Alternatives to Diesel Fuel in California — Fuel Cycle Energy and Emission Effects of Possible Replacements Due to the TAC Diesel Particulate Decision

by

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DISCLAIMER

- The results documented in this presentation derive from an analysis performed under auspices independent of the State of California and its agencies and in no way reflect or represent views or positions adopted by either the California Energy Commission or California Air Resources Board

Background

- CARB on 8/27/98 officially declared the particulate matter component of diesel exhaust a human carcinogen and thus a toxic air contaminant subject to the provisions of California Proposition 65

- Flexibility of the declaration's language facilitates orderly progress toward removing or significantly reducing the toxic constituents of diesel fuel and/or introducing more benign alternatives

What CARB Expects to See...

- Prohibition of diesel fuel in California is not contemplated, because "…given what we've learned, with dedicated efforts from (vehicle) manufacturers, fuel suppliers, and ARB staff, we can expect near-zero emission diesel (fuel) within a decade."

  Current Director, CARB

- Our charge at ANL was to investigate a few of the scenarios that may be substituted if this expectation is not met

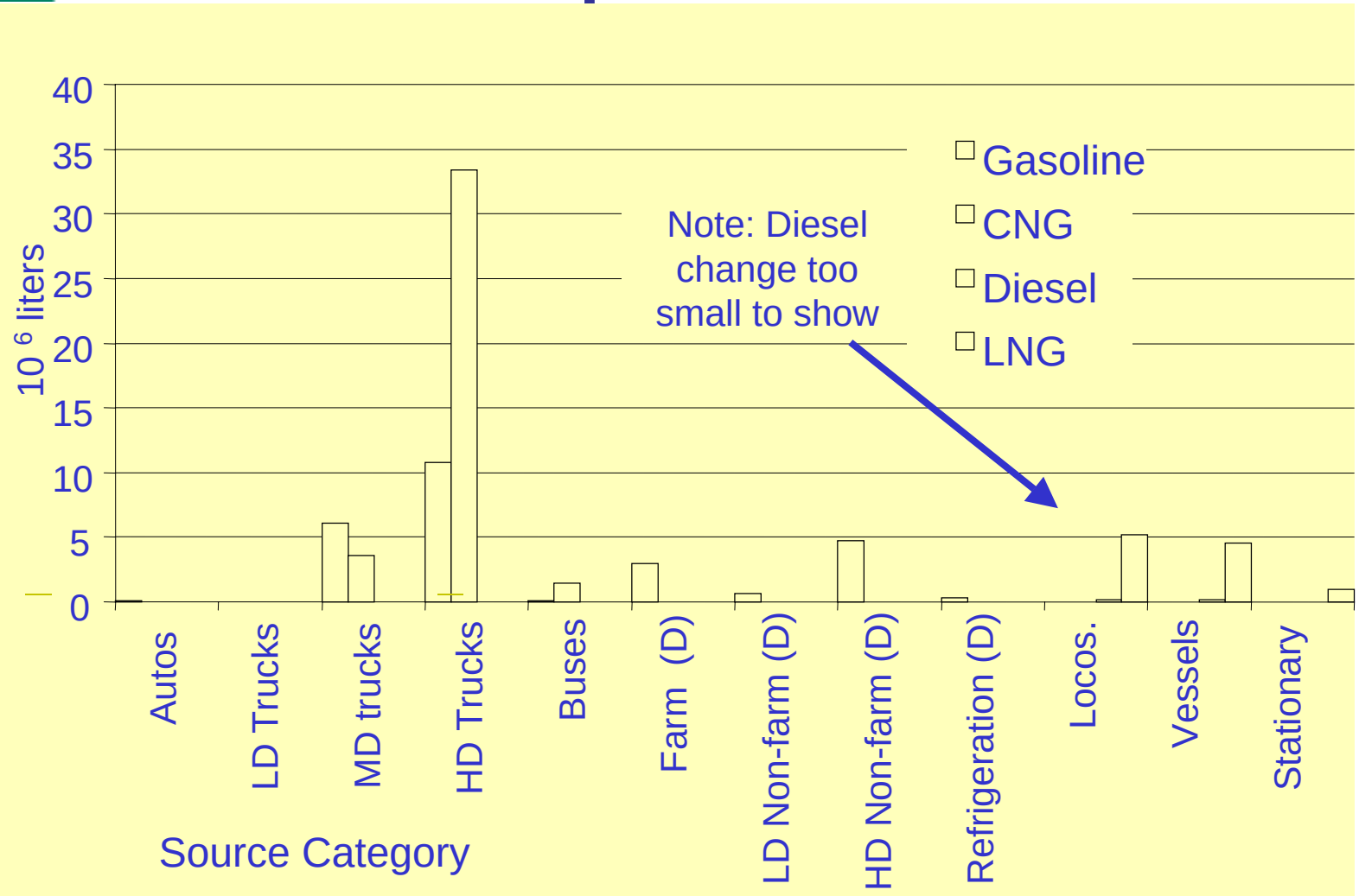
We Examined Three Transitional Cases

- Phase out diesel use except as pilot fuel, enabling retention of a subset of CI engines in (primarily off-road) heavy-duty application (most heavy trucks would use NG)
- Transition 100% to Fischer-Tropsch synthetic diesel from NG, enabling complete retention of CI engines
- Transition 100% to dimethyl ether (DME), also enabling retention of CI engines

