



LEANSHIPS: DEMONSTRATING METHANOL AS A MARINE FUEL

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Demonstrate the potential of methanol as marine fuel



- ✓ Develop retrofit solution
- ✓ Convert engine to dual-fuel
- ✓ Perform tests on dual-fuel
- ✓ Disseminate results to industry
- ✓ Follow-up projects

WHY ARE WE HERE AGAIN?

- We want to set out the path to **sustainable shipping**
- That means: aiming, **long-term**, for a chain
energy source – energy carrier – energy converter



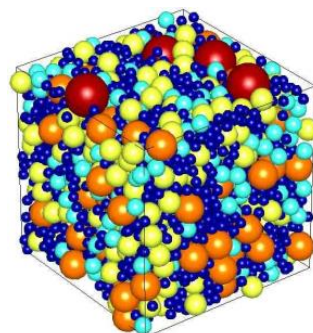
- **Sustainable**

- Source: solar, wind, bio, ...
- Closed cycle for energy carrier and converter materials



- **Scalable**

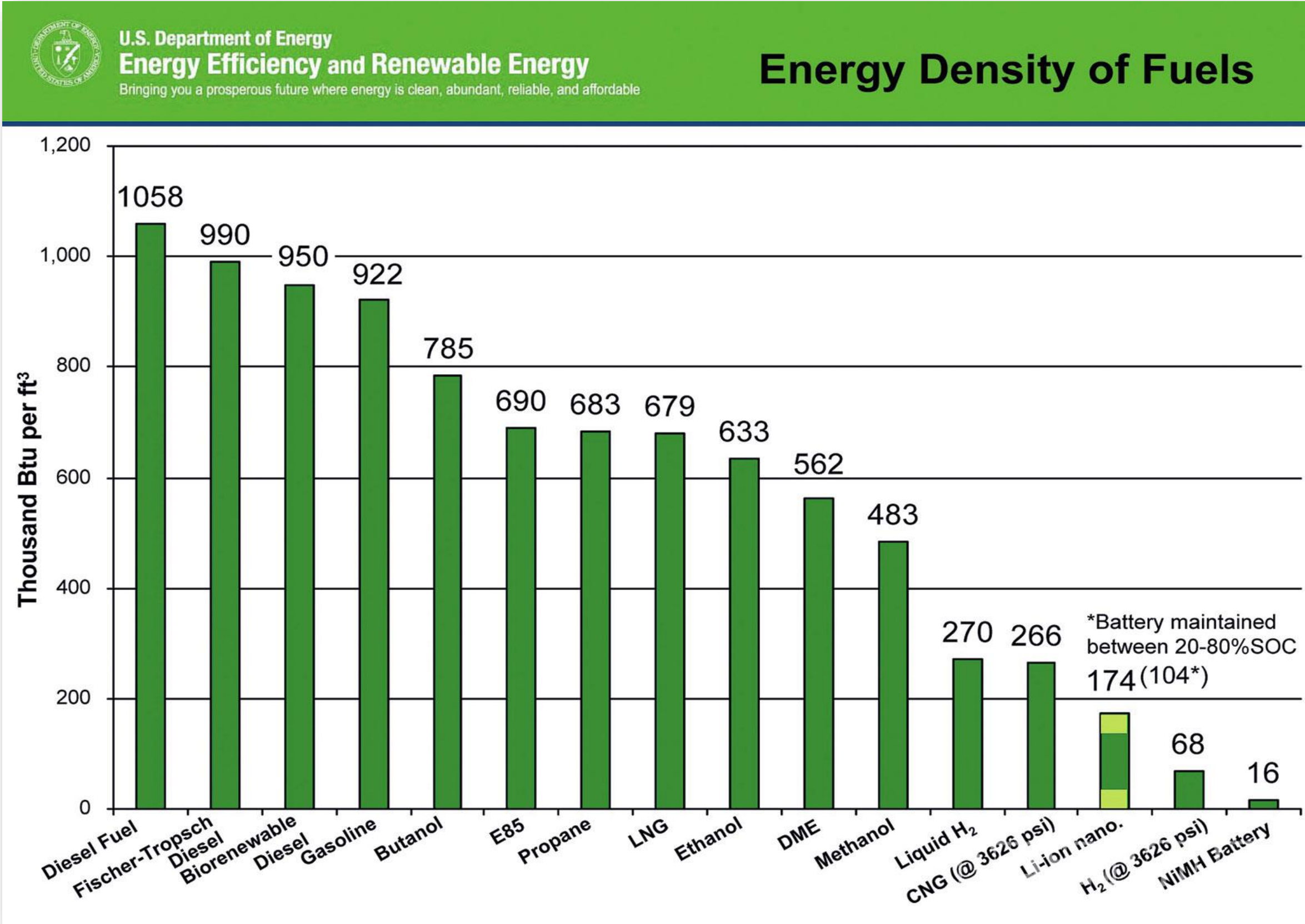
- Use abundantly available resources
- Also implies affordable



