Designer Fuels:
The Next Fuel Generation

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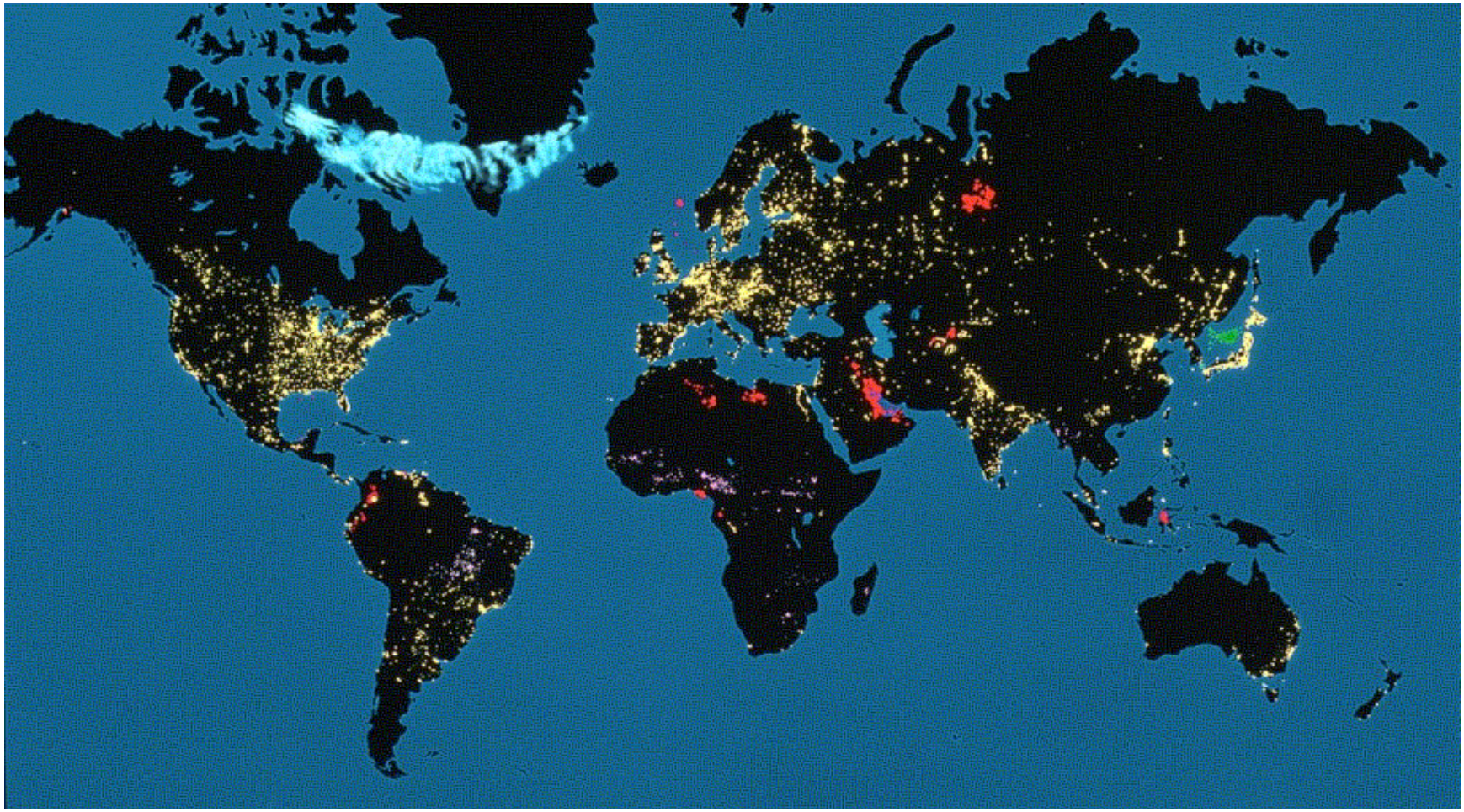
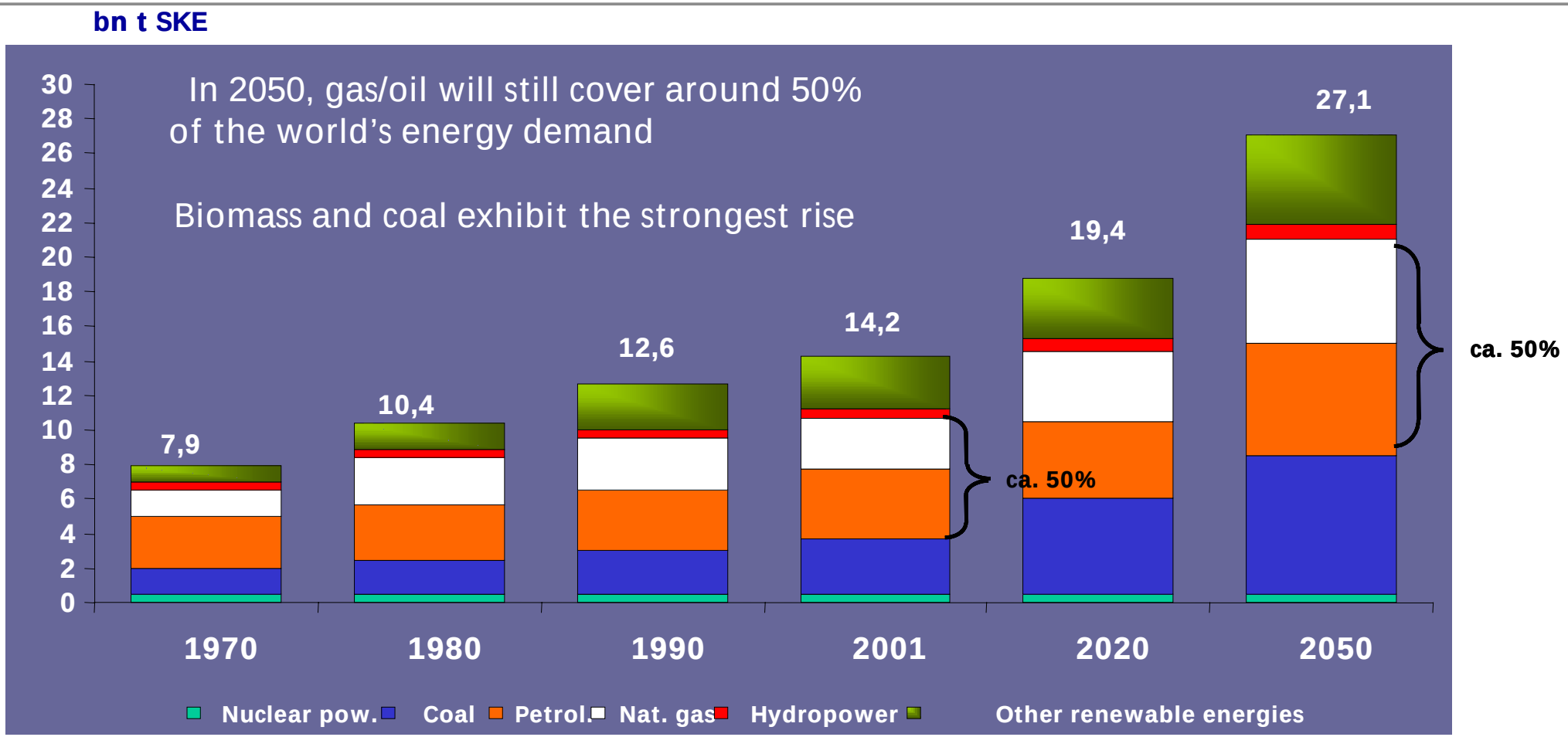
Dr. Ing. Ludolf Plass
Executive Vice President Technology - Lurgi AG

