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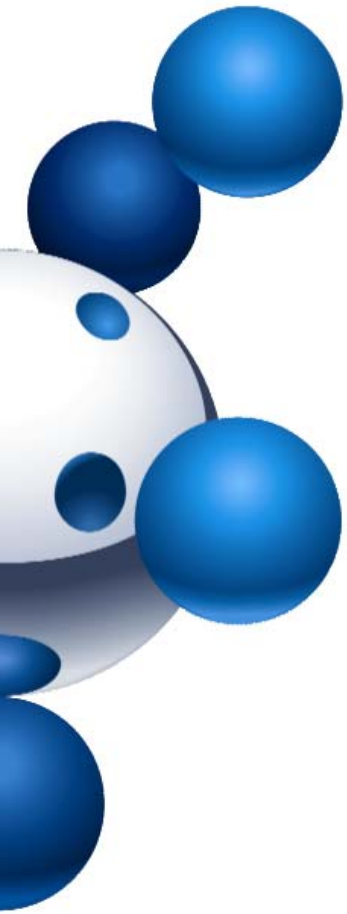


Application of Synthetic Diesel Fuels

"Future Fuels : Issues and Opportunties"

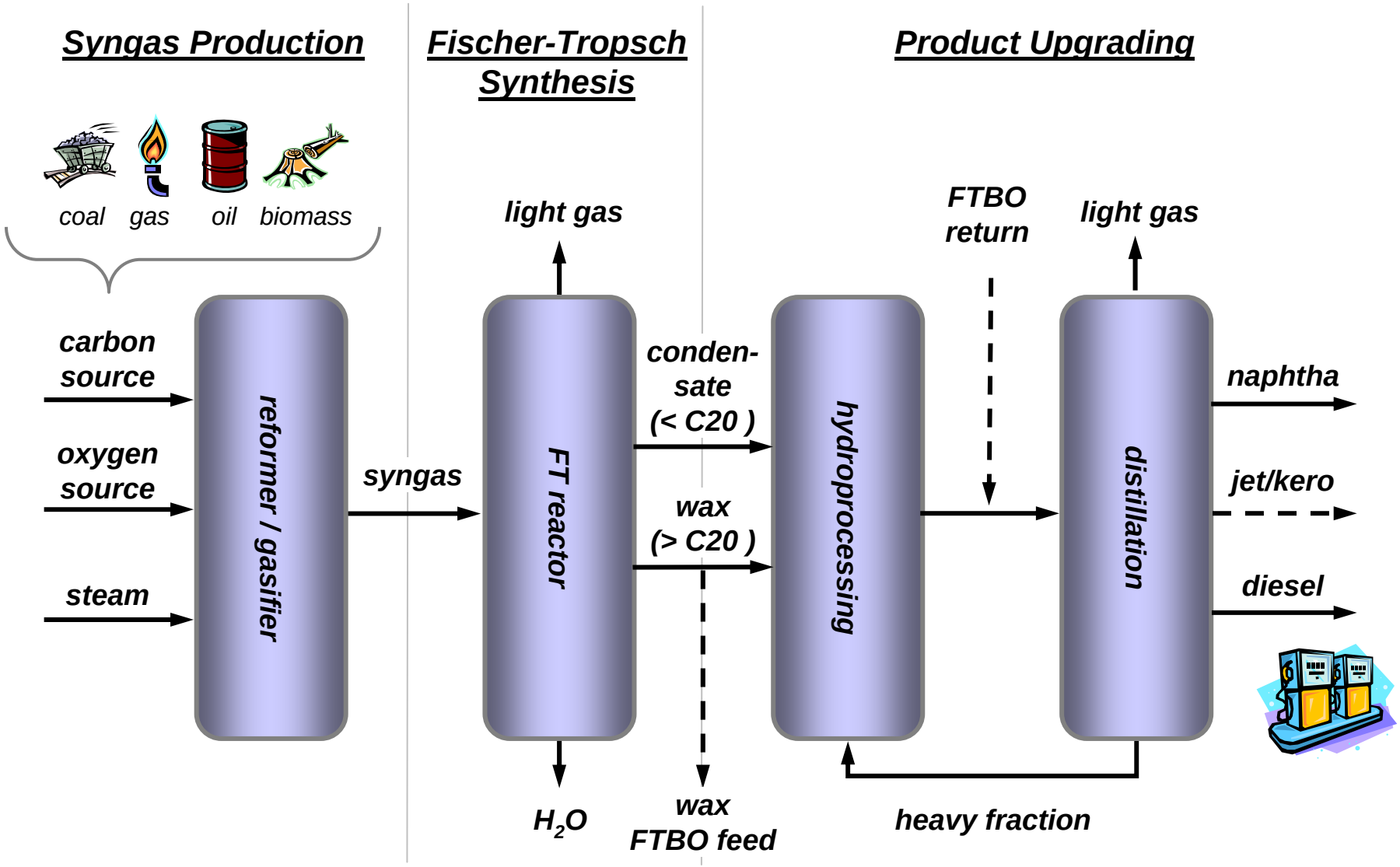
11th Diesel Engine Emissions Reduction Conference, Chicago, August 21-25, 2005

