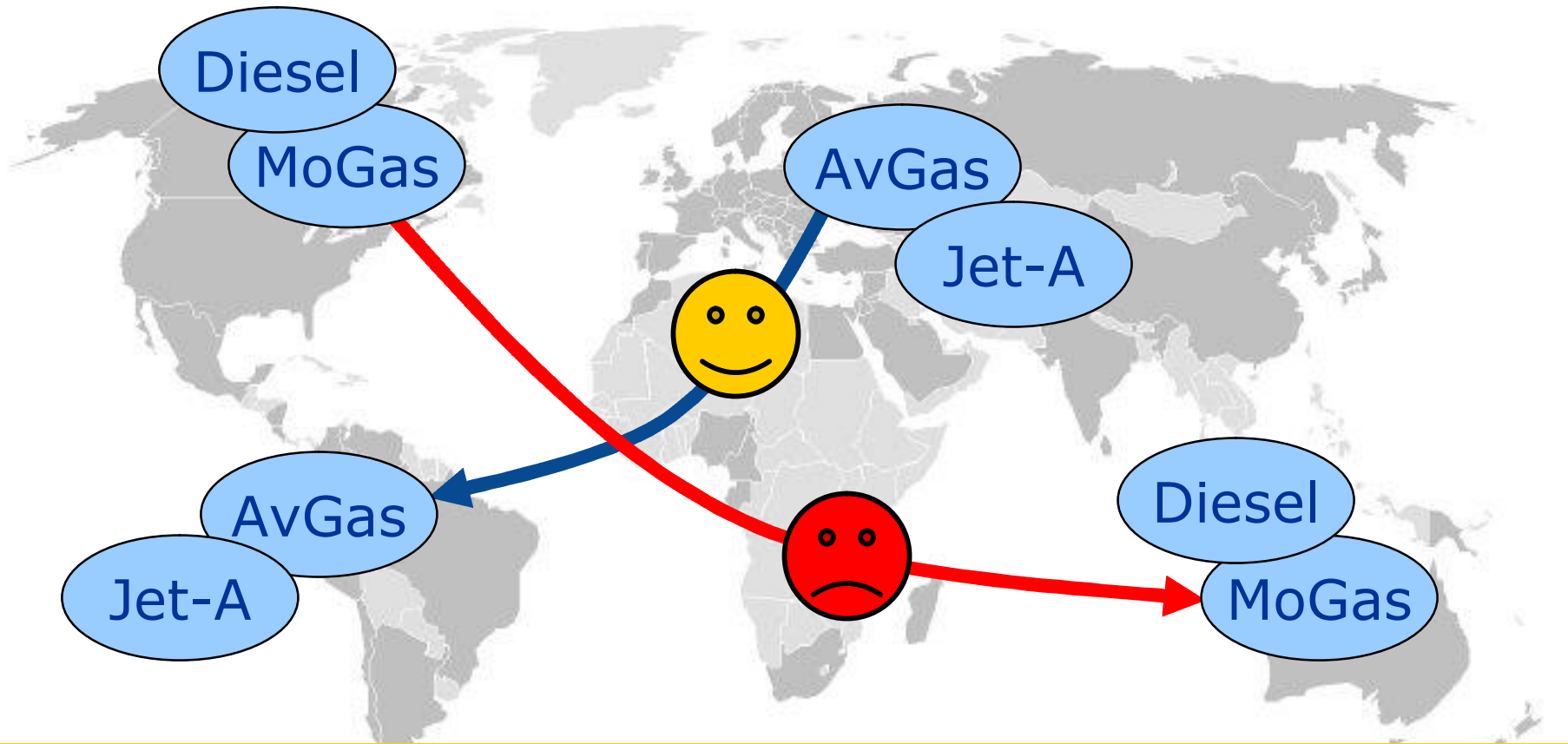


The Modern Refinery...



