

# **Emissions Reduction Performance Benefits of Fischer-Tropsch Fuel Combined with Advanced Aftertreatment**

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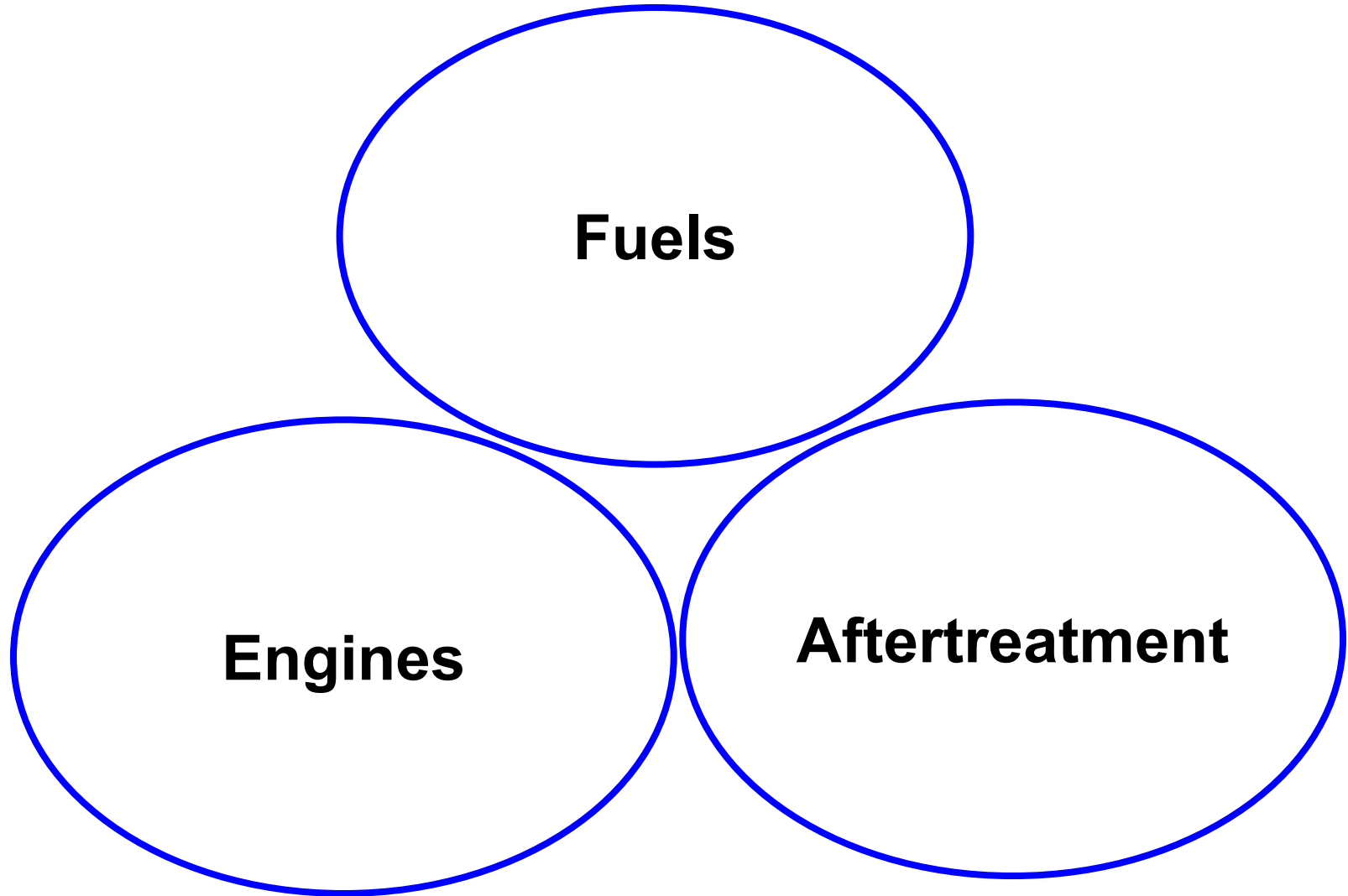
# Agenda

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- Overview
- Test Programs
  - CEC/Caltrans/CaTTS
  - SCAQMD/NREL Demonstration Program
- Summary

