

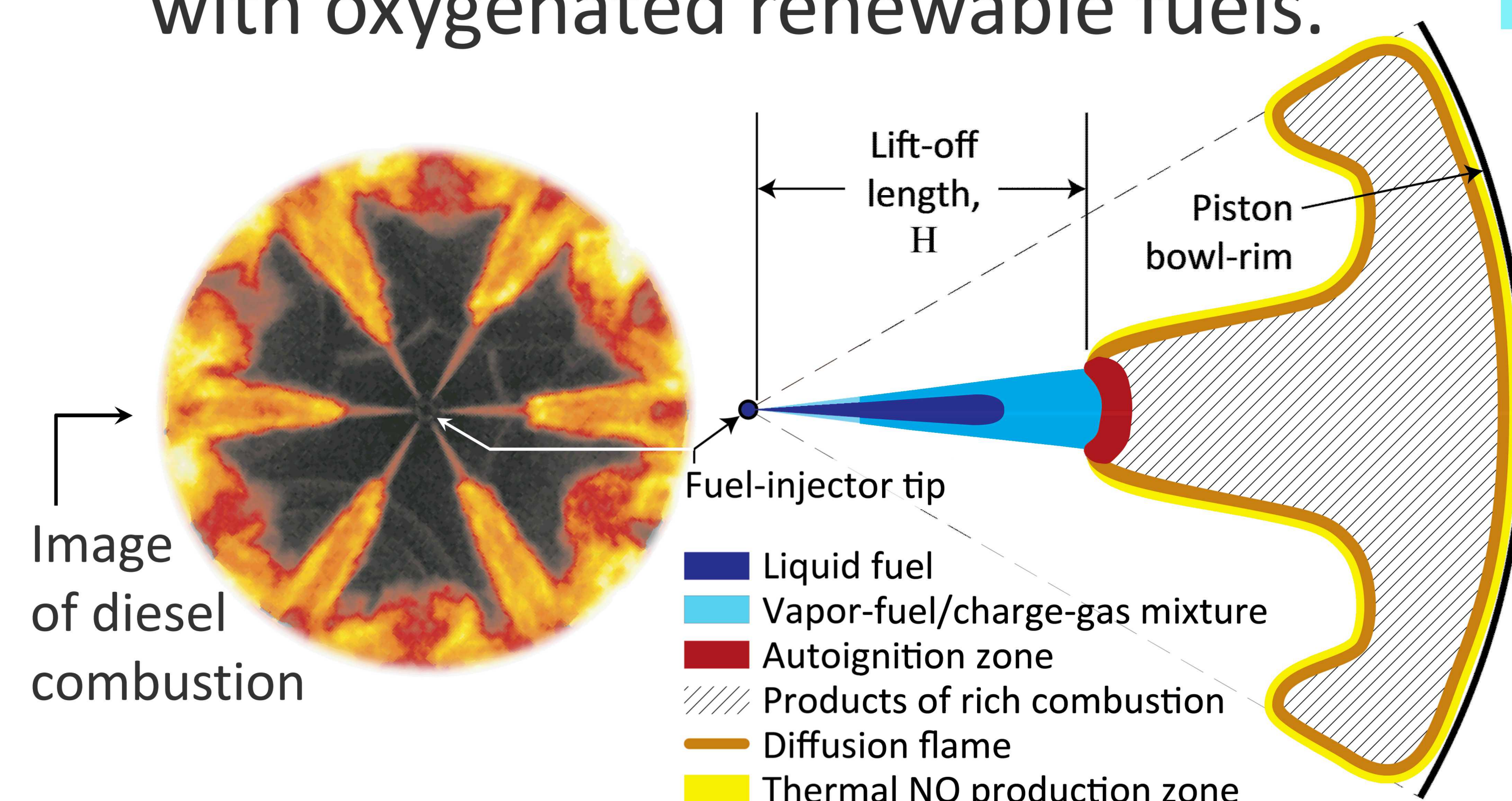
A Vision for Clean, Sustainable, Cost-Effective Heavy-Duty Engines & Fuels