Aviations Fuels = Optimized for Aviation Engines

Global Consistency of Fuels



Aviation Fuels = Optimized for Global Transportation

Key Facts – Part 1

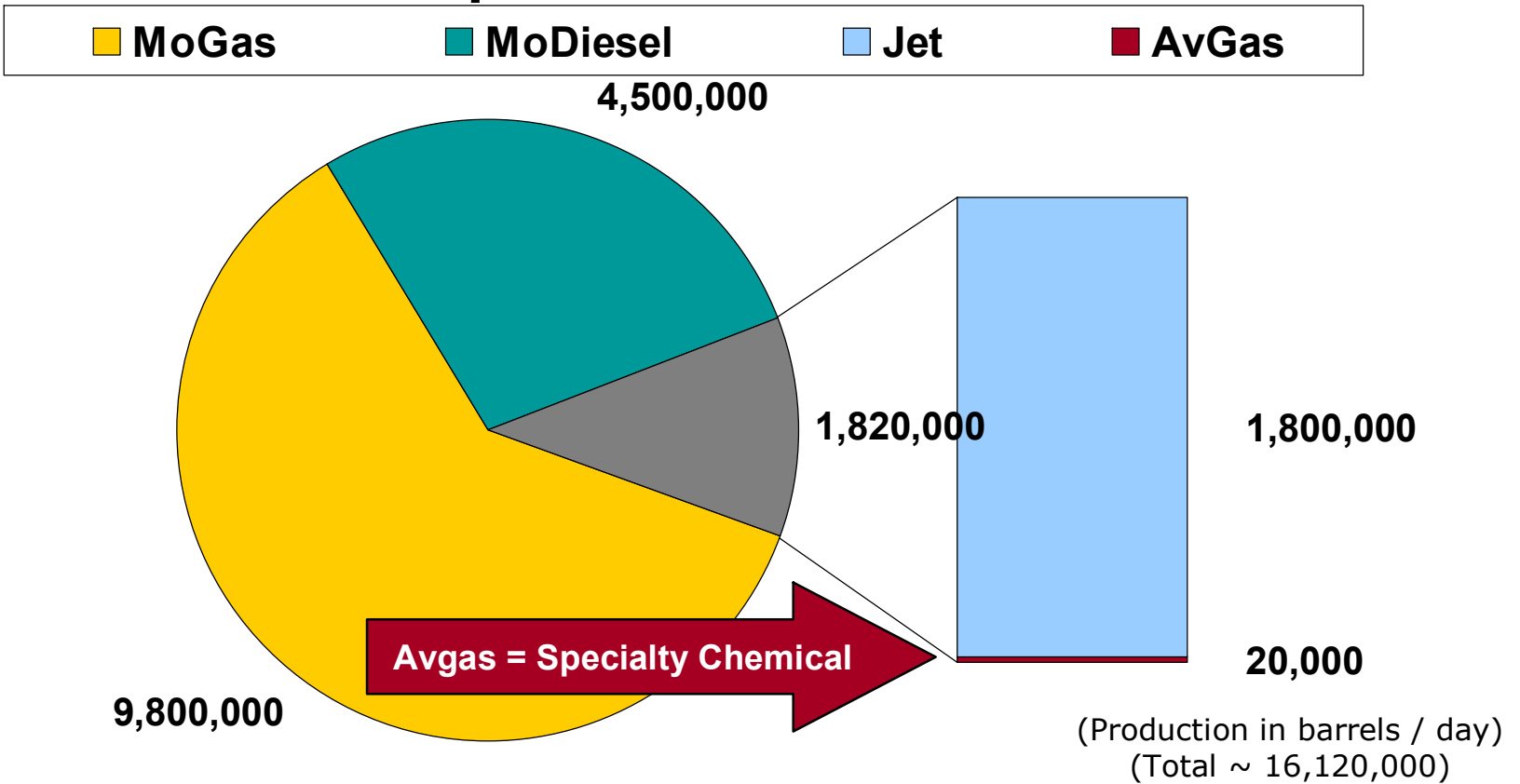
- 1. Aviation fuels and Aviation engines were jointly optimized to arrive at today's high performance solutions**
- 2. Aviation fuels are designed to be globally consistent**