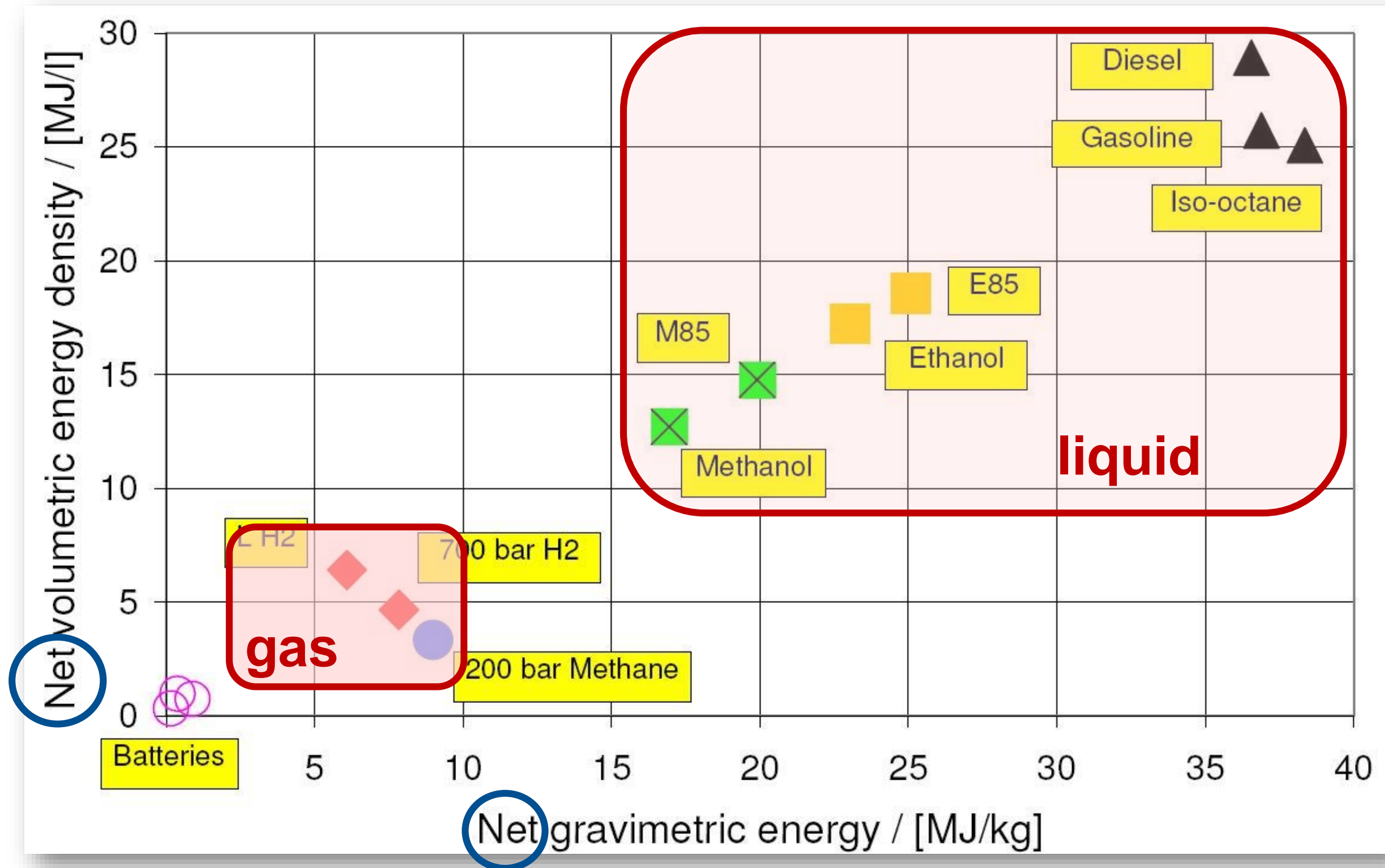
- **Storable**

- High energy and power density: need range & payload

FUEL ENERGY DENSITY IS IMPORTANT

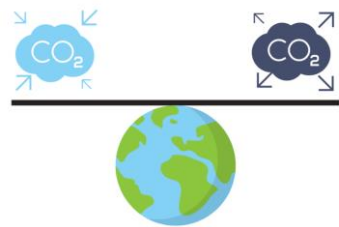


SYSTEM ENERGY DENSITY EVEN MORE

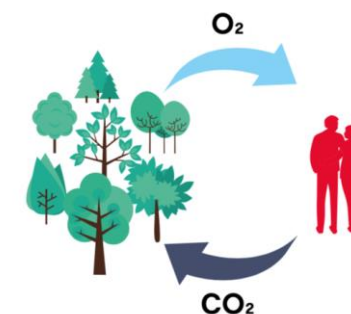


WHICH FUELS?

- Fuels containing carbon have highest energy densities