# Low Emission Power Train Strategy

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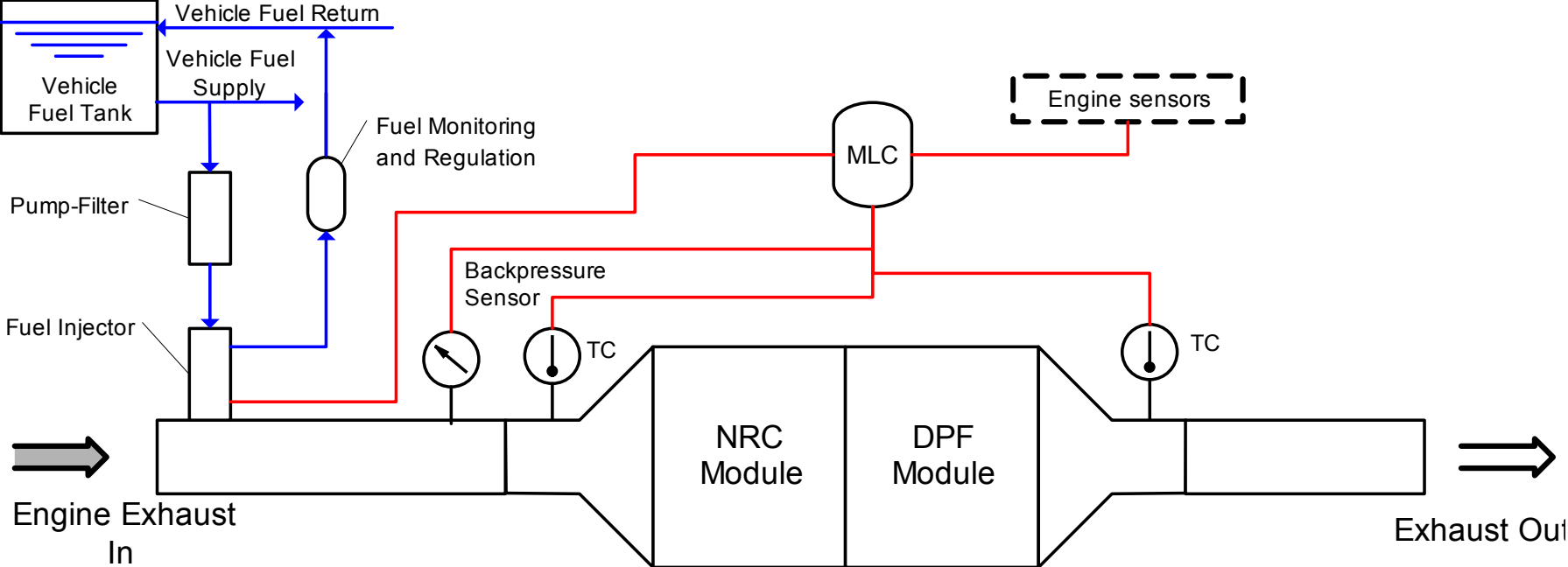


# Fischer-Tropsch fuel

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- **Good for the Engine**
  - High cetane number – lower NO<sub>x</sub>
  - Lower aromatics – lower PM
- **Good for the aftertreatment**
  - No sulfur
  - No aromatics
  - Straight chain hydrocarbons may be more selective for NO<sub>x</sub> reduction

# Cleaire Longview™



Longview™



# Cleaire Longview

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- CARB verified as of April 11, 2003
- 25% NOx reduction
- >85% PM reduction
- Requires ULSD (or better) fuel

# Test Program #1

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- CEC/Caltrans/CaTTS



# Test Program #1: CEC/Caltrans/CaTTS

## Vehicle

Caltrans Truck with 1996 International  
DT466, 230 hp

## Test Cycles

Transient (UDDS), Steady (Cruise-60)