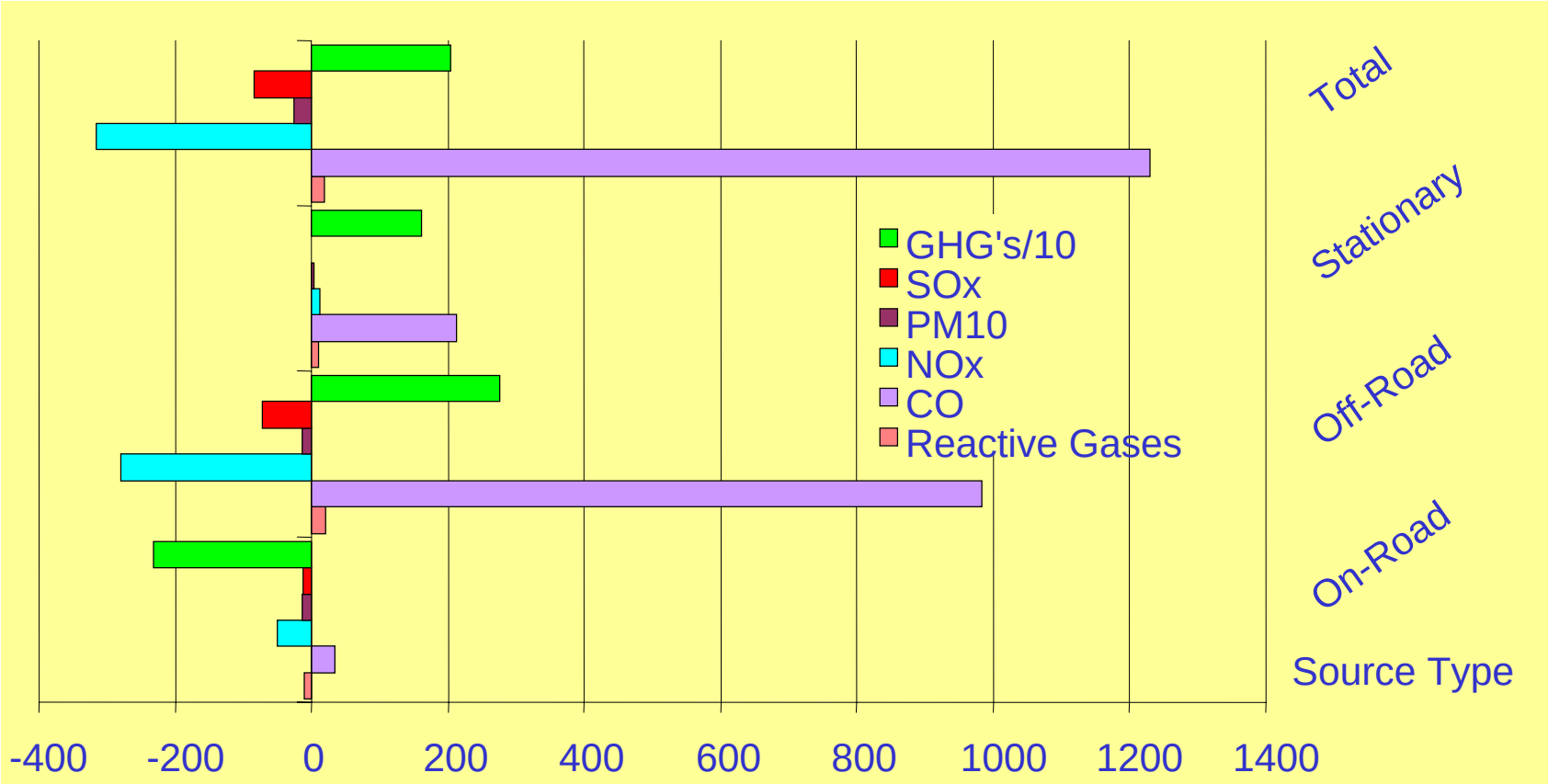
How Do We Get to the CI Displacement Case by 2010?