Night View of the Blue Planet

GEA Group Lurgi

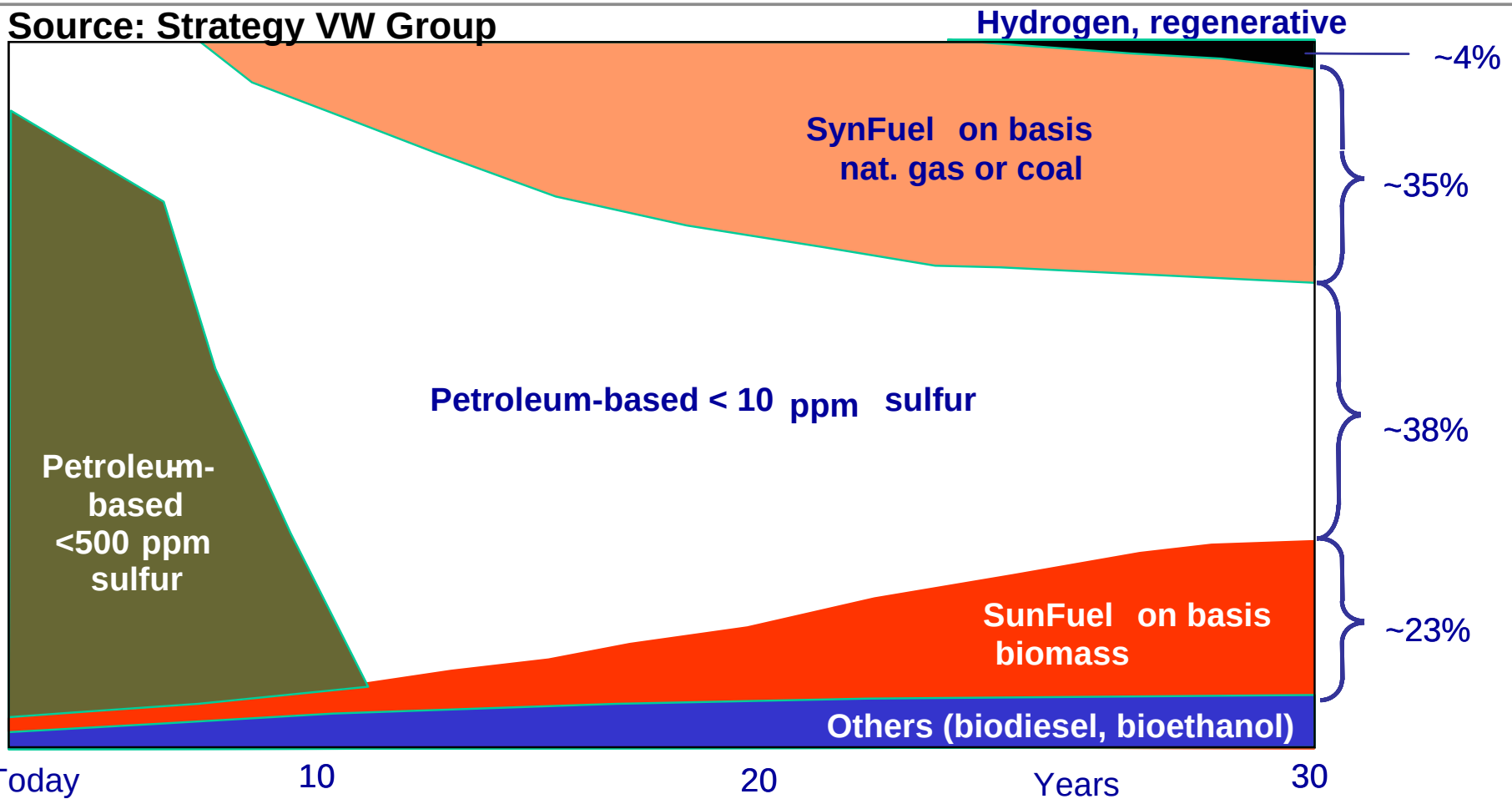


World Energy Consumption