Synthetic Biofuels as a Strategic Element in the Automotive Industry

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EUCAR / Ford

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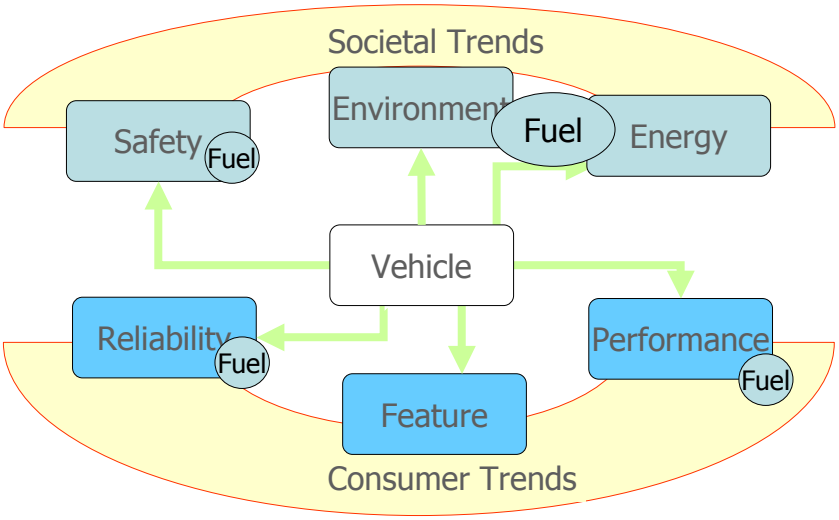
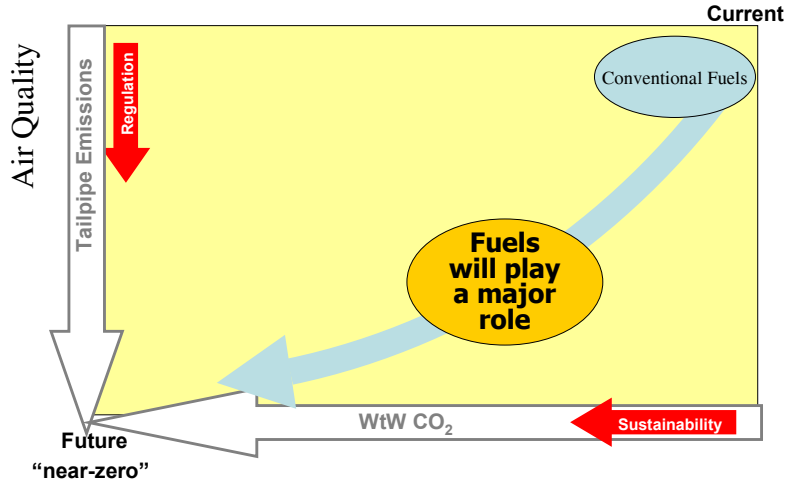
Mega Trends

Societal and Consumer



Mega Trends

Emissions, CO2 and today's fuels



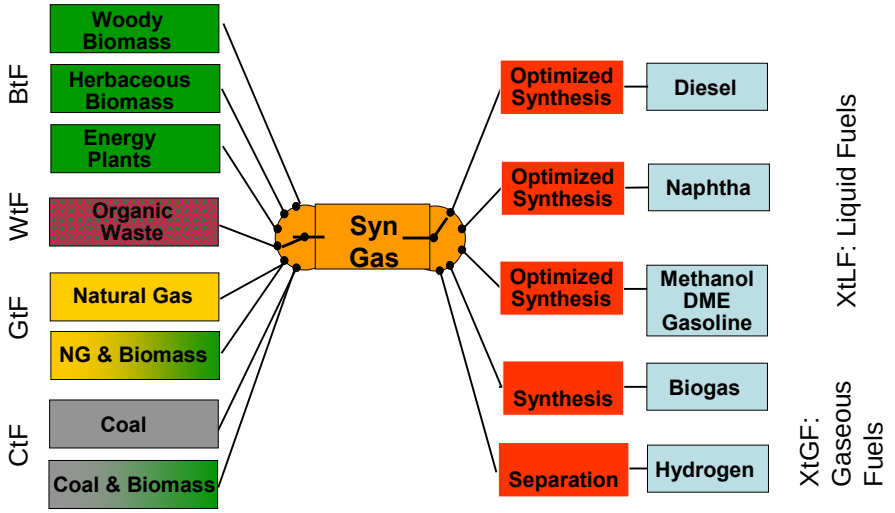
Biofuels today

Problematic non-fossil liquid fuels as .....