Fuel Usage & Production

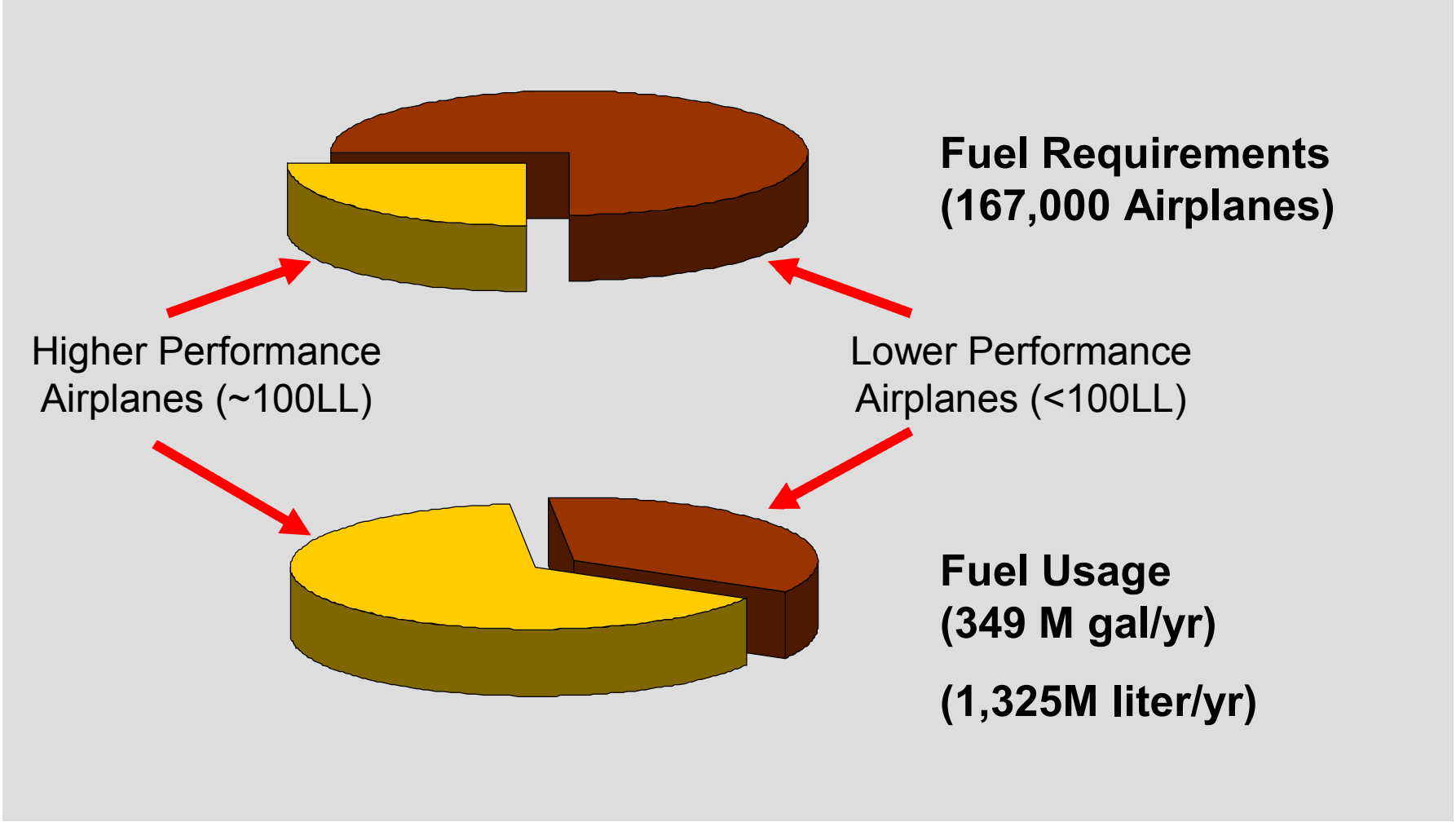
Total Fuel Consumption

US Transportation Fuel Production



“AvGas” stopped being a high volume commercial fuel in the early 1960’s

AvGas Consumption



Key Facts – Part 2

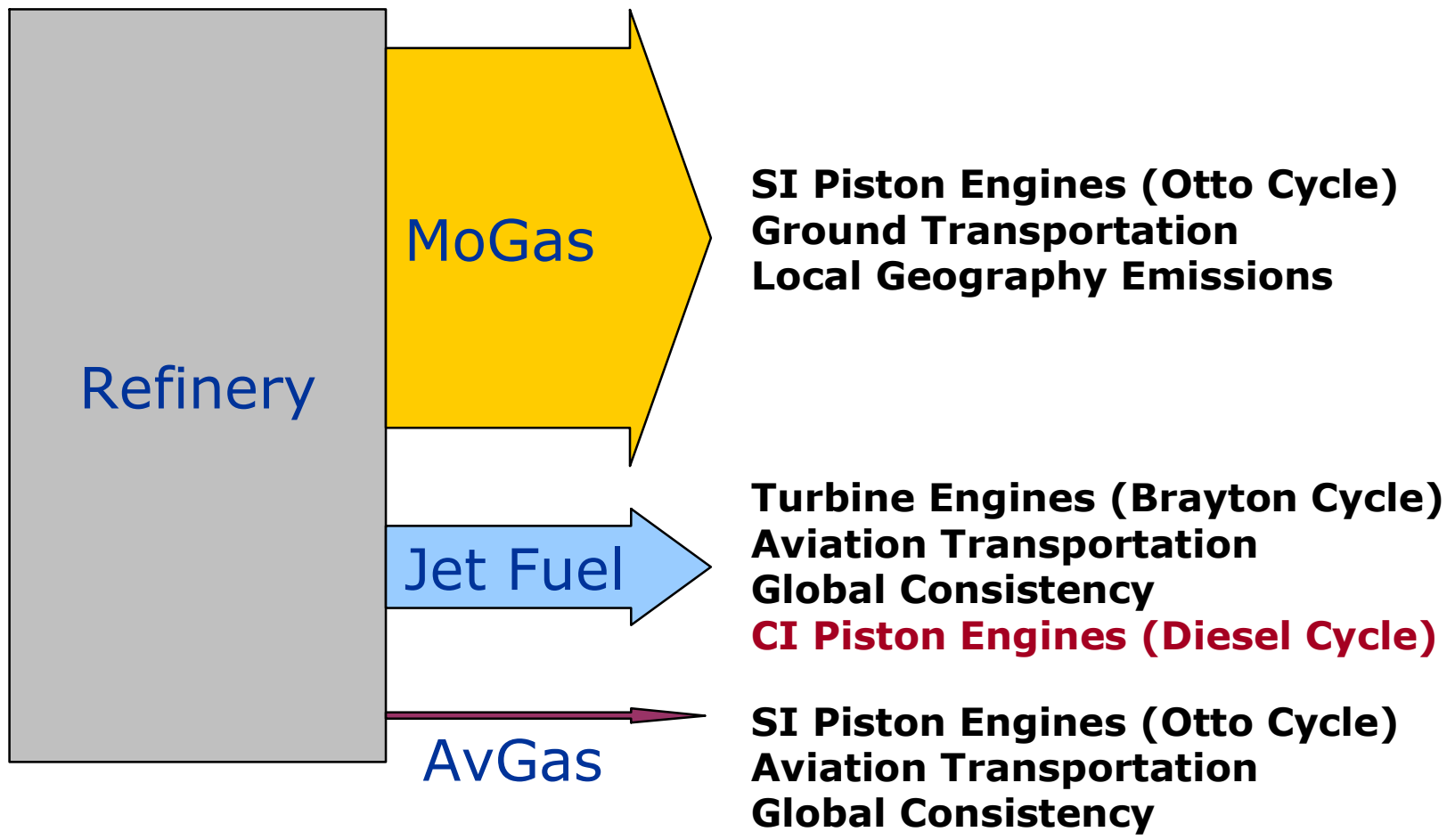
- 1. ~25% of all Aviation Piston Engines need 100LL which consume ~60% of the AvGas**
 - **These “60% Consumers” are predominantly revenue applications (business aircraft)**
- 2. Any “custom” aviation piston fuel will be a boutique fuel or specialty chemical**