by Energy Sources



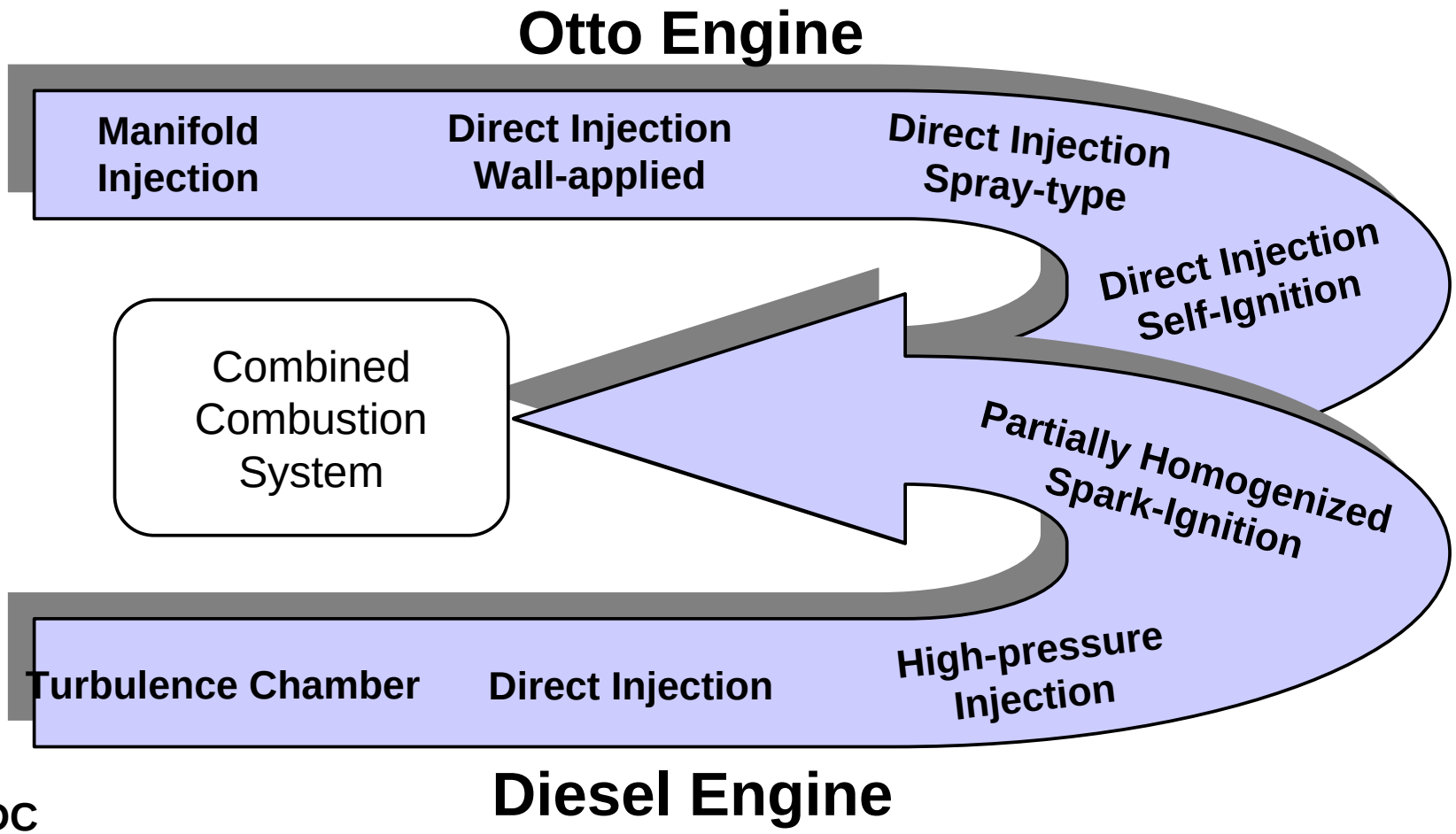
Source: BP (until 2001), World Energy Council)