What we have	Ethanol	Fatty Acid Methyl Esters (FAME)
Resource selected from excess livestock feed	Corn, sugar beets, sugar cane	NA: Soy (US), Canola (Canada), EU: Rape, Sunflower
Fuel selected for simplicity and low investment	E5	B5
Vehicle forced to accommodate the fuel (single component)	Material changes, RVP adjustment	Cold flow, filter plugging, corrosion from oxidation products
Quantity capped unless vehicle changes	>E10 requires wide-range stoic. control and materials for FFV	>B5 at risk due to inconsistent FAME quality control, poor cold flow, poor oxidation stability
Economics based on incentives	State tax relief	State tax relief
Regional variations	Regional determined by resource	Regional determined by resource

X-to-Fuels (XtF)

Resource Diversification & Fuels for the future



Simplified conversion routes from resources to fuels

BtL-Fuels

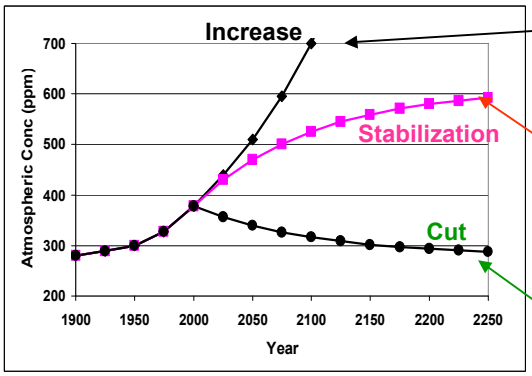
Indicators to Success: any single indicator can be a showstopper

- Environment
  - Health of the Planet: GHG Emissions
  - Health of the People: Air Quality
  - Health of the Ecosystems: Soil, Water
  - Health of the Habitat
- Energy Resource
  - Availability
  - Affordability
  - Potential
  - Resource Vulnerability (monocultures)
- Resource Competition
  - Non-transport sectors
  - Food production
  - Materials

Environment

Global Climate Change: CO2 Concentrations

CO_2 Concentrations | **Scenarios**



Business As Usual (BAU)
Strong Climate Impact

Stabilization at X ppm
Chance for "modest" climate impact if X is less 2 x pre-industrial

Cut
⇒ Pre-Industrialization level

BtL-Fuels

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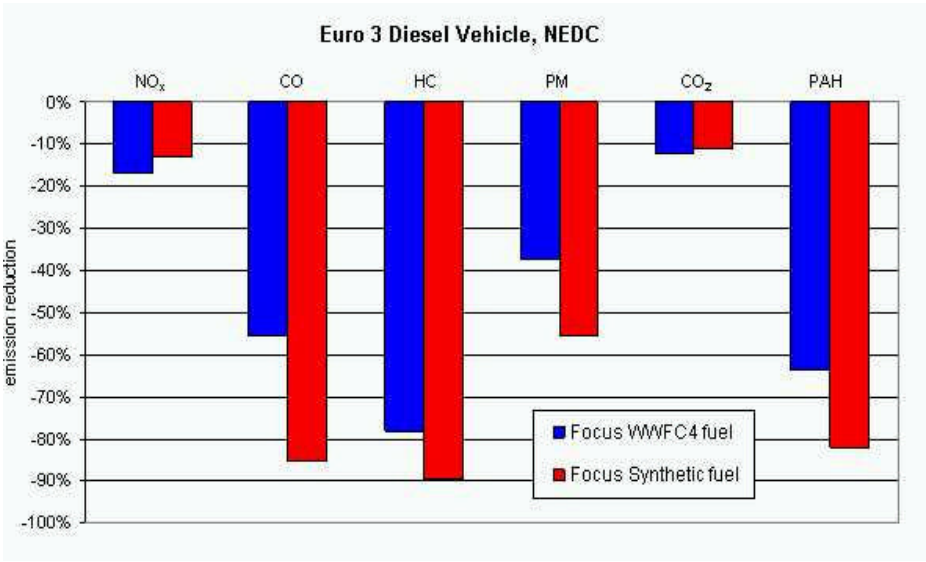
Vehicle Testing:

CLEAN Project



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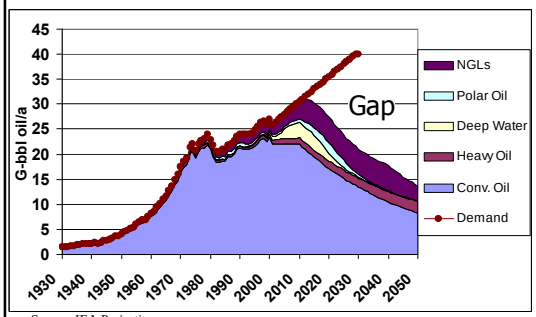
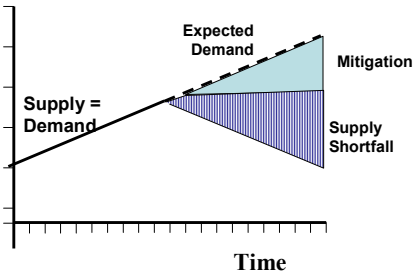
Energy

World Oil Production & Demand Gap

- Mitigation Options should close the gap
  - if not supply shortfall
- Early timing for introduction of mitigation options is necessary



Source: IEA Projection
www.peakoil.net



BtL-Fuels

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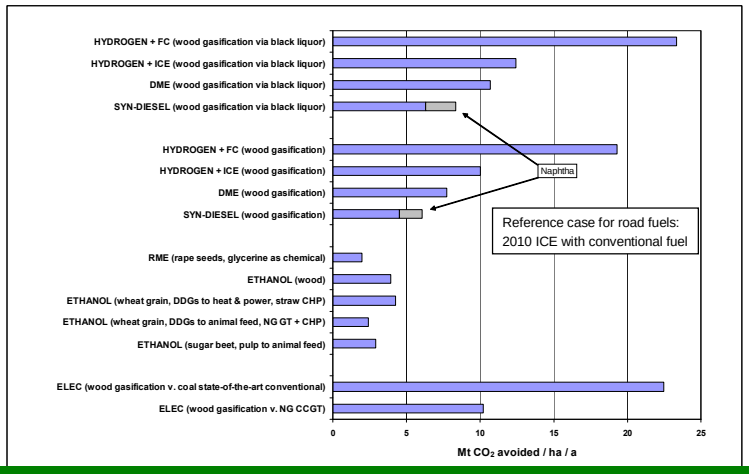
  - Food production
  - Materials (if e.g. wood)

Biomass Resources

Alternative usage

Potential for CO_2 avoidance from 1 ha of land



Wood gasification or direct use of biomass for heat and power offers greatest GHG savings

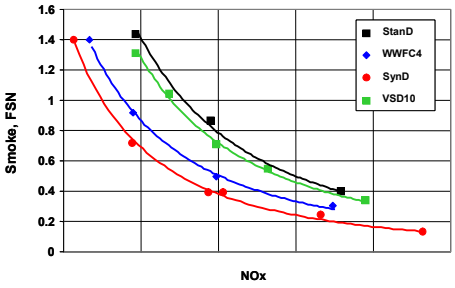
Bt-Fuels

Indicators to Success: any single indicator can be a showstopper

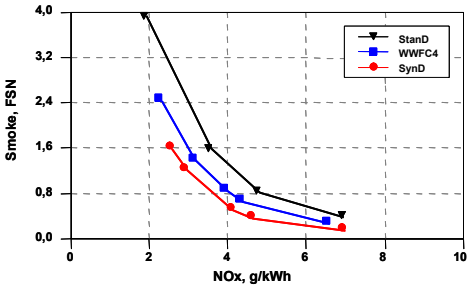
- Economic aspects
  - Technology developments
  - Domestic Employment
- Fuel & Infrastructure
  - Fungible
  - Safe & easy to handle
  - Designability
  - Globally uniform properties
- Vehicle
  - Backward compatible in fleet
  - Powertrain optimization potential
  - Allow Customer choices

Engine Testing:

CLEAN Project



Smoke (FSN) - NOx trade-off of a HD engine by varying the exhaust gas recirculation rate (EGR) at the ESC test stage A25 (1200 rpm, quarter load).
Source: Volvo.



Effect of SynD and WWFC4 on PM and NOx emissions of a 2.2 L Euro 3 / 4 engine. Operating conditions: 2500 rpm, BMEP 9 bar, stationary test bench data. Exhaust gas recirculation rate (EGR) variation.
Source: Ford.