Paul Schaberg, Sasol Technology

Presentation Outline

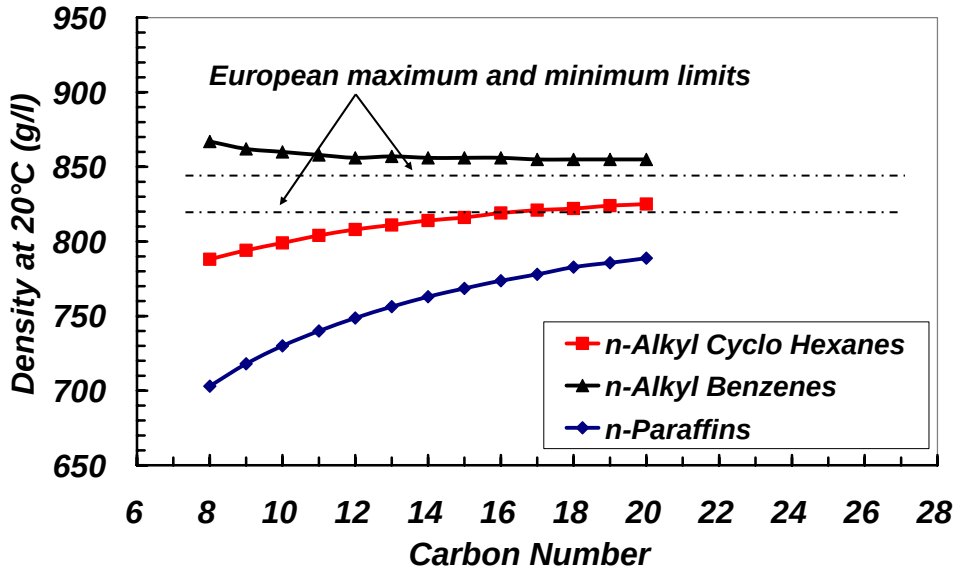
- *Description of synthetic diesel fuel production processes*
- *Description of synthetic diesel fuel properties*
- *Overview of Sasol's current GTL and CTL plans*
- *Possible market introduction scenarios*
- *Combustion and exhaust emissions with GTL diesel fuel and blends*
- *Opportunities for engine optimisation*
- *Summary and concluding remarks*