Future Quantity Scenario for Transport Fuels



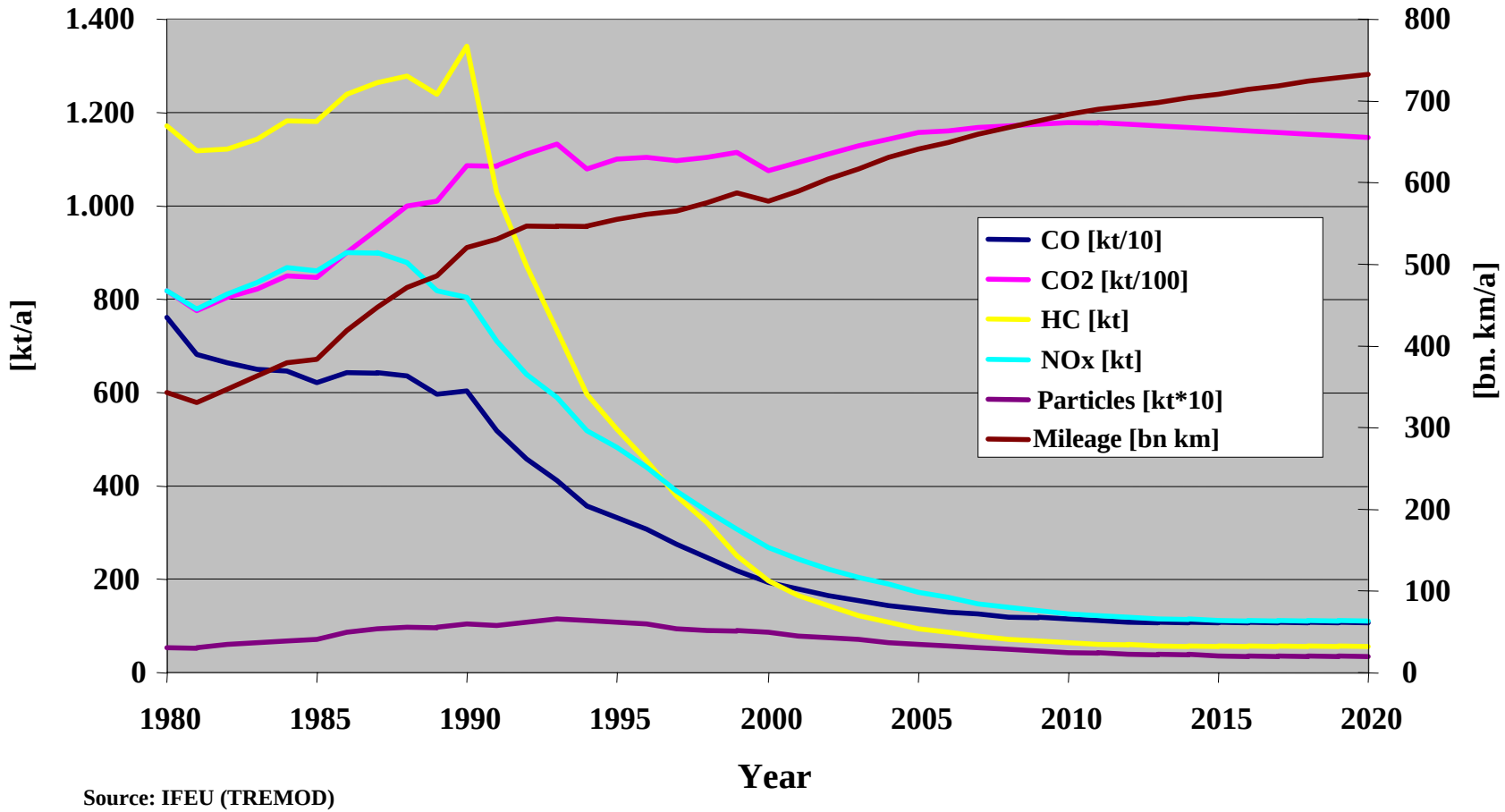
Vision 2030: Only ca. 38% petroleum-based fuels