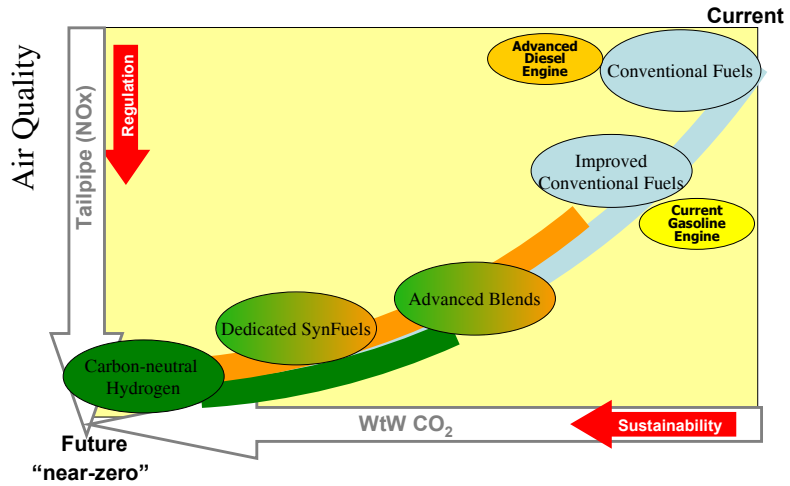
Bio Fuels

Significant non-fossil liquid fuels if .....

What we get with bio SynFuels	Diesel	Gasoline
Resource bio-engineered for yield, final properties, sustainable for climate	Switch grass, waste biomass, wood	Switch grass, waste biomass, wood
Fuel selected for best finished properties	FT diesel	FT gasoline, TBD (Butanol, mixed alcohols, ??)
Backward compatible into vehicle fleet, positive blend properties	Cetane positive, matched cold flow and stability	Octane positive, matched volatility, consistent materials (oxygen optional)
Increasing quantity as supply matures	Properties stable with blends up to 30%	Properties stable with blends up to 30%
Economics competitive with future fossil fuels	Key issue	Key issue
National, global uniformity	Fuel properties independent of feedstock type	Fuel properties independent of feedstock type

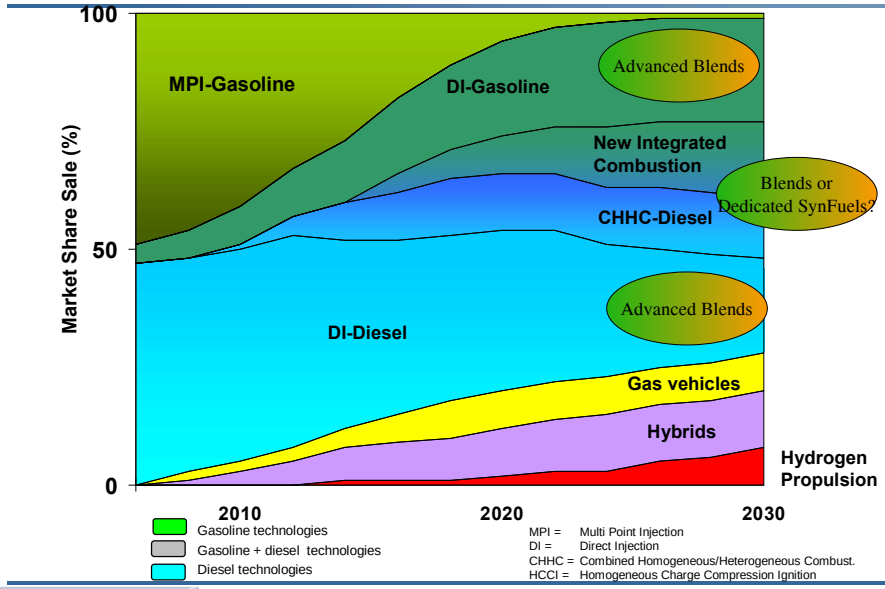
Mega Trends

Emissions, CO2 and fuels pathways



EUCAR Vision of PT in Europe

PC & LCV



MPI = Multi Point Injection
DI = Direct Injection
CHHC = Combined Homogeneous/Heterogeneous Combust.
HCCI = Homogeneous Charge Compression Ignition

Open issues on Xt-Fuels

Which energy crops?

Logistics

Gasification & Gas treatment

Product Quality: "towards the optimum Fuel"

Strategy for marketing: which Blend

Political framework

…

Summary

Synthethic Biofuels have a future

But

Coordinated development among all stakeholders is crucial