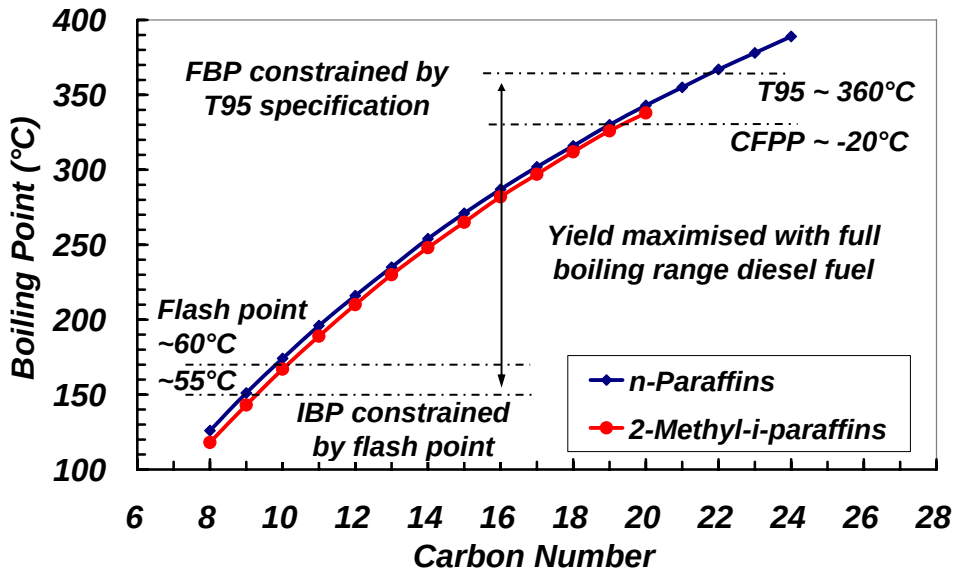
Generic xTL Process



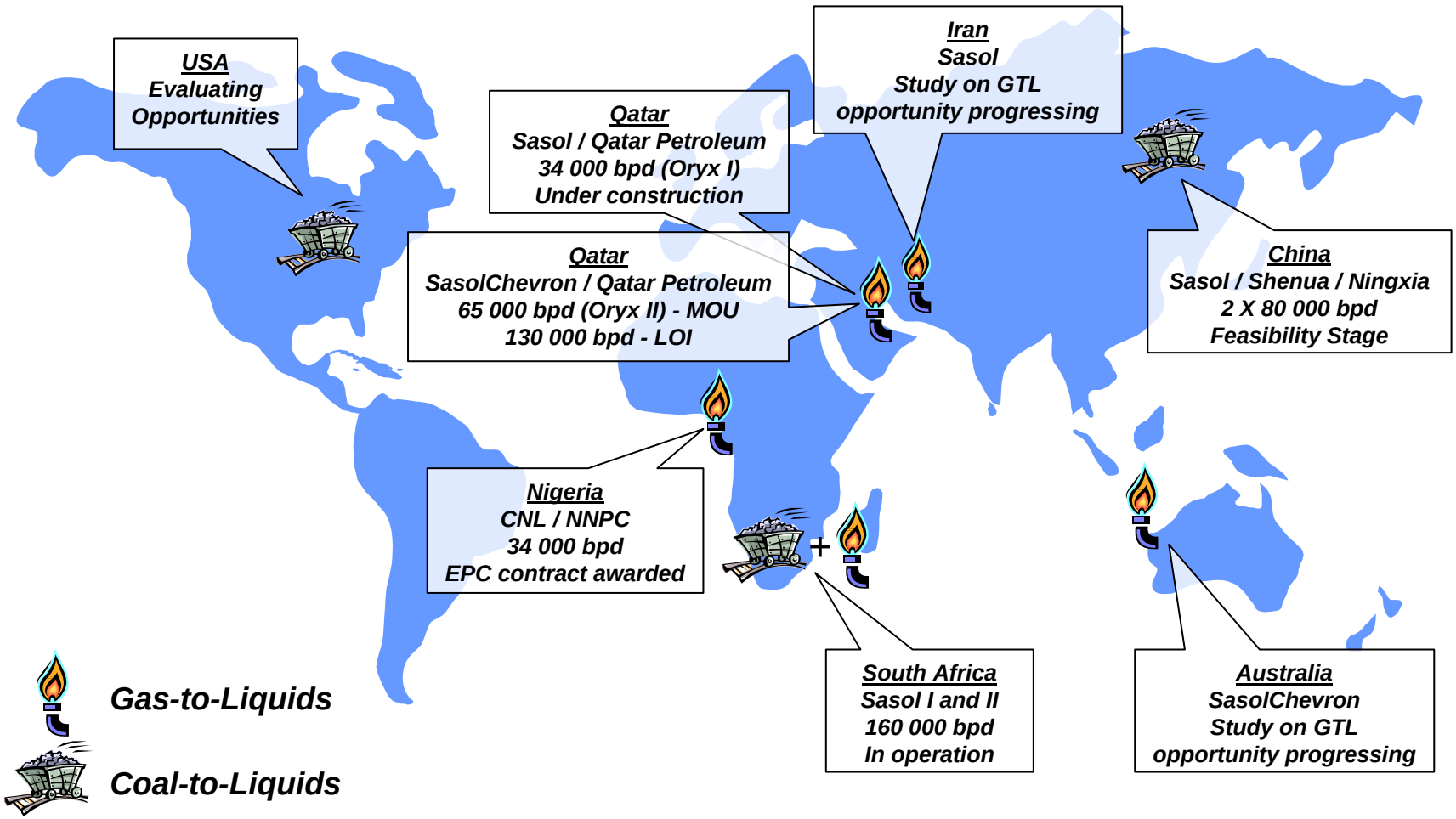
Diesel Fuel Properties

- *Clear, odourless liquid*
- *Highly paraffinic (total aromatics < 1%, polycyclic aromatics < 0.05%)*
  - *Density ~ 770 g/l*
  - *H/C ratio ~ 2.10 mol/mol*
  - *LHV ~ 43.8 MJ/kg*
  - *Cetane number > 70*
- *Very low sulphur (< 1ppm)*
- *Good thermal stability*
- *Distillation range determined by:*
  - *Applicable specifications (T90, flash point, cold flow properties)*
  - *Jet / kerosene production*