Development Combustion Engine Technologies



Source VW, DC

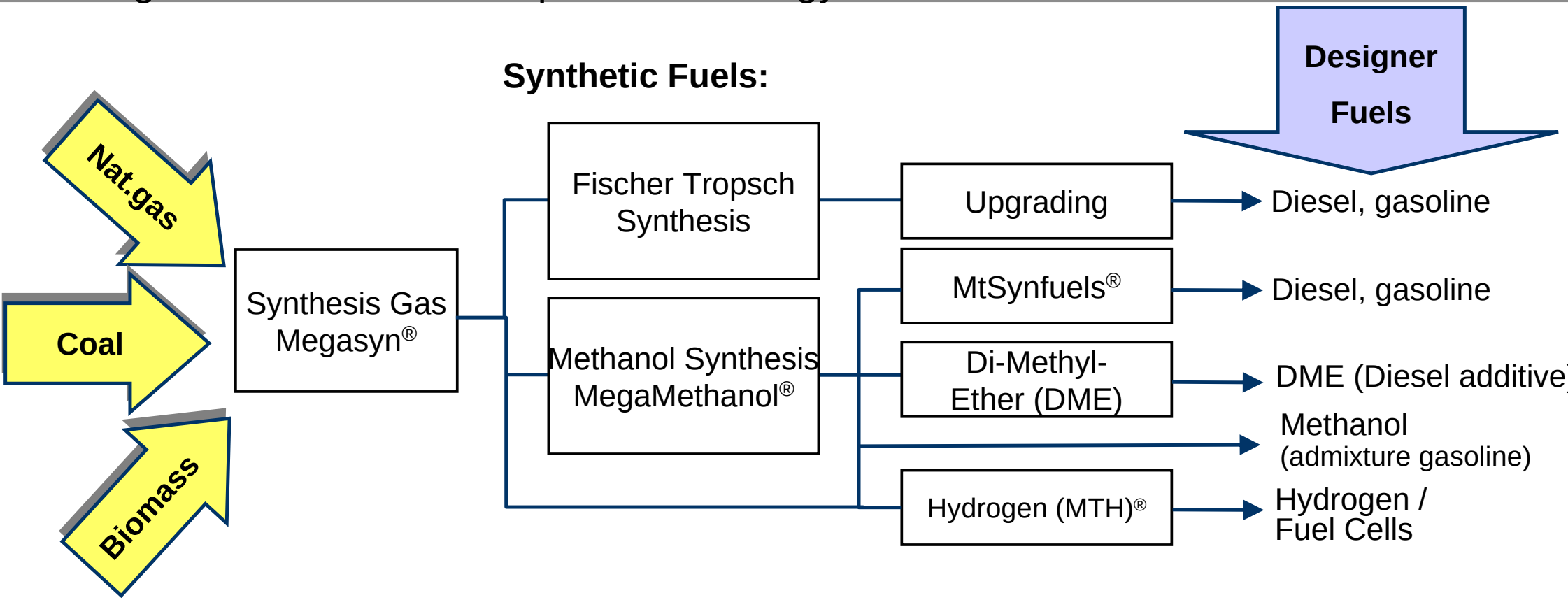
Development Car Emissions



Source: IFEU (TREMOD)