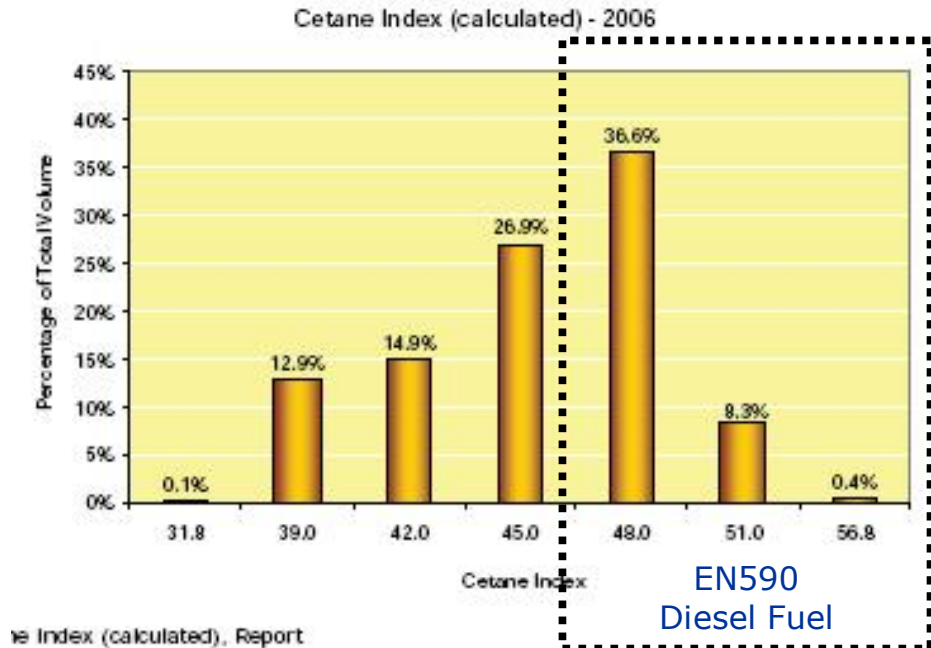
Aviation Engine Fuel Options

A World without 100LL

Options for Piston Aviation?



Jet Fuel Considerations...



- Cetane controls the delay time for ignition in Diesel cycle piston engines
- Jet fuel specifications and production methods do not control cetane number
- Fuel with lower cetane than engine calibration can impact power, starting, and reliability

• Cetane variation of Jet Fuel is one of the main reasons behind ExxonMobil conditions for supplying jet fuel to aircraft with piston Diesel Cycle engines

MoGas Considerations...

PLUS

- High volume production / competitively priced commodity
- High availability worldwide

DELTA

- Lower octane
- Higher vapor pressure
- Geographical and seasonal variation
- No “Aviation” influence on specification

Attractive for its availability - however - increases complexity for newly designed, high performance applications and problematic for legacy aircraft.



Conclusions, Recommendations and Actions

Lycoming's Perspective

Conclusions

- **There is no “magic bullet” for the existing installed base of engines / aircraft that require 100LL**
 - **The economic impact in North America of “no supply” of 100LL or equivalent would be severe**
- ***Newly Developed* engines need to anticipate the alternate and lower performance fuels that will be available in the future**
 - **Broader cut lower octane unleaded gasoline**
 - **Jet-A, Jet-A1, JP-8 and Synthetic Jet Fuels**
- **More sophisticated technology to maintain piston engine performance on lower performance fuels will be required**
 - **Lower power/weight ratio is sometimes the compromise**

Advanced Electronic Controls become a Necessity

Recommendations

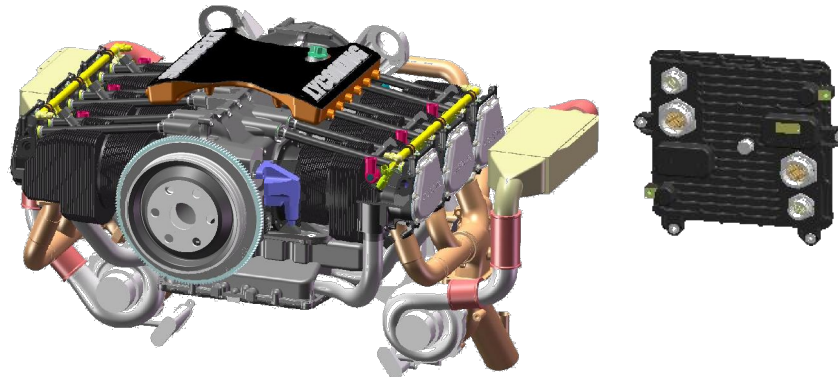
- 1. Aggressively pursue synthesized high octane unleaded aviation grade 100LL substitute fuel (100UL)**
 - FAA Technical Center testing to date of SWIFT fuel shows strong promise for this approach**

- 2. Aggressively pursue a universal aviation fuel based on current Jet Fuel formulations**
 - Include minimum cetane as a parameter in specification and production**
 - Accept the trade-off impacts to the airframe and engine capability**

These two actions must be pursued collectively by regulatory agencies and industry.