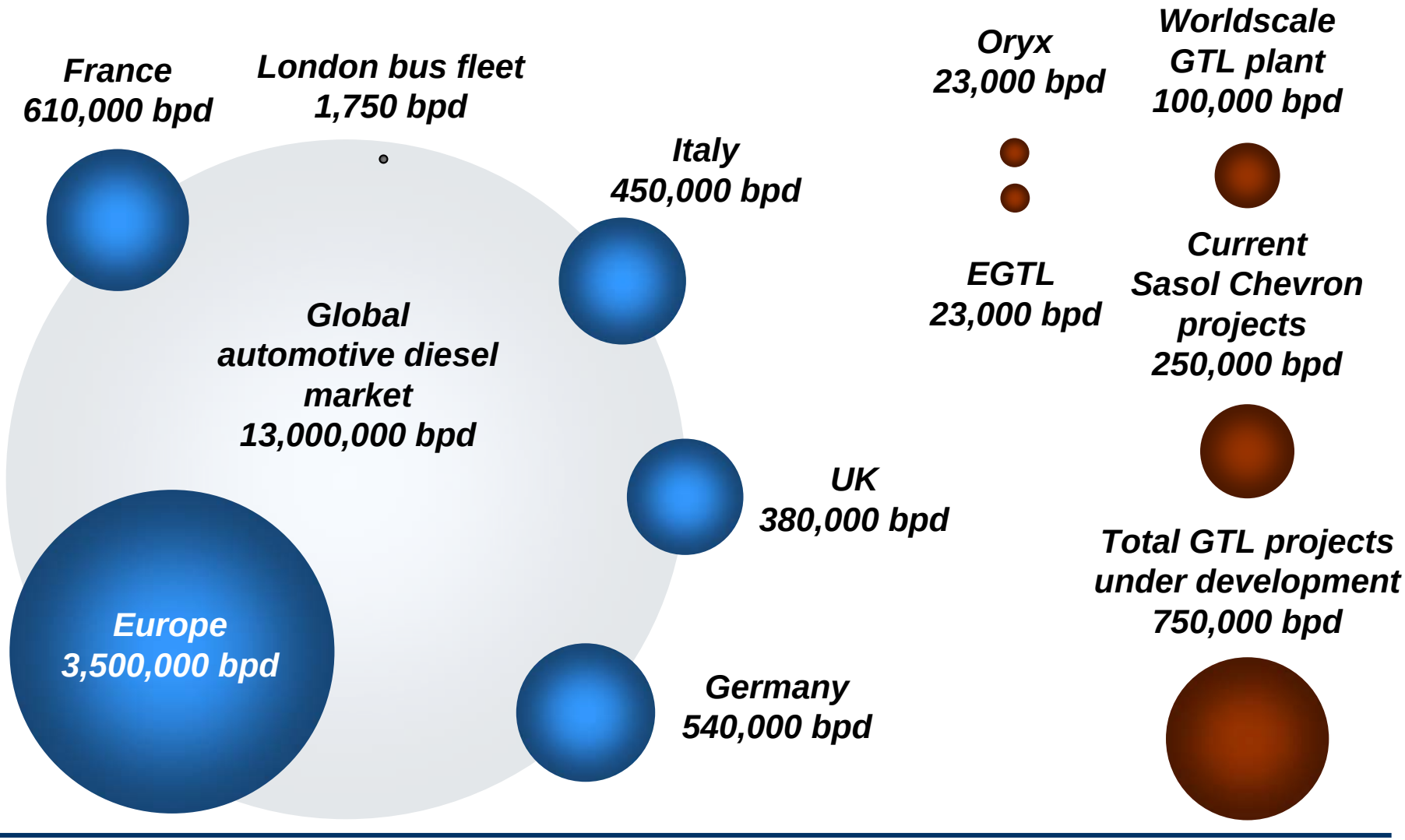
Current GTL and CTL Plans



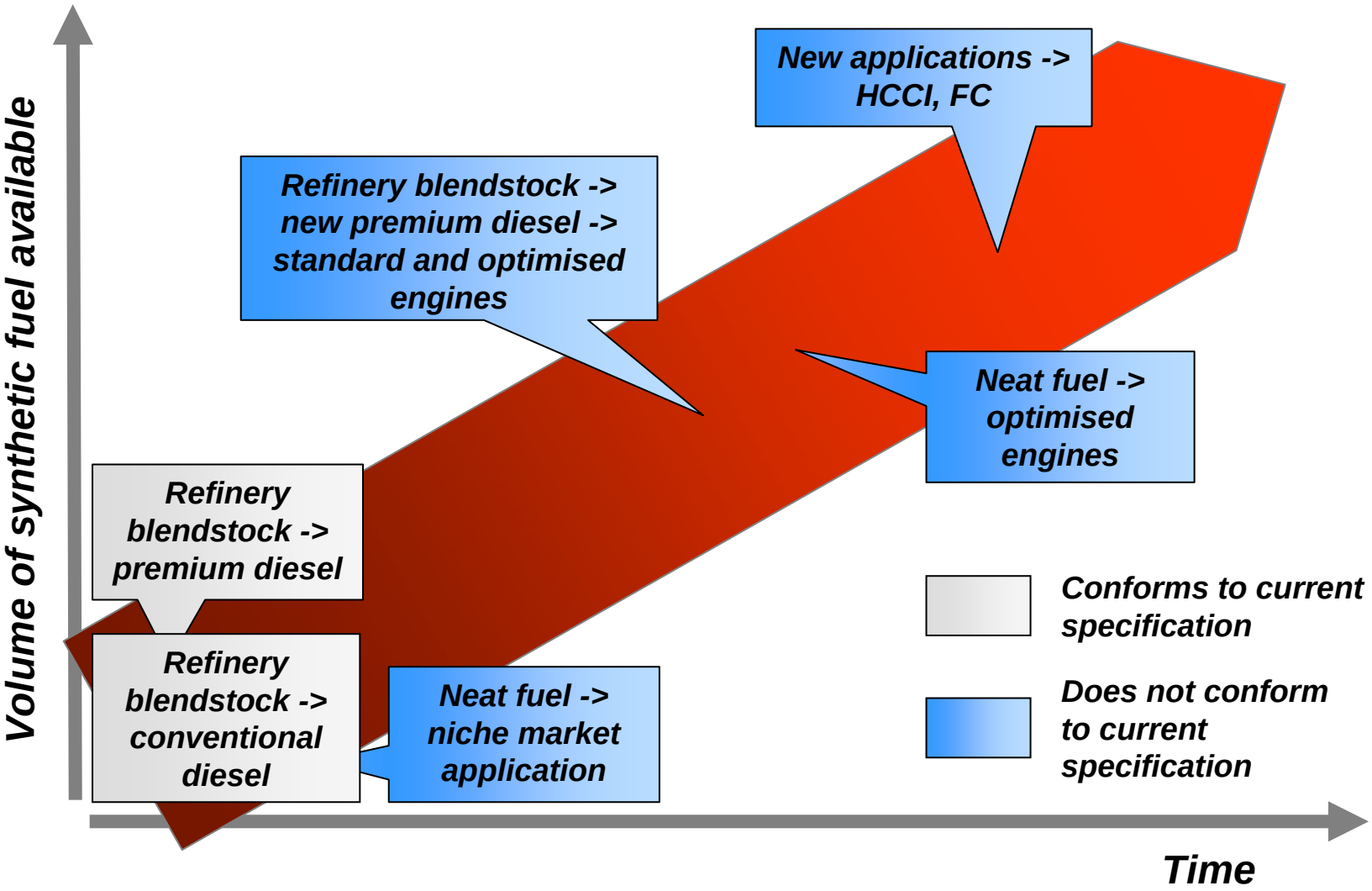
Oryx GTL, Qatar

- *34 000 bpd initial capacity, expansion to 100 000 bpd*
- *Startup end Q1 2006*
- *FT reactor*
  - *Mass = 2200 tons*
  - *Height = 60m*
  - *Diameter = 10m*

GTL Diesel Relativity

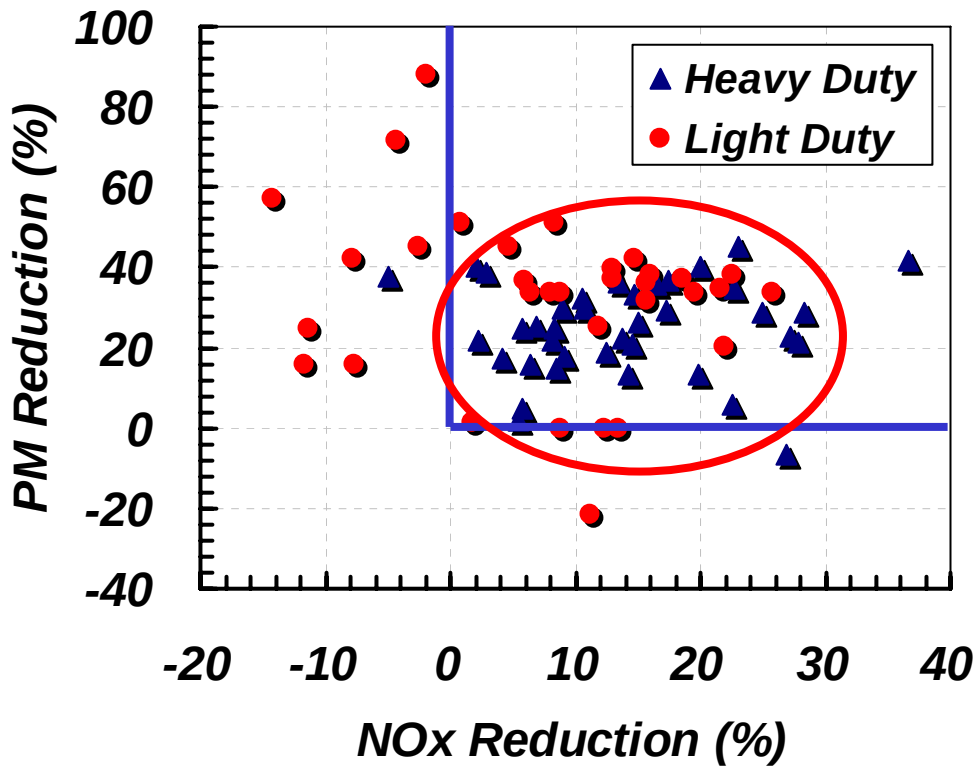