- Note **carbon in itself is not a problem** – biosphere works on it!
- BUT: we need to restore the carbon balance
= close carbon cycle, increase speed at which carbon is captured



- Can't rely on fossilization, can't rely on biomass: **too slow**
- Must use chemistry, driven by renewable energy, to capture carbon

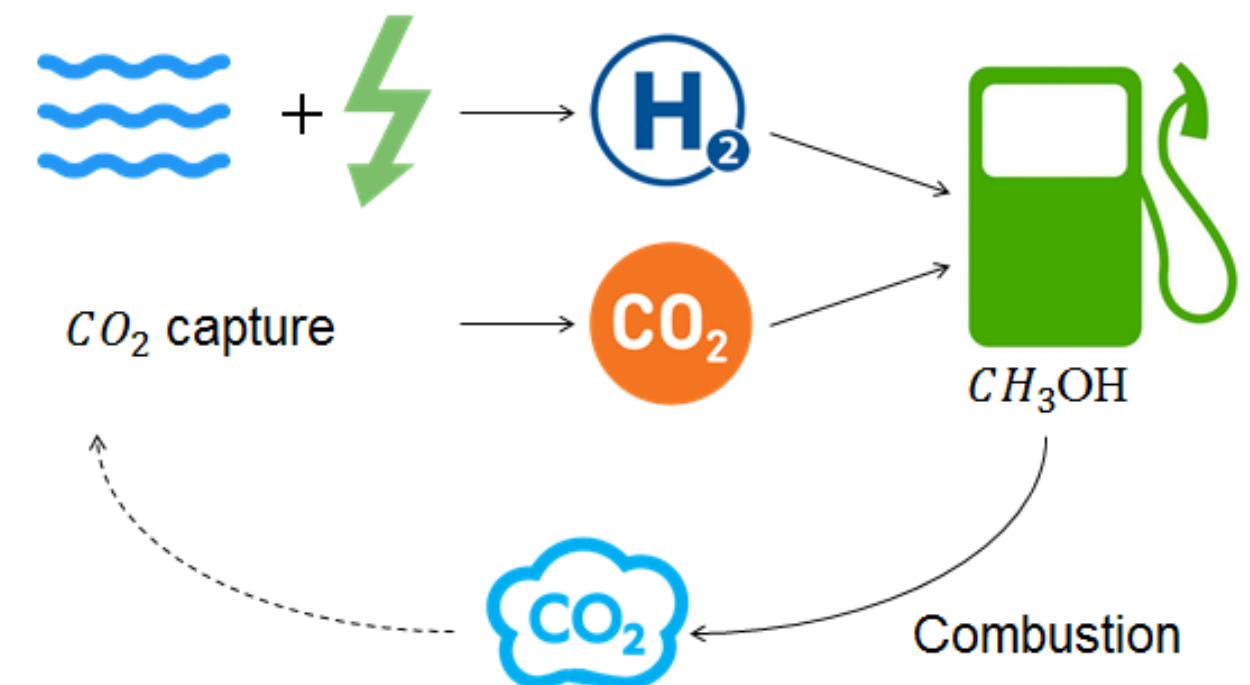


WHICH FUELS? (2)