Lycoming Engines Actions

- 1. Public Information and Education Campaign**
- 2. Direct participation with industry and regulators to evaluate technology options and alternative fuels**
- 3. Alternate fuel approval for existing engines**
- 4. Closed loop feedback adaptive electronic engine controls (iE²)**



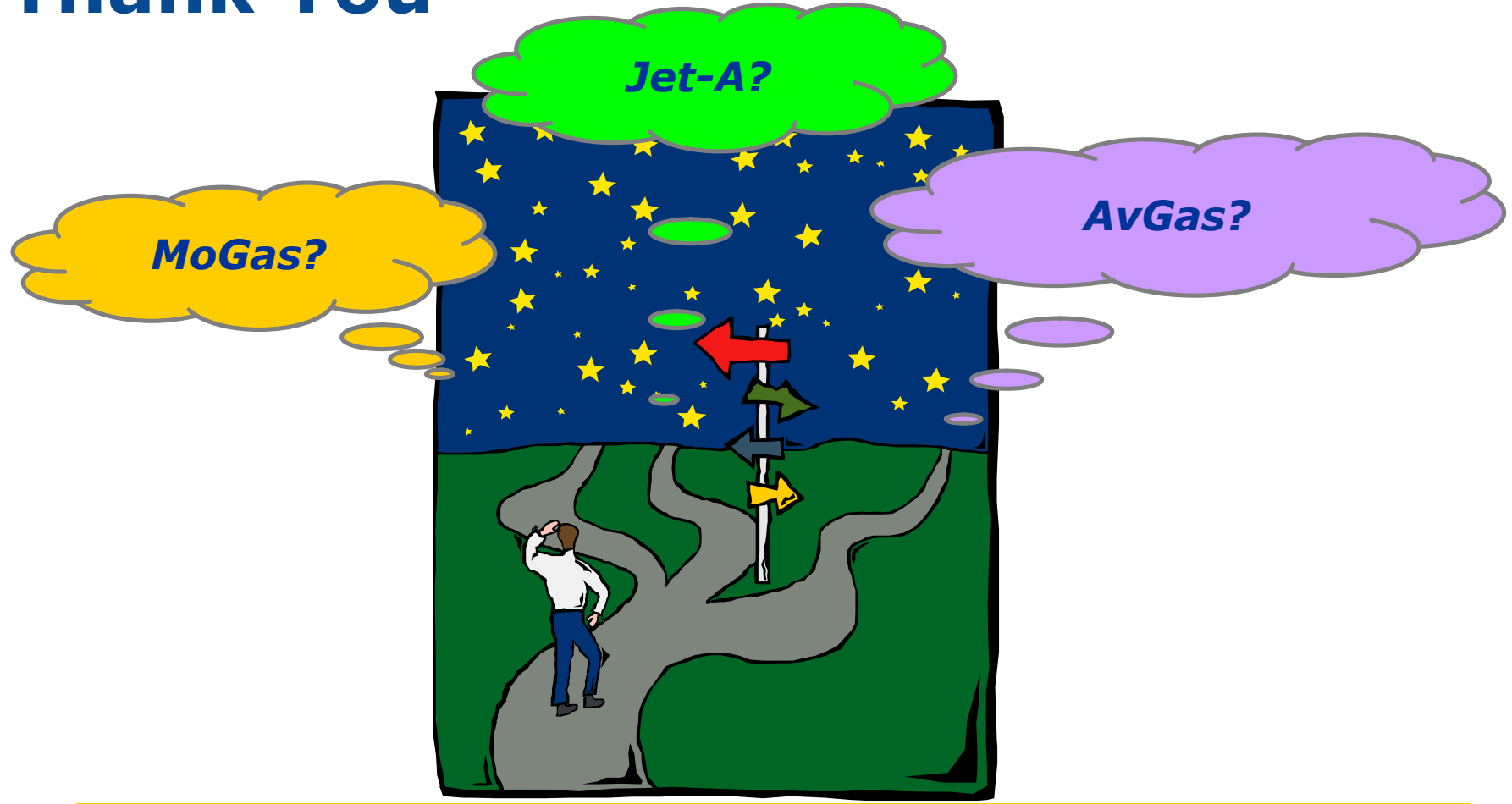
The Reality

- **In the eyes of the EPA, the clock is ticking on TEL.**
- **The EPA wants a plan:**
 - **What are we going to do?**
 - **When are we going to do it?**



GAMA Transition Plan to be Released in 2009

Thank You



Solution = Technology + Policy + Public Demand