Some Application Scenarios



Exhaust emissions with GTL diesel fuel, conventional engines

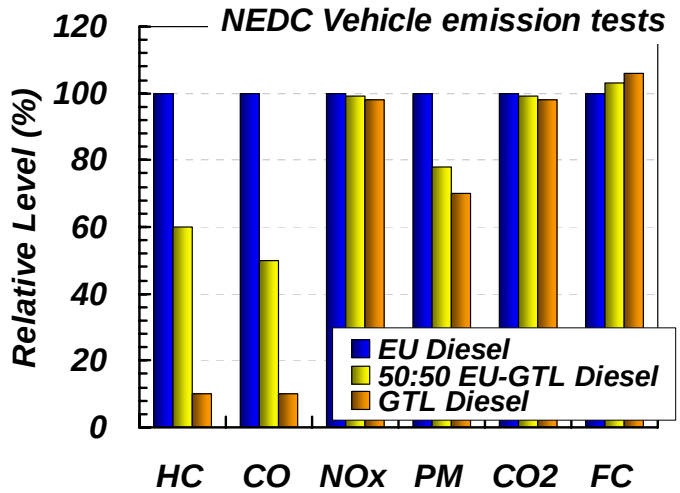
- *Typically obtain reductions in all regulated emissions (HC, CO, NOx, PM)*
- *Reductions in CO_2 and other unregulated emissions*
- *NOx and PM critical:*
  - *13% avg. NOx reduction*
  - *26% avg. PM reduction*