## Fuels

CARB #2 Diesel

Fischer-Tropsch

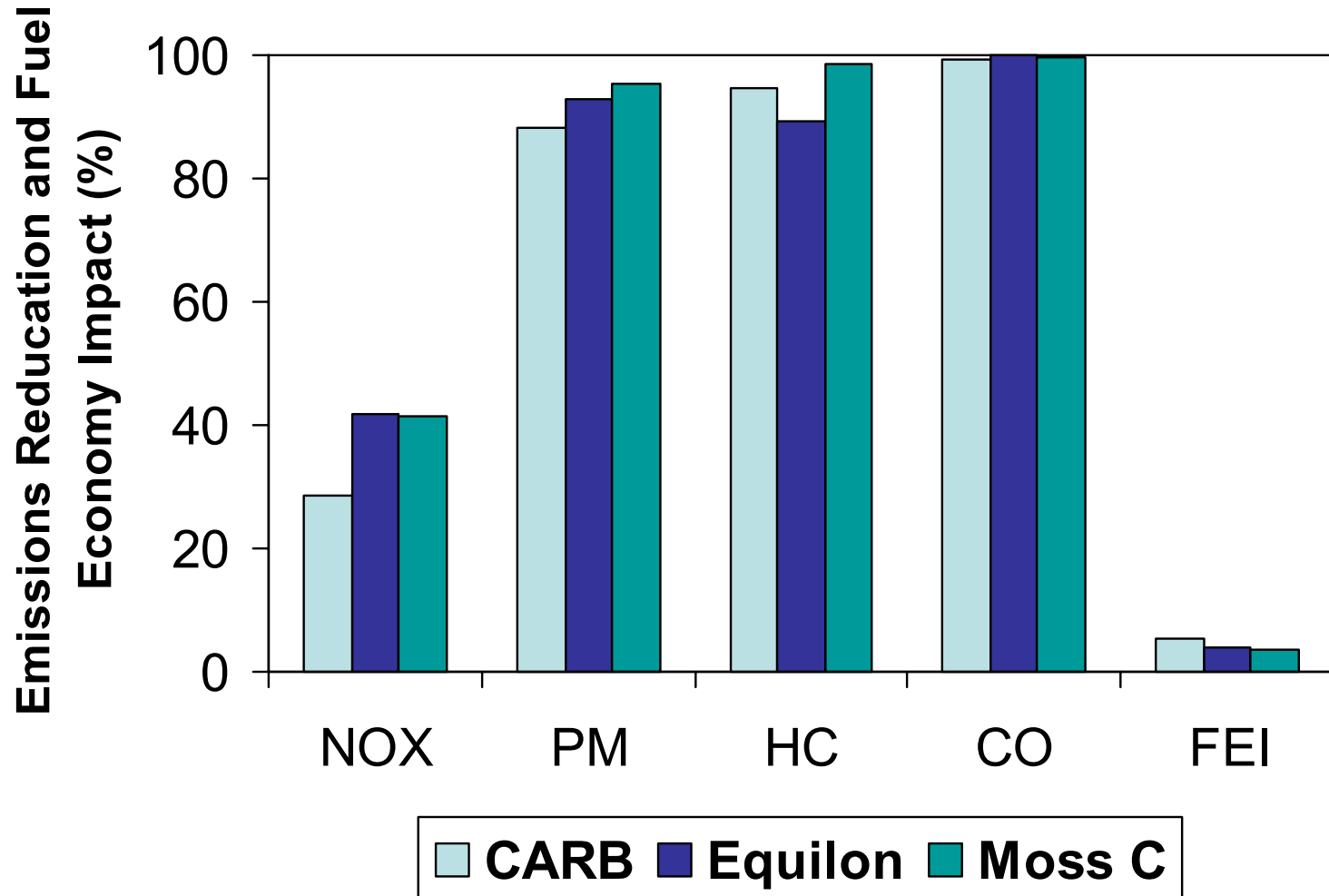
Shell (Equilon), Petro AS (Moss C)