From Energy Feedstock to Synthetic Fuels –

Lurgi commands the complete technology chain



"Designer Fuels" Based on Fischer-Tropsch (FT) Technology

GEA Group Lurgi

300,000 tpa Synth. Diesel
Mossel Bay, South Africa

FT Demonstration Plant
Mossel Bay, South Africa

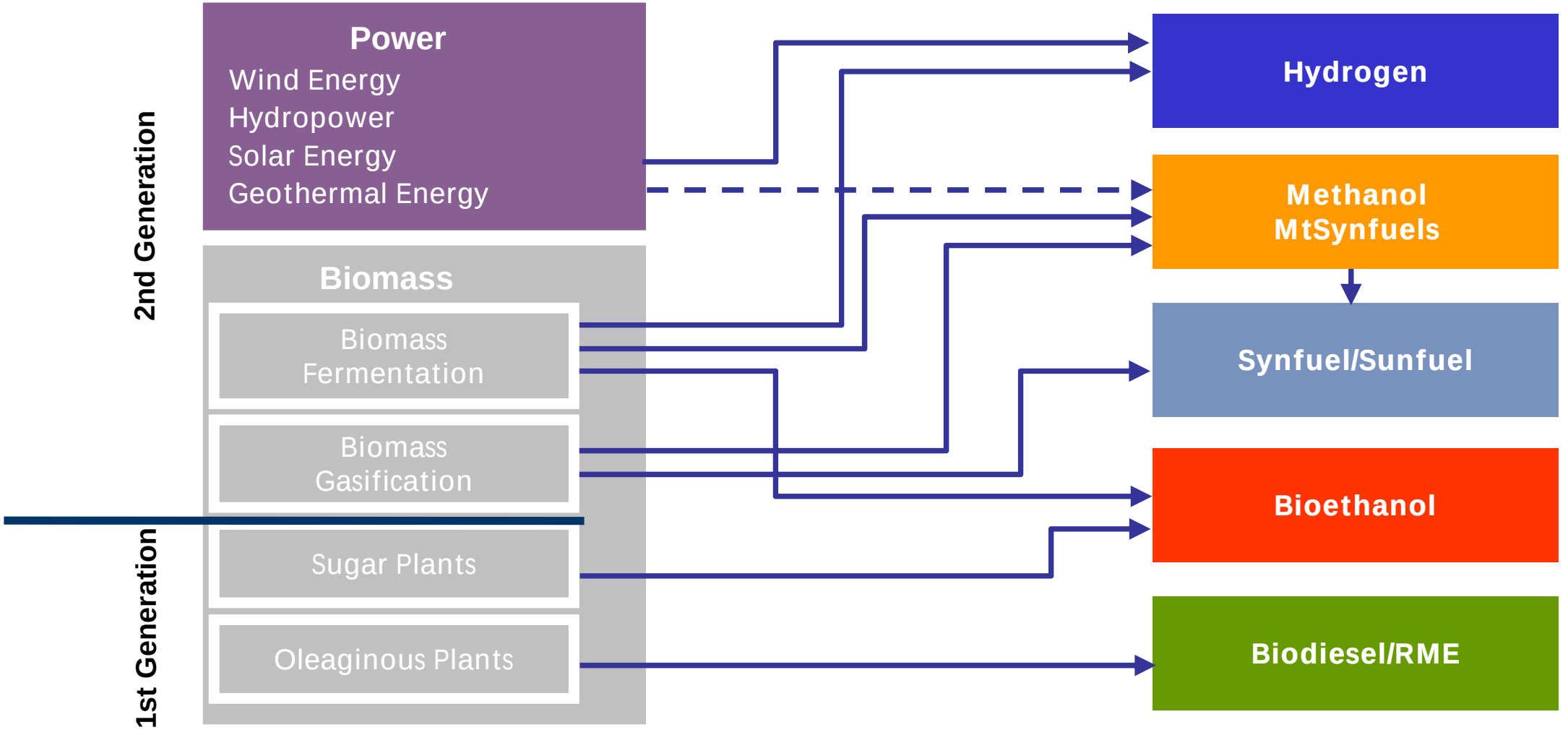
"Designer Fuels" Based on "Methanol-to-Synfuels" (MtSynfuels)

GEA Group Lurgi

MegaMethanol Plant Atlas 5,000 tpd MeOH

MtSynfuels Pilot Plant at Lurgi‘s R&D Center

Fuels From Renewable Resources



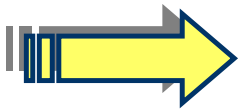
Important Biofuels – Raw Materials

1st Generation Biofuels

- Oleaginous plants (biodiesel)
  - Rapeseed/Soybean/Palm/Sunflower Seed Oil, etc. (food)
  - Animal Oils and Fats (non-food)
  - Jatropha/Cotton/Pongamia Oil (non-food)
- Starch-containing plants (bioethanol)
  - Grain, Sugar Beet, Sugar Cane, Potato, etc. (food)
  - Spoilt Grain (non-food)