• Light-duty diesel-powered highway vehicles	→ • Replaced 100% by catalyst-controlled SI gasoline vehicles
• MD trucks; HD trucks with engine displacement < 8 L	→ • Replaced 1 for 1 by gasoline-powered units
• All trucks with engine displacement ≥ 8 L	→ • Replaced 1 for 1 by SI units burning NG (at 30% fuel economy reduction)
• Buses < 8.4 m (27.5 ft) long	→ • Replaced 1 for 1 by gasoline
• Buses > 8.4 m long	→ • Replaced 1 for 1 by CNG
• Locomotives, vessels, stationary diesel engines	→ • Retrofitted/replaced with pilot diesel-assisted LNG powerplants
• Smaller off-road equipment	→ • Reverts to SI gasoline

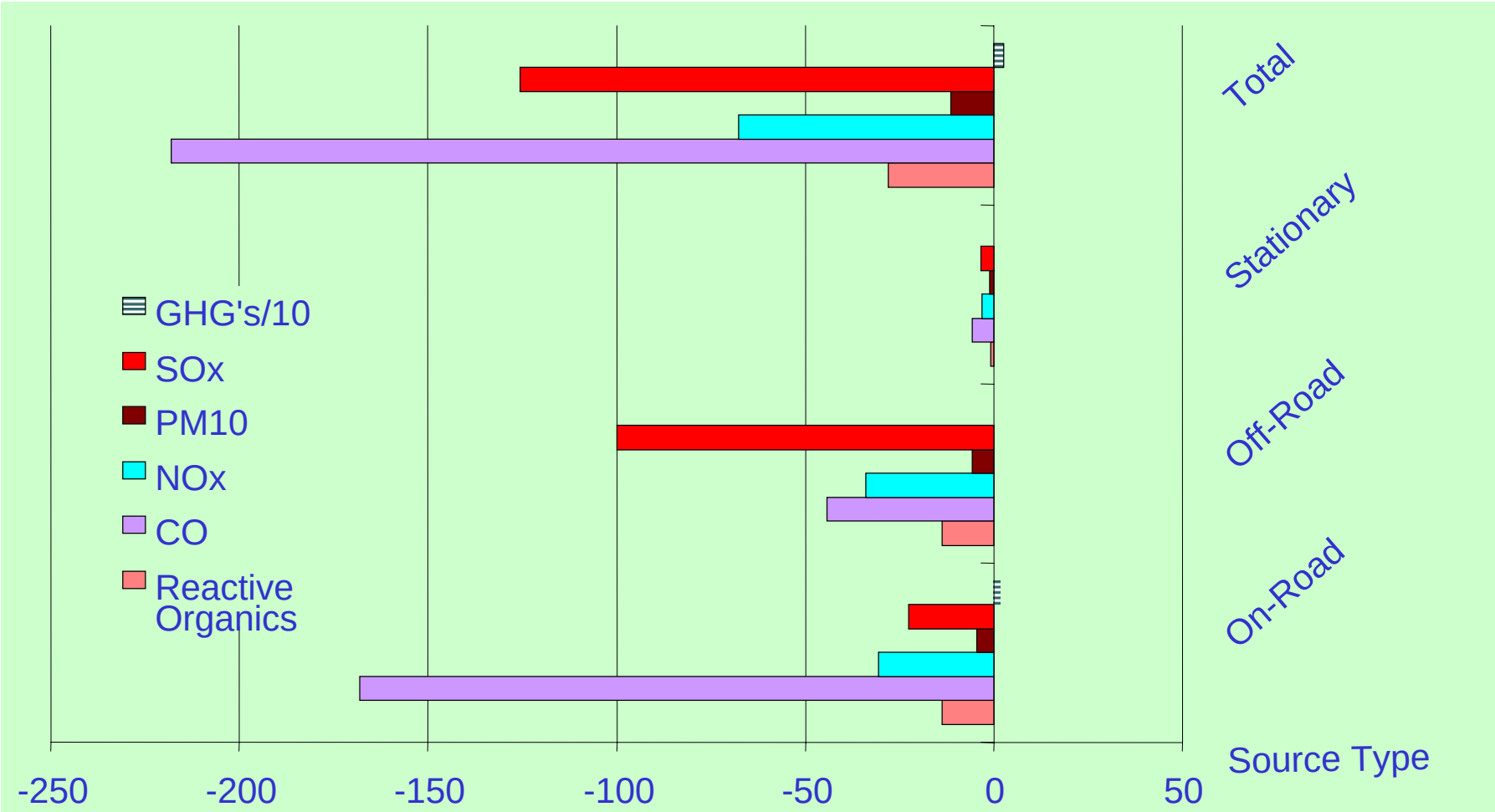
CI Displacement Leads to More SI Fuel Consumption