- Now that we need to synthesize fuels, let's make what we want
 - Sufficient energy density & preferably simple molecules
 - Production (WTT) and use (TTP) is more efficient
- Abundantly available building blocks: C, H, O, N, ...
- Thus, most simple fuels:
 - Hydrogen, H_2 (at p_{atm} , liquid at $-253^\circ C$)
 - Methane, CH_4 (at p_{atm} , liquid at $-182^\circ C$)
 - Ammonia, NH_3 (at T_{atm} , liquid at 8.6 bar)
 - Methanol, CH_3OH (liquid) **RENEWABLE LIQUID FUEL**

WHY METHANOL?

- Methanol is biodegradable
- Great engine fuel:
 - Low emissions (no PM, no S, low NOx)
 - High efficiencies
- One of the most traded chemicals worldwide
- Liquid at room temperature and pressure
- Can be produced in different ways
 - Biomass, fossil fuels
 - Synthesize using renewable energy



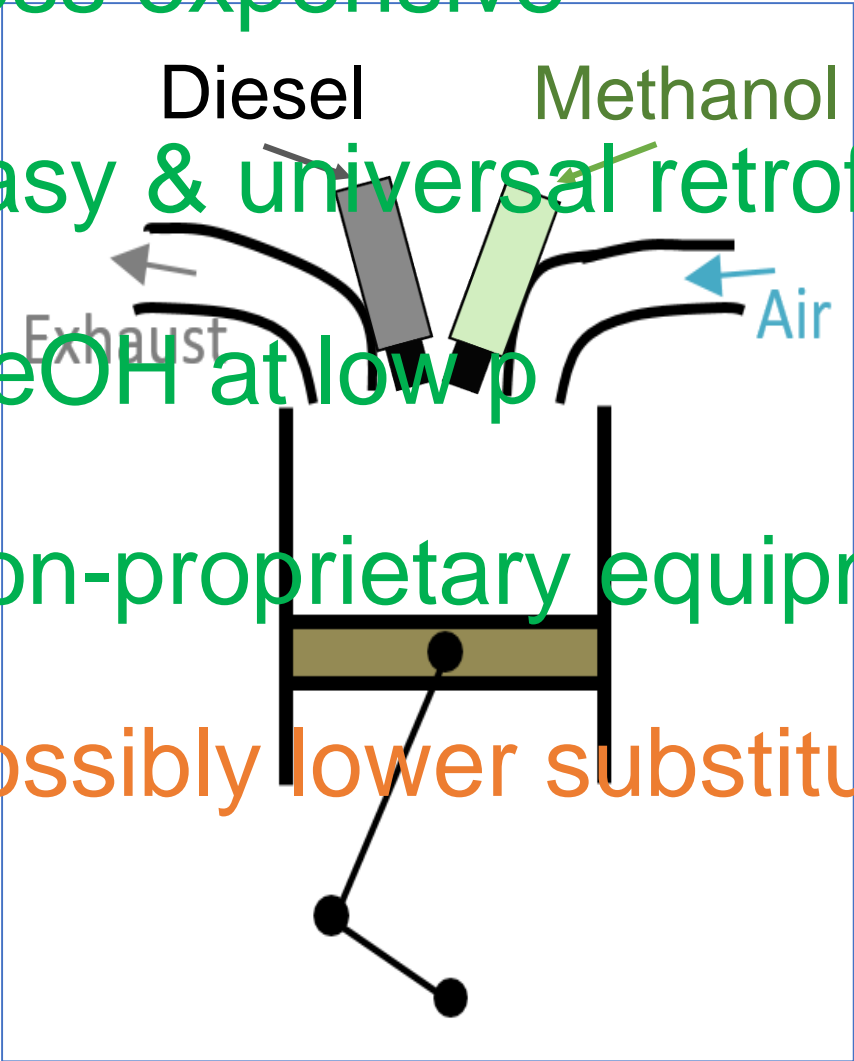
RETROFIT: DUAL-FUEL TECHNOLOGY

1 dual-fuel injector
Direct injection



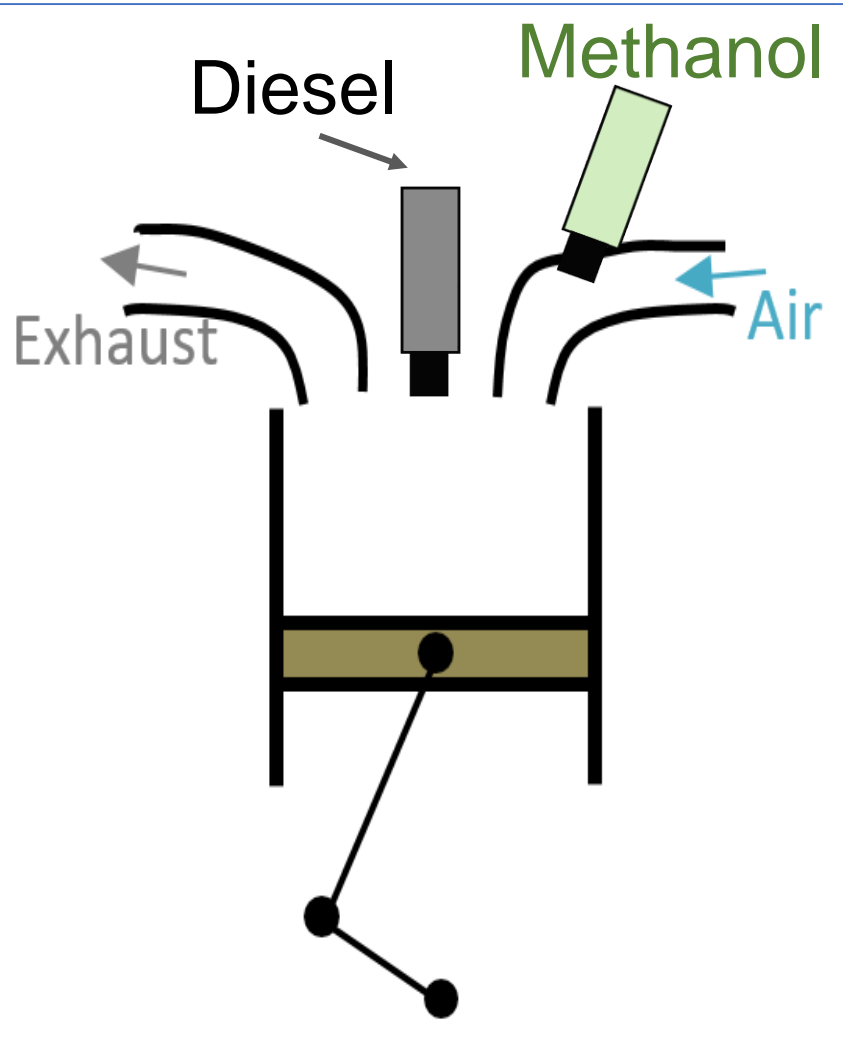
2 injectors
Direct injection

- ✓ Less expensive
- ✓ Easy & universal retrofit
- ✓ MeOH at low p
- ✓ Non-proprietary equipment
- X Possibly lower substitution



FUMIGATION TECHNOLOGY

2 injectors
DI + PFI

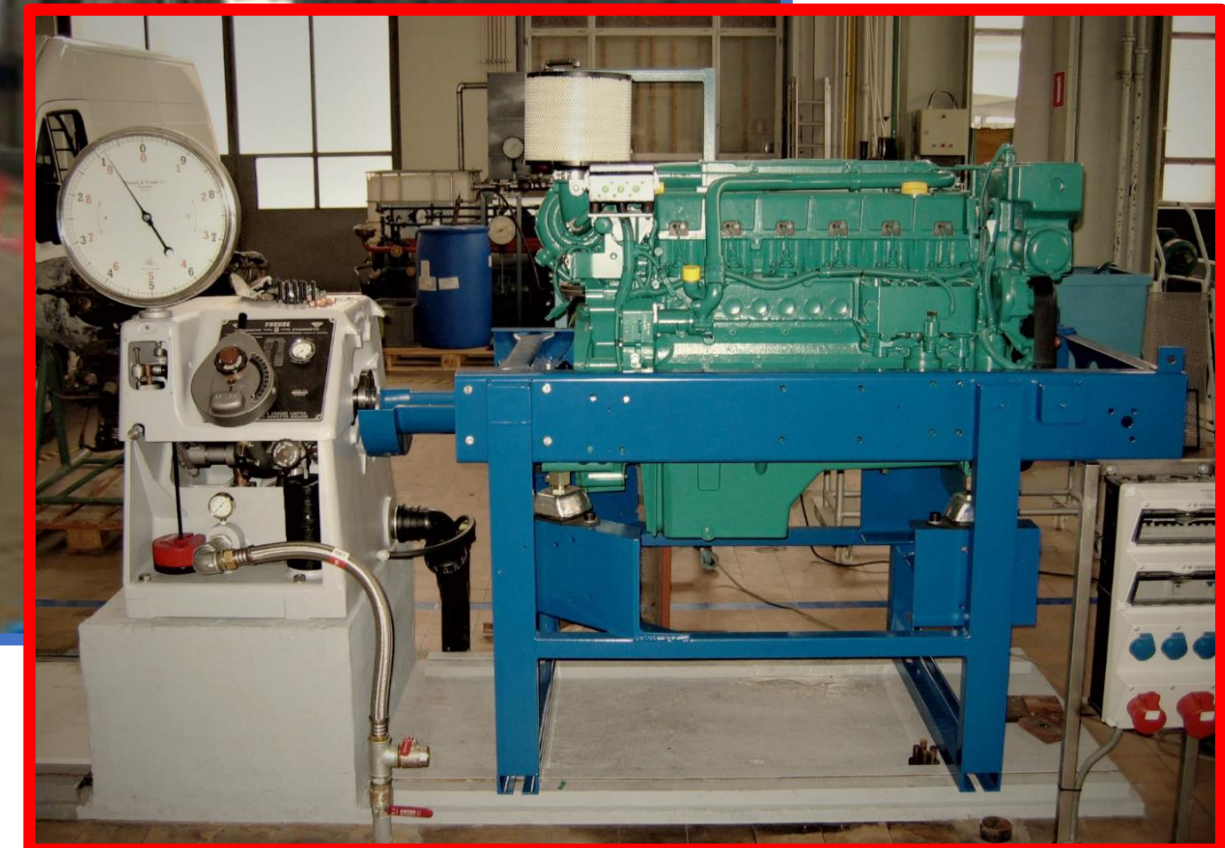


ENGINE CONVERSION TO DUAL-FUEL

END

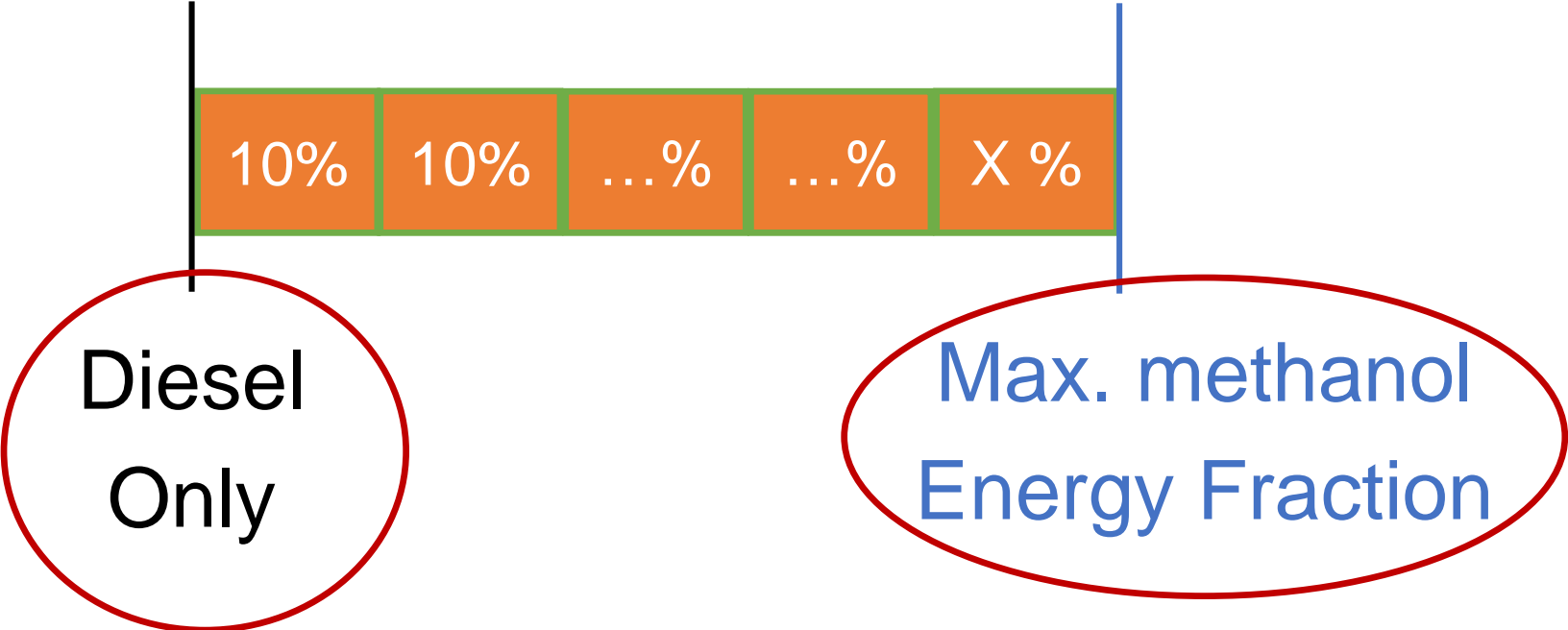
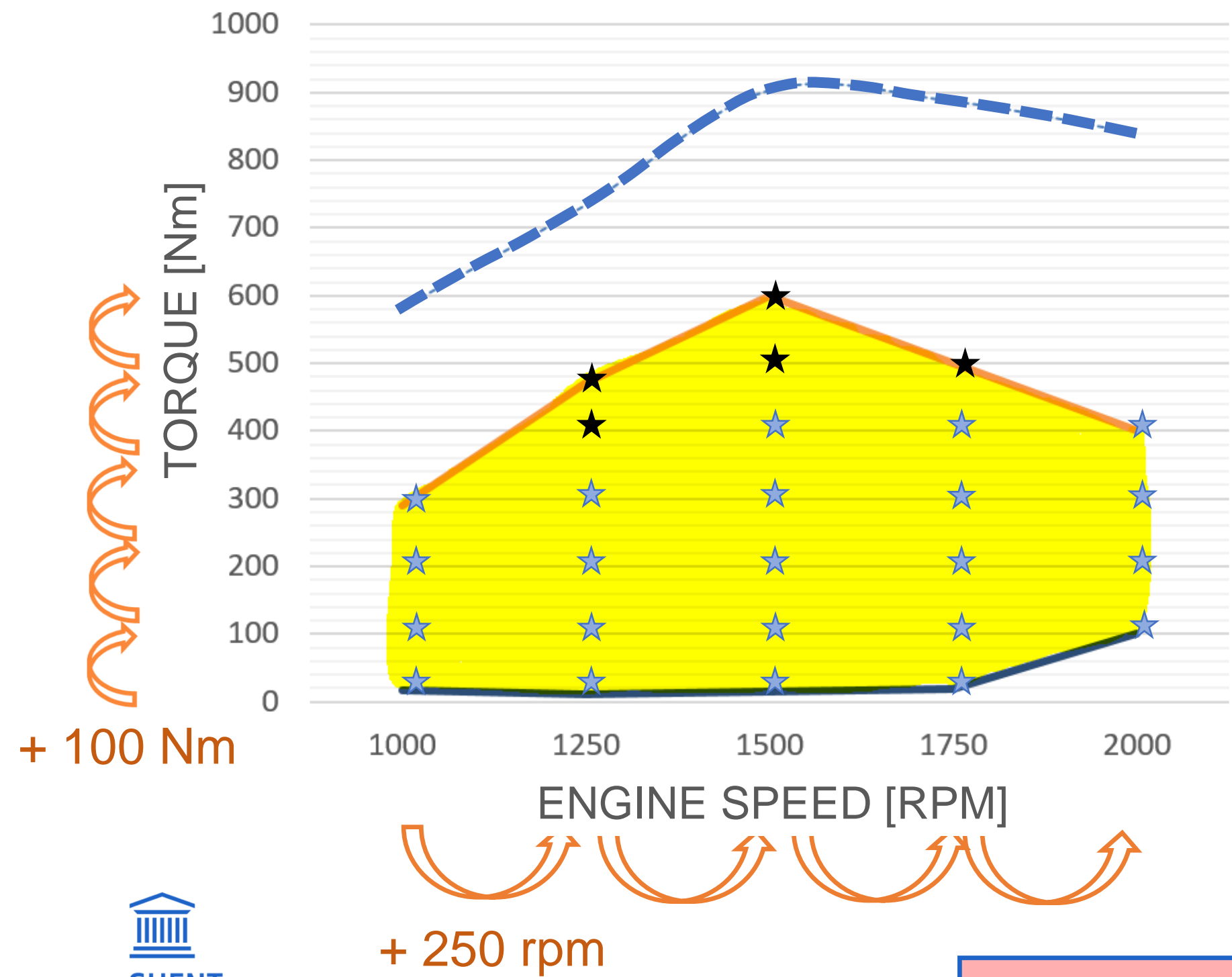


START

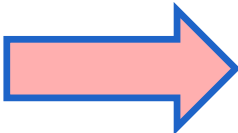


BENCH TEST PROGRAM

--- Maximum torque



- 4 engine parameters:
- 1. Methanol Energy Fraction
 - 2. Brake thermal efficiency
 - 3. NO emissions
 - 4. Soot emissions



LIMITATION: fixed diesel injection timing

SUMMARY OF RESULTS

- **Methanol energy fraction:** between 25% and 70%
- **Efficiency:** max + 12%
 - Lower at low loads, higher at high loads
- **NO emissions:** average -60%
- **Soot emissions:** average -77%



2019 | 013

Efficiency and Emissions of a High-Speed Marine Diesel Engine Converted to Dual-Fuel Operation with Methanol

5 - Low Carbon Combustion - What Are the Alternative Fuels for the Future

Jeroen Dierickx, Ghent University

Louis Sileghem, Ghent University
Sebastian Verhelst, Ghent University



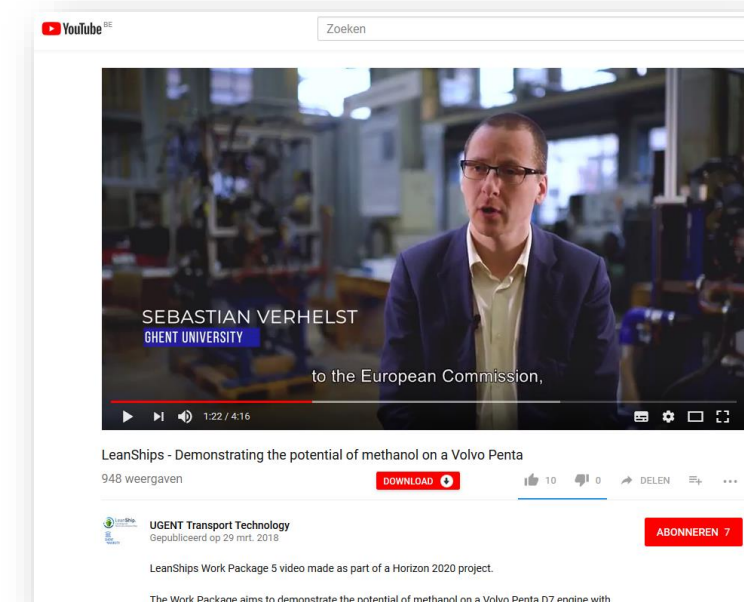
2016 | 224

Using Alcohol Fuels in Dual Fuel Operation of Compression Ignition Engines: A Review

10 Fuels Lubricants & Fluid Technologies

Jakob Coulier, Ghent University

Sebastian Verhelst, Ghent University



NEXT ACTIONS

- In follow-up projects **barriers are tackled** to use methanol as a marine fuel



**Commercial
dual-fuel
engine technology**



**Real life
demonstrators**



**Methanol marine
fuel logistics**



Rules & regulations

- Judge alternatives minimally by 3 criteria:
sustainable – scalability – storability
- Need to make hydrogen storable → use CO₂ to make it into liquid
→ **methanol simplest option**
 - And already available, biodegradable, safe, clean, ...
- **Combustion engine** is sustainable, scalable technology
- Dual-fuel technology is attractive solution
- And methanol is a great engine fuel!
 - High power, high efficiency, very low emissions



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