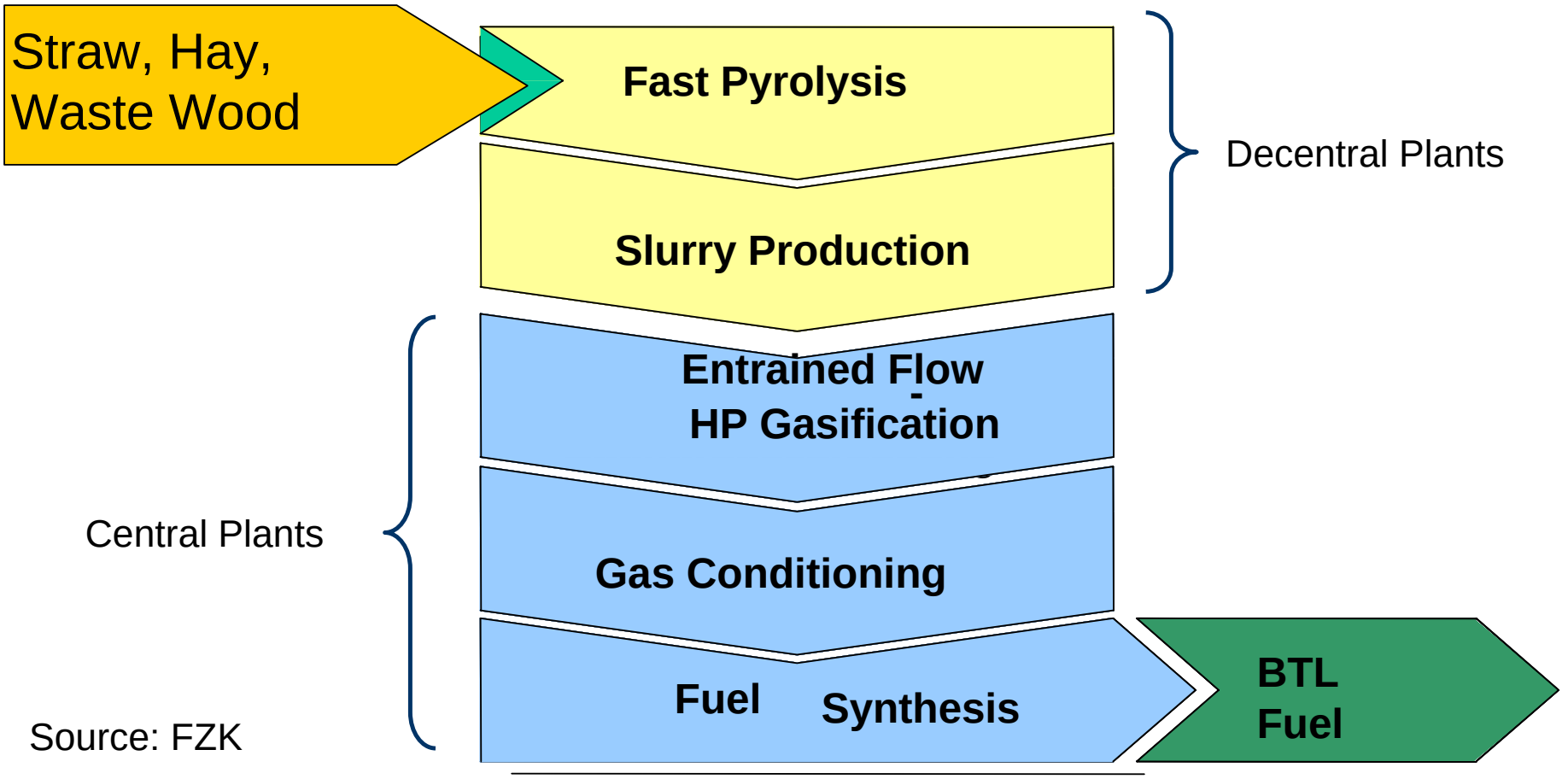
2nd Generation Biofuels

- Utilization of the complete plant (spec. yields up by a factor of 10 and more)



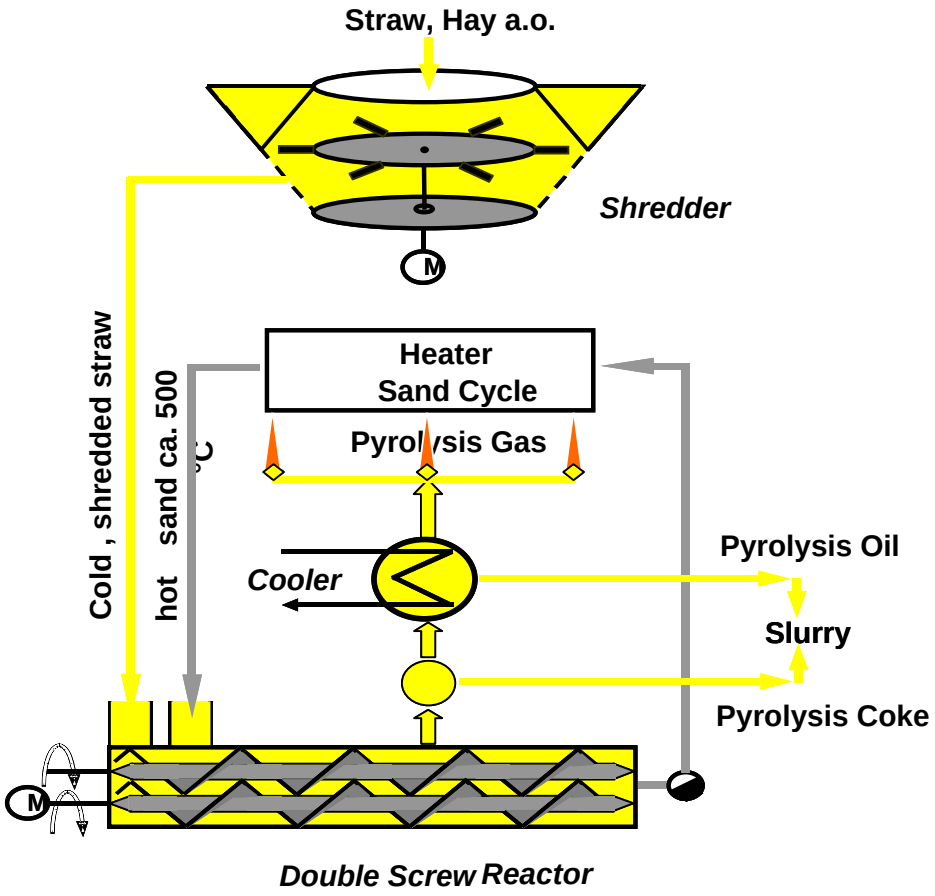
Production of Synthetic Fuels: Designer Fuels