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Summary of approach

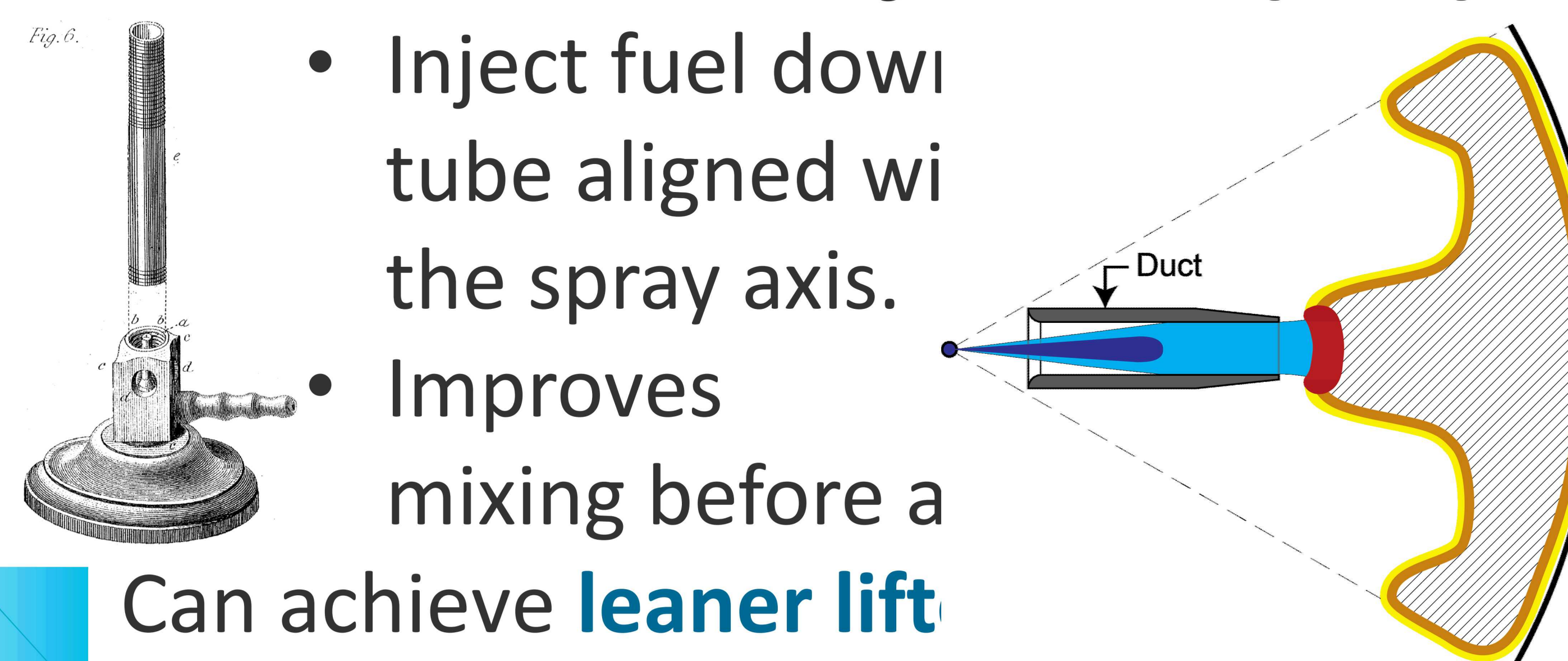
1. Greatly attenuate diesel soot formation.
2. Lower soot enables cost-effective reduction of nitrogen-oxide (NO_x) emissions via dilution.
3. Combustion strategy is synergistic with oxygenated renewable fuels.