## Aftertreatment

Claire Longview

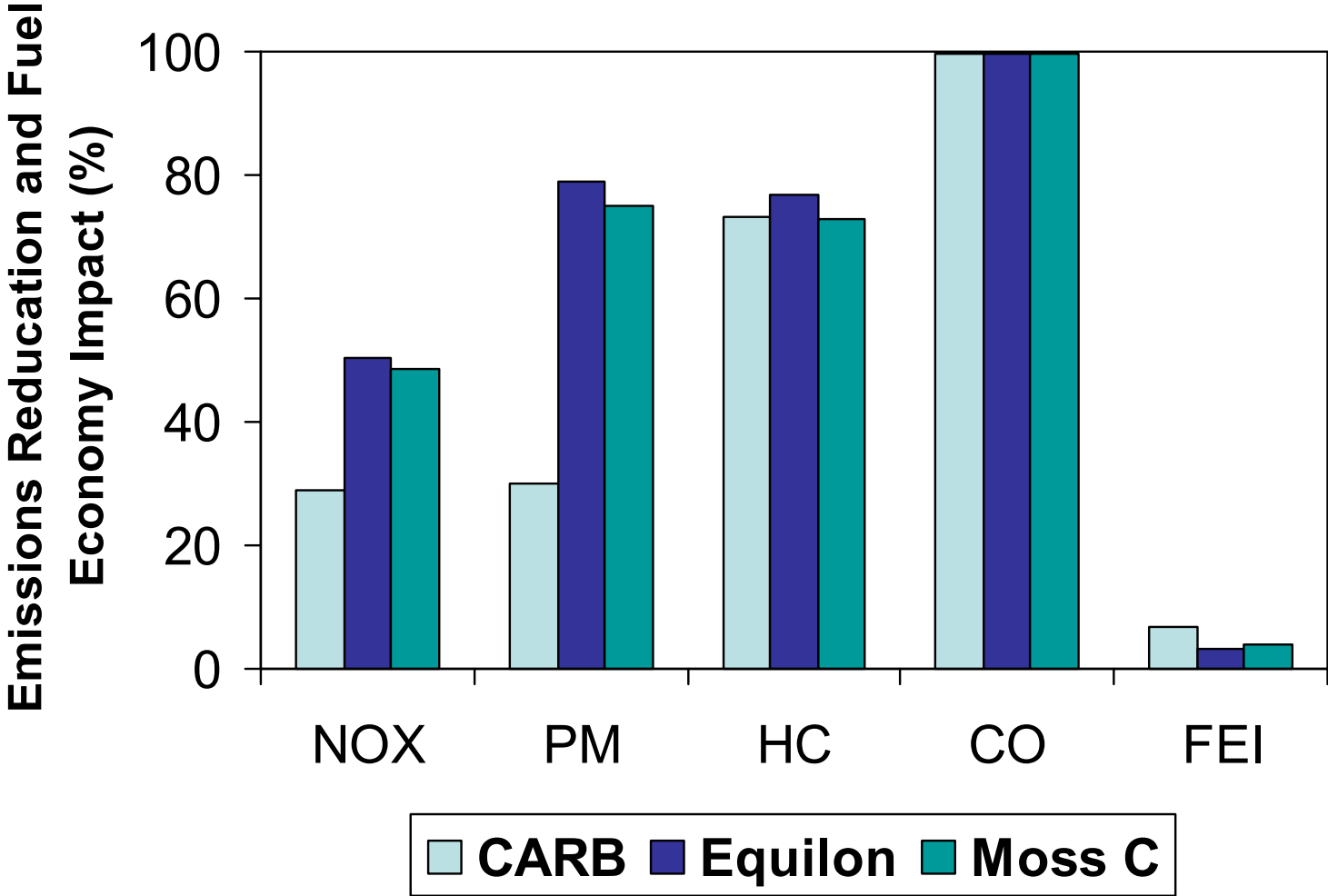


# CARB vs. F-T Fuel over UDDS Cycle



Engine: 1996 International DT-466

# CARB vs. F-T Fuel over Cruise-60 Cycle



Engine: 1996 International DT-466

# Test Program #2

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- SCAQMD/NREL Fischer-Tropsch Demonstration

# Test Program #2: Use of FT Fuel on an Engine with Emission Controls

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- Development and Demonstration of Fischer-Tropsch Fueled Heavy-Duty Vehicles with Control Technologies for Reduced Diesel Exhaust Emissions
  - SCAQMD RFP #P2002-18
  - Co-funded by National Renewable Energy Laboratory
- Team includes Automotive Testing Labs, Ricardo, Shell, and Cleaire
- Program includes work in test cell and in field

# Engine and Emission Targets

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- Engine
  - 2002 Cummins ISM, 370 hp
  - Pistons modified by Ricardo
  - Increased EGR rate
- Emission targets on composite FTP (g/bhp-hr)
  - NO<sub>x</sub>      1.2
  - NO<sub>2</sub>      0.4
  - PM          0.01
  - HC          1.3
  - CO          15.5

# Method to Reach 1.2 g/bhp-hr NOx

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- Baseline, standard diesel 2.3 g/bhp-hr
- Baseline, FT 2.0 g/bhp-hr
- Higher EGR rate, new combustion bowl, F-T 1.5 g/bhp-hr
- Higher EGR rate, new combustion bowl, F-T, DPF, Lean NOx catalyst 1.2 g/bhp-hr

# Targets are achieved

Composite FTP results (g/bhp-hr)

	Target	Result
NOx	1.2	1.17
PM	0.01	0.005
HC	1.3	0.04
CO	15	0.06
NO2	0.3	0.4

Emissions performance is achieved within engine operating limits. Good transient performance is expected



# Summary

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- F-T Fuel in combination with advanced aftertreatment lowers engine emissions with no engine modification
  - NO<sub>x</sub>: 40-50%
  - PM: >85%
- F-T Fuel in combination with advanced aftertreatment and engine modification lowers engine out emissions
  - NO<sub>x</sub>: <1.2 g/bhp-hr
  - PM: 0.005 g/bhp-hr
  - Very low CO and HC (including some air toxics)

# Summary

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- F-T Fuels lowers engine emissions
- F-T Fuels enables aftertreatment to work better
- Benefits appear to be synergistic but not interdependent, which is attractive from a deployment point of view