Biomass-to-Liquids (BTL) - Concept



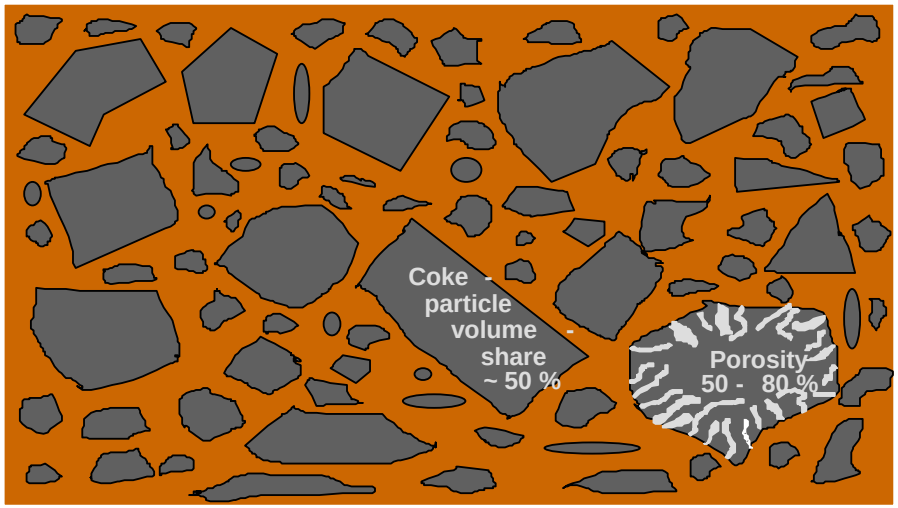
Source: FZK

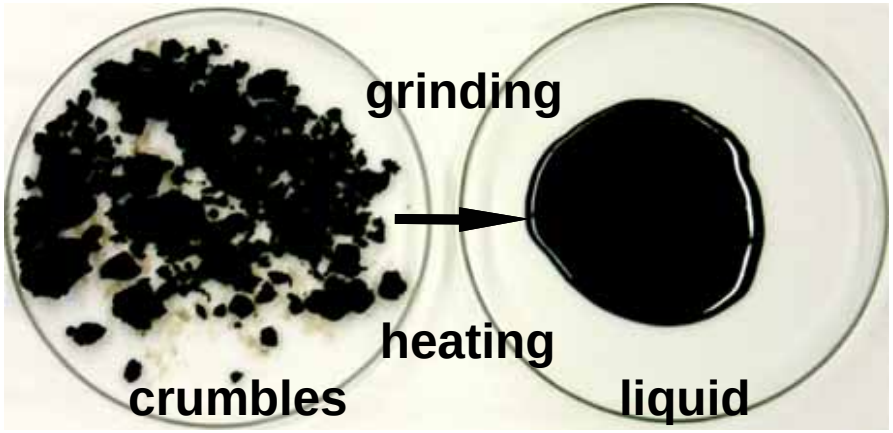
Fast Pyrolysis



Source: FZK

Slurry with Pyrolysis Coke





- Joint grinding of pyrolysis oil and coke gives pumpable/storable slurry
- Energy concentration from biomass to slurry by factor 13
- ca. 80% of the energy content of the biomass is contained in the slurry

Summary

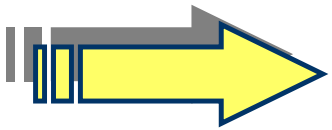
"Designer Fuels" required for

- Optimization in engine development
- Reduction of traffic emissions (including CO_2, particulates, hydrocarbons)

Economic effects of "Designer Fuels"

- Natural gas (GTL), coal (CTL) and biomass (BTL) are utilized
- No change in the distribution networks for fuel transport
- Reduced dependency on oil/gas imports
- Additional value added in agriculture

Conclusion:



Lurgi commands all technologies from energy feedstock to synthetic fuel (designer fuel)