Advantages

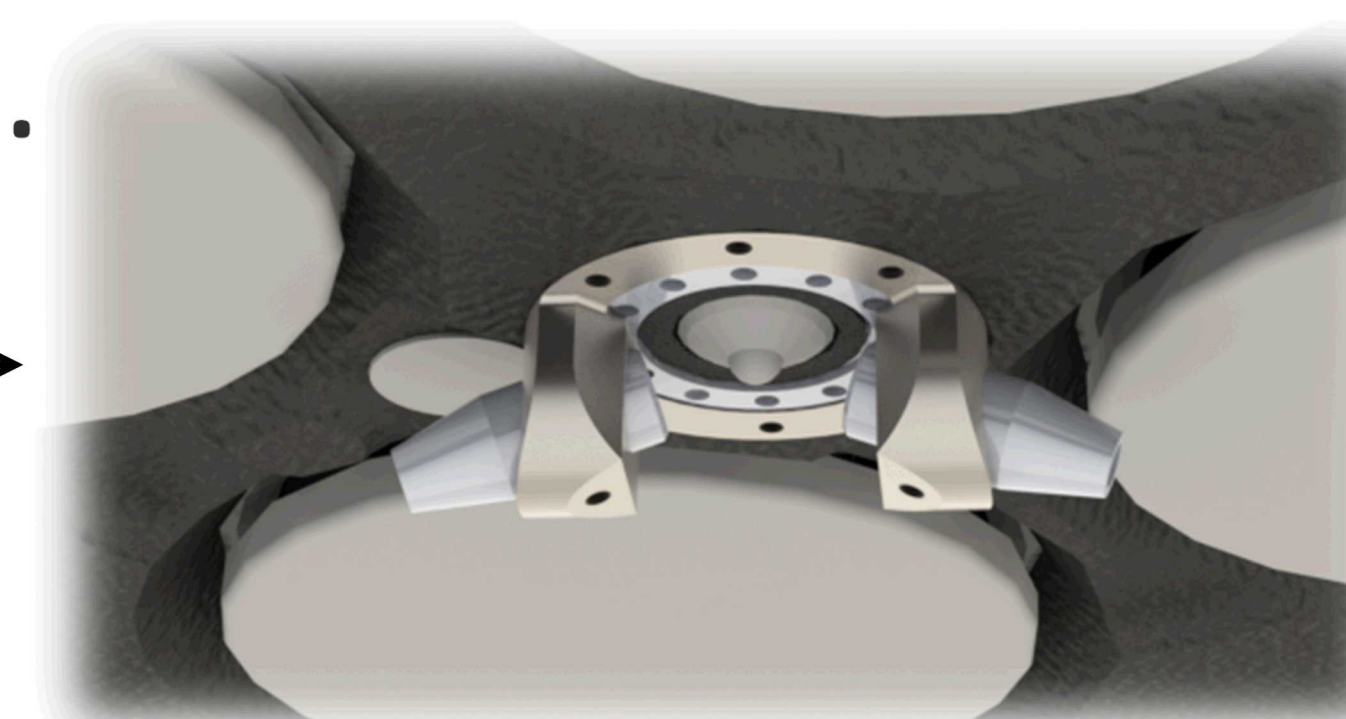
- Inherently high thermal efficiency
- Low HC & CO emissions (HC = hydrocarbon, CO = carbon monoxide)
- Easy to control (vs. globally premixed)
- Compatible with current diesel fuels
- Synergistic with oxygen'd bio/solar fuels
- Conceptually simple (low cost)
- Retrofittable to existing engines
- Scientifically distinct (from globally premixed)

Ducted fuel injection (DFI)