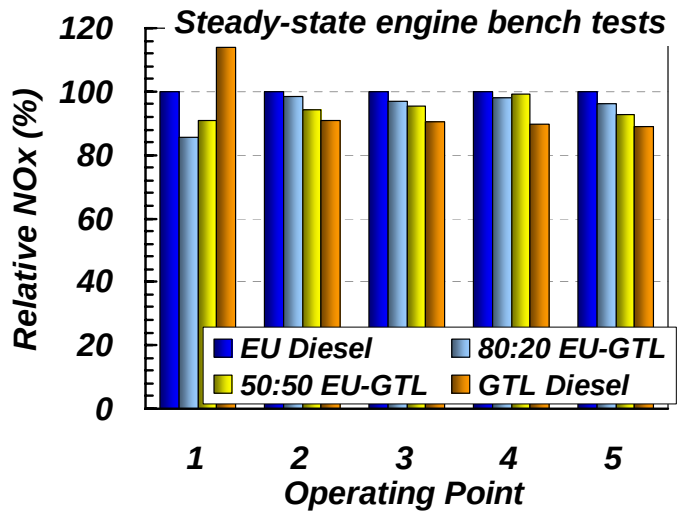


Source : NREL SAE Paper 2003-01-0763

Passenger Car Emission Tests

- *Tests performed with a Mercedes E220 CDI (Euro 3) vehicle and engine*
- *Neat GTL diesel fuel and blends compared with sulphur-free EN590 diesel fuel*
- *All calibration parameters kept constant during steady-state tests*
- *Blends showed disproportionate reductions in soot / PM in both vehicle and engine tests*
- *Disparity in NOx response between vehicle test and engine tests : non-optimal engine calibration for lower density, higher cetane fuels.*

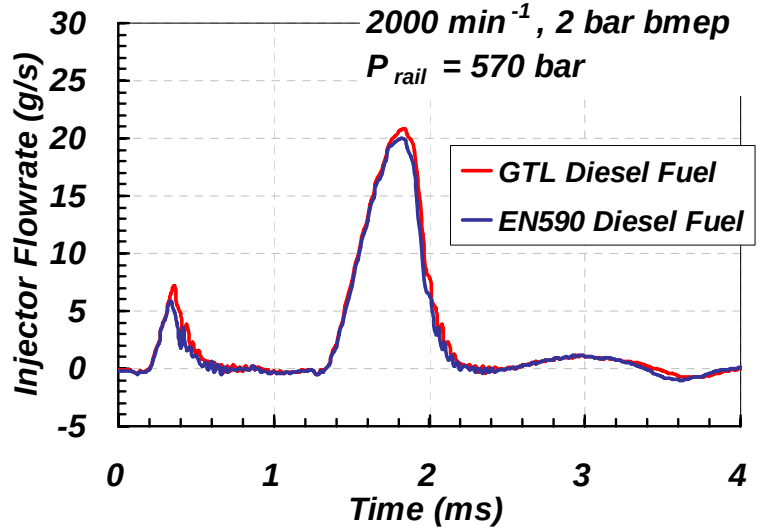


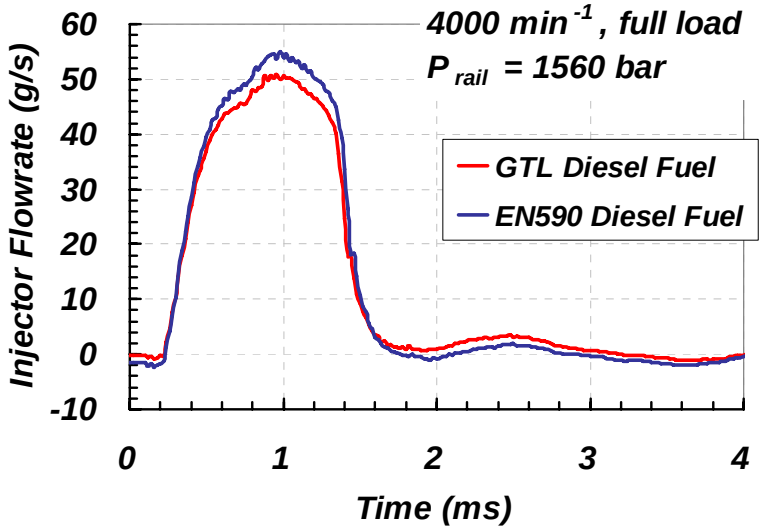


Injection System Performance

Common-rail FIE

- *Injection rates for the two fuels are similar at low loads*
- *Expected deviation due to density difference is evident at higher loads*
- *No negative effects on operation of FIE*
- *Besides lower density, lower viscosity of GTL diesel fuel could to be influencing parameter*

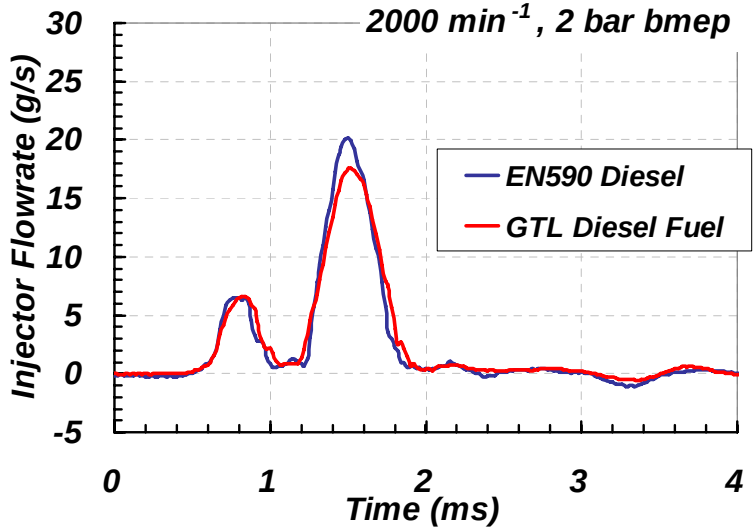


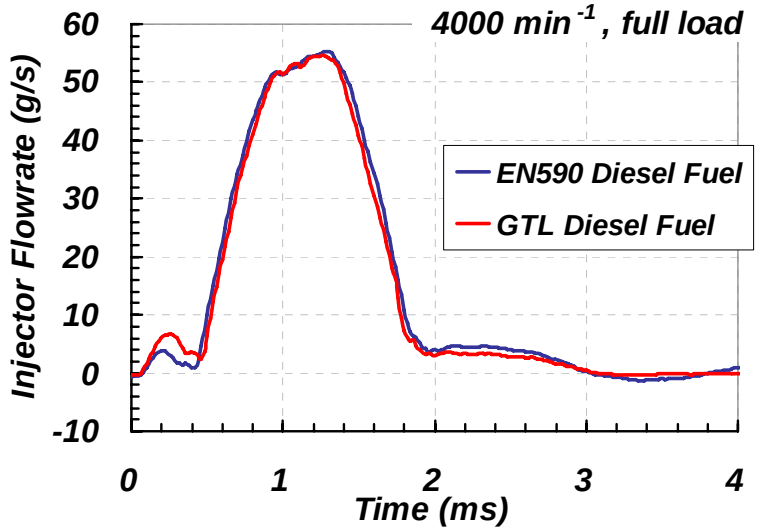


Injection System Performance

Unit Injector FIE

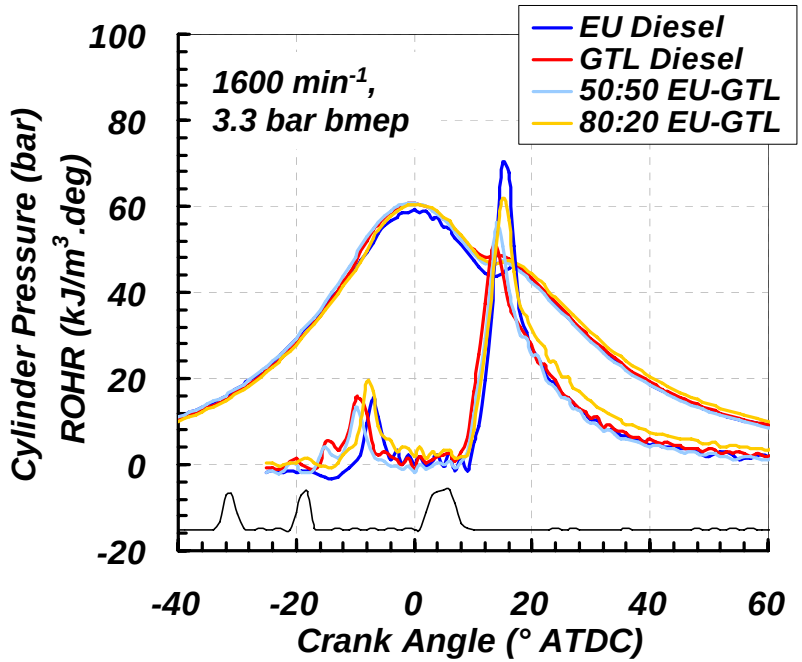
- *Injection rate for the GTL diesel fuel is lower than EN590 diesel fuel at low loads*
- *Deviation at higher loads is smaller*
- *No negative effects on operation of FIE*
- *Besides density, lower bulk modulus of GTL diesel fuel could be an influencing parameter*

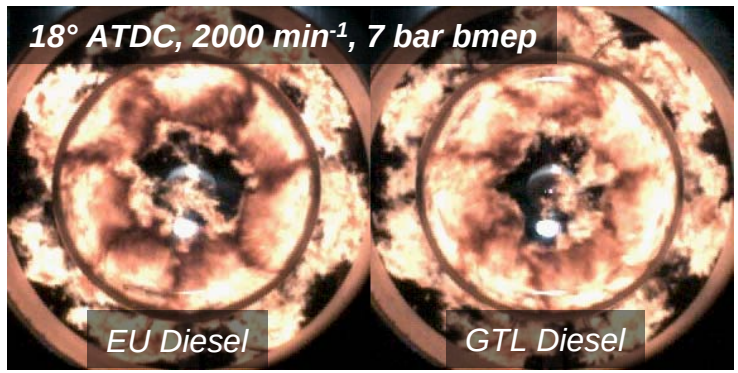




Combustion Properties

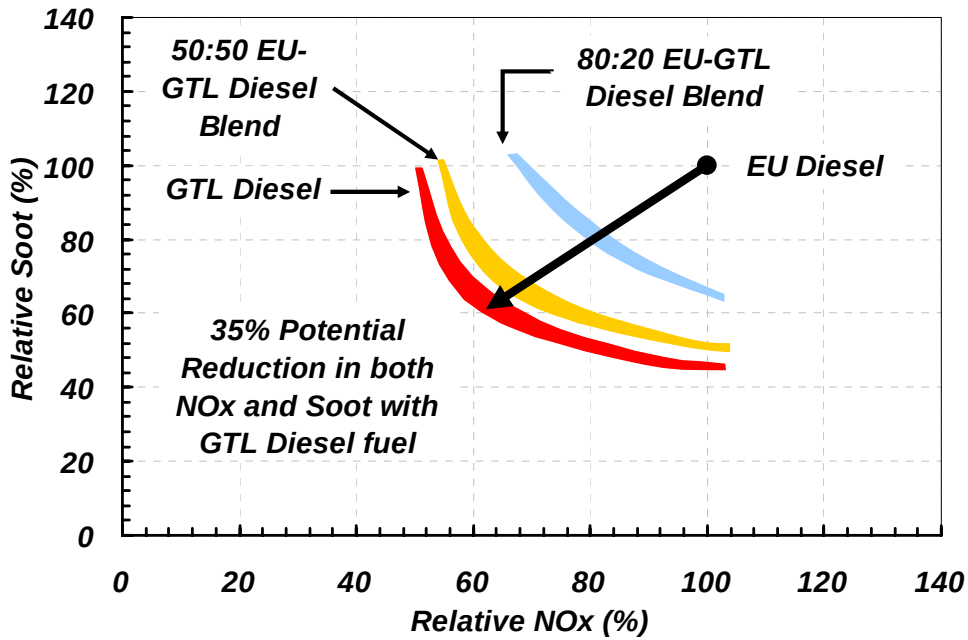
- *Combustion processes of GTL diesel fuel have been compared to EN590 diesel fuel, using both classical and advanced in-cylinder diagnostics*
- *As expected, differences in ignition properties and soot formation have been observed*
- *Difference in ignition delay is a non-linear function of cylinder pressure and temperature (load).*

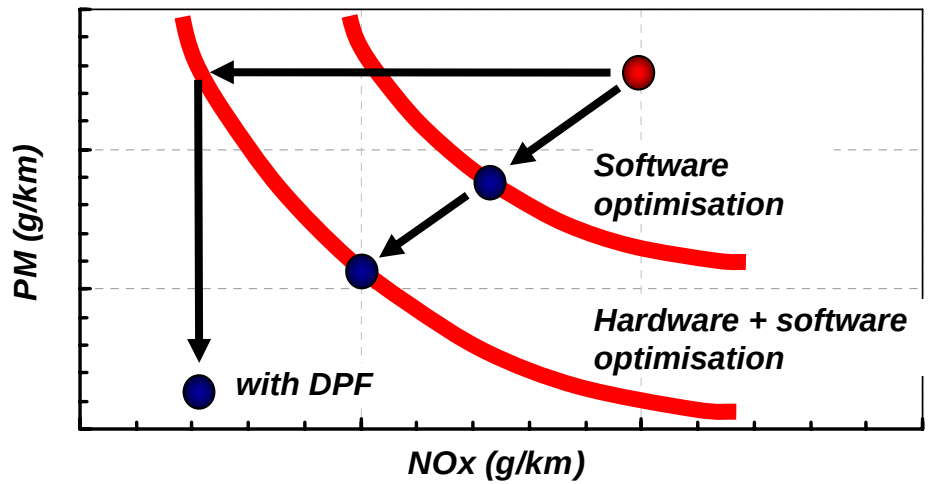




Opportunities for Optimisation

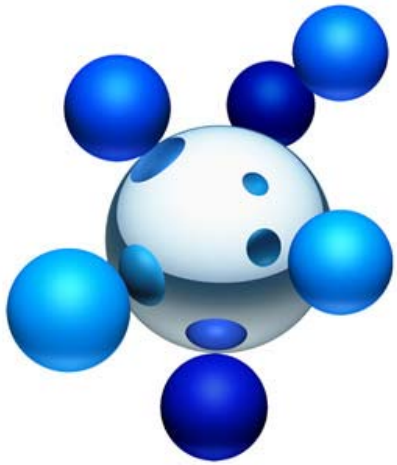
- *35% reduction in both soot and NOx through software optimisation*
- *Hardware optimisation (combustion system, FIE) is expected to compliment this further*
- *End result could be reduced requirement for exhaust gas aftertreatment, i.e. cost saving*





Summary

- *Dawn of the synthetic fuels age*
  - *Synthetic fuels technology is enabling the production of clean, very high quality fuels from diverse feedstocks, including non-petroleum and renewable feedstocks*
  - *Plans for a significant number of large scale GTL production plants have been announced, the first of which will start up in 2006*
- *Relative synthetic fuel volumes will be small for many years – global impact will be small, but regional impact can be significant*
- *Developing an understanding of the combustion and emissions properties of synthetic diesel fuels in order to:*
  - *Ensure problem-free operation in both neat and blended form*
  - *Quantify the benefits*
  - *Understand opportunities for engine optimisation*
  - *Understand the opportunities for future combustion systems*



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