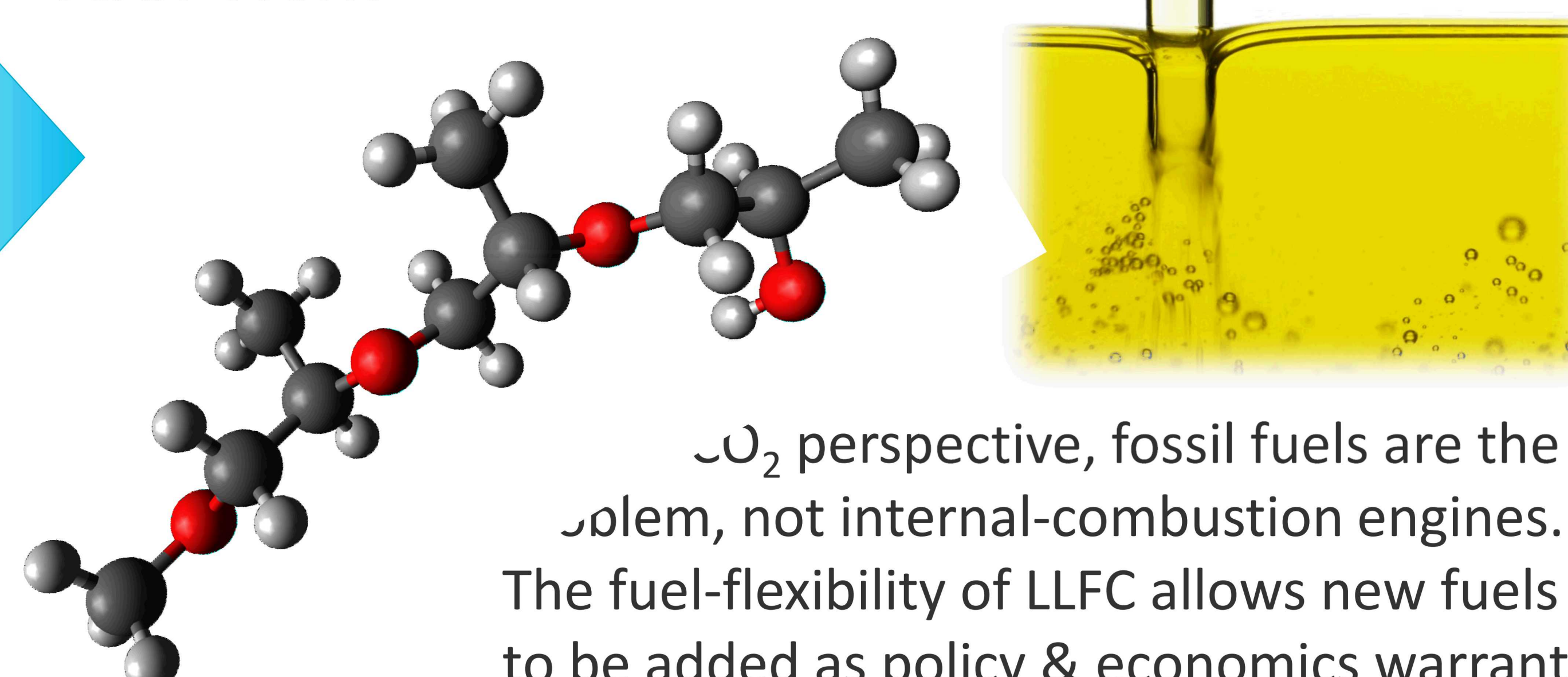
Can achieve **leaner lift combustion (LLFC)** = diesel combustion that does not produce soot because it occurs in mixtures that are "lean enough" (i.e., $\phi < 2$).

DFI implementation with a two-hole injector tip & two ducts.



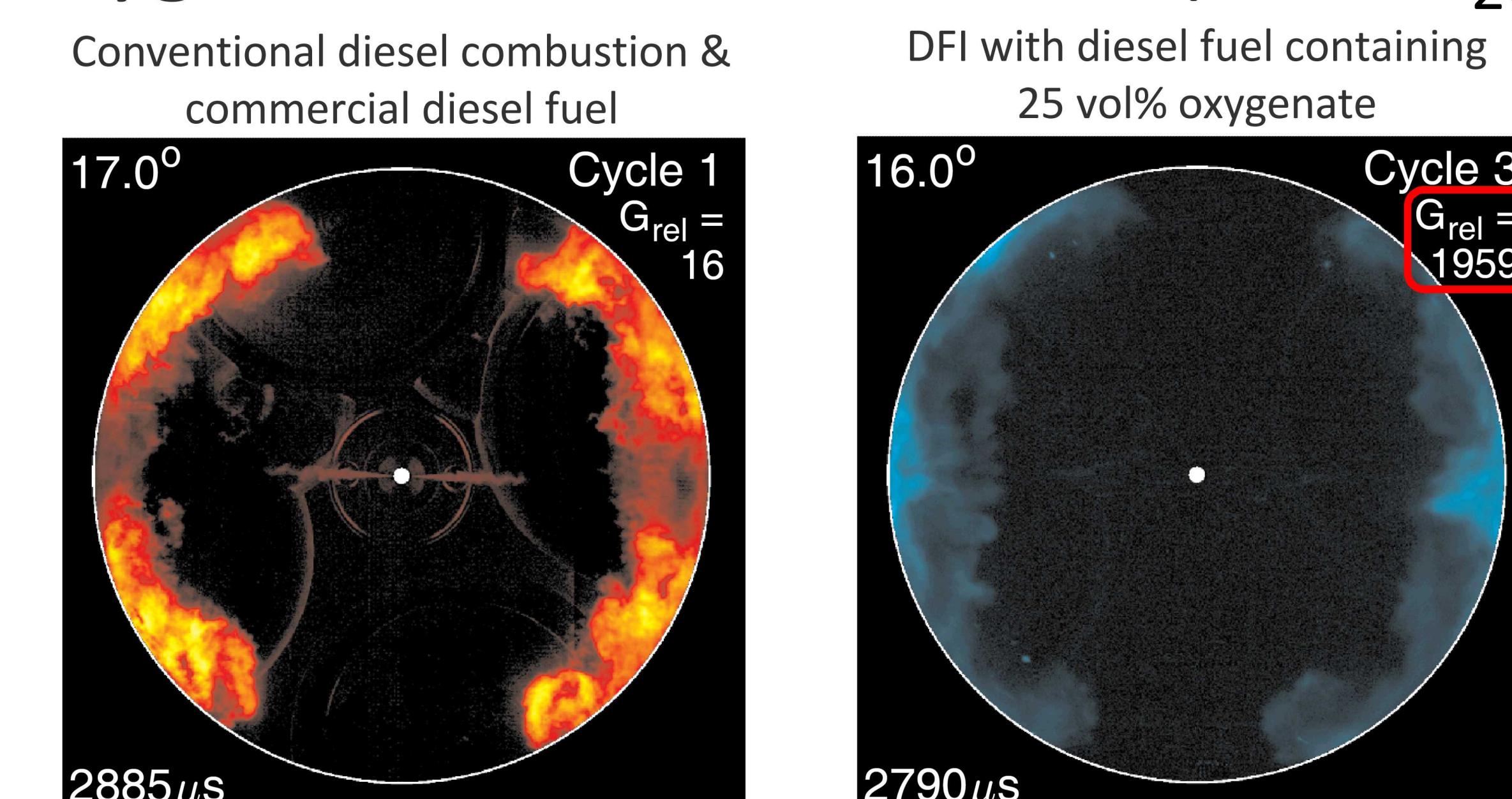
Oxygenated renewable fuels

are synergistic with **LLFC** because they provide oxygen where the mixture is most fuel-rich.

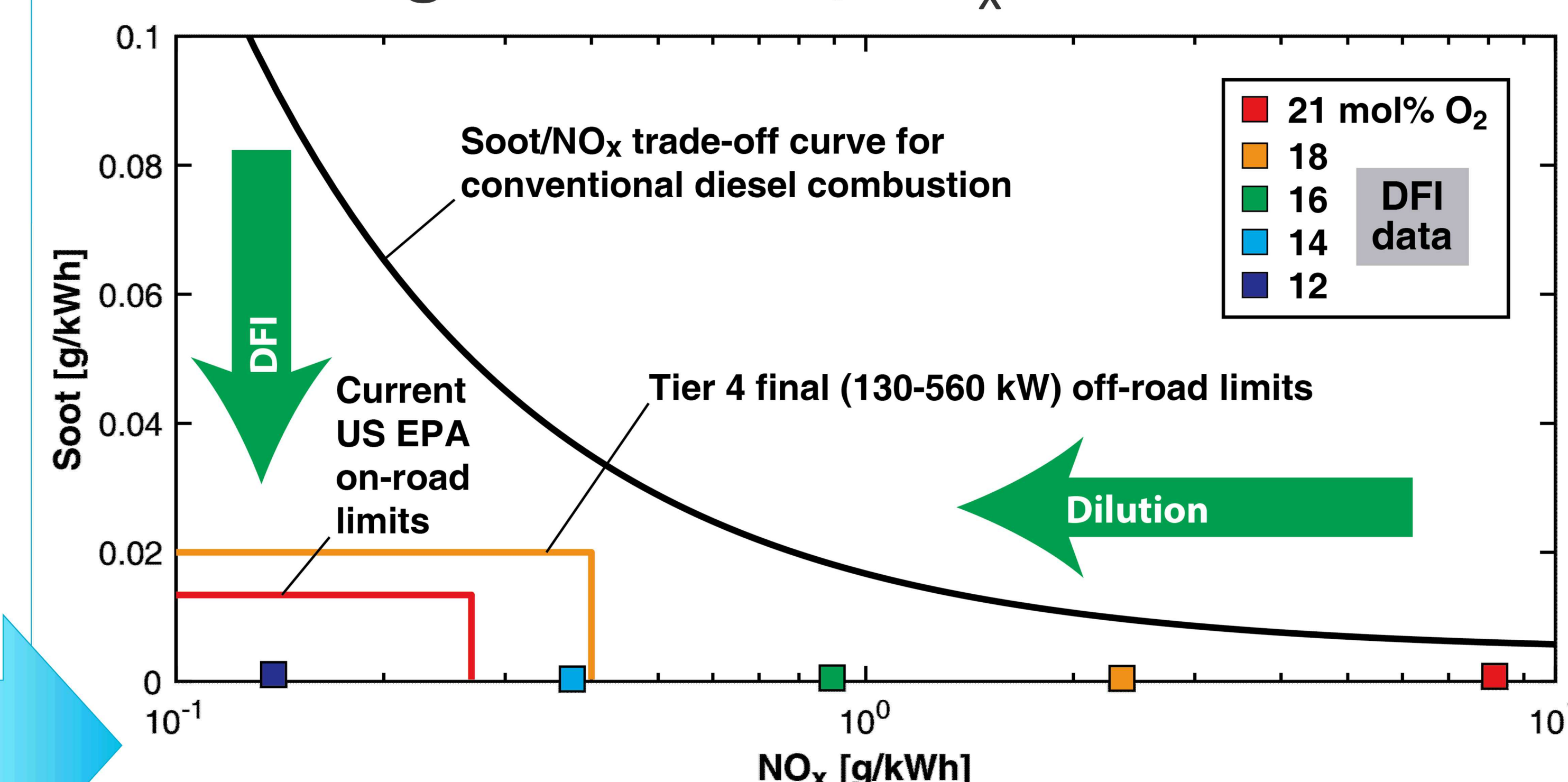


Results

- Soot incandescence images show DFI with diesel fuel containing 25 vol% oxygenate can achieve **LLFC** (16% O_2):



- DFI with dilution can break the long-standing diesel soot/ NO_x trade-off:



- Other emissions & efficiencies are not significantly affected by DFI.
- DFI has been successfully demonstrated to ~50% engine load with a four-hole injector tip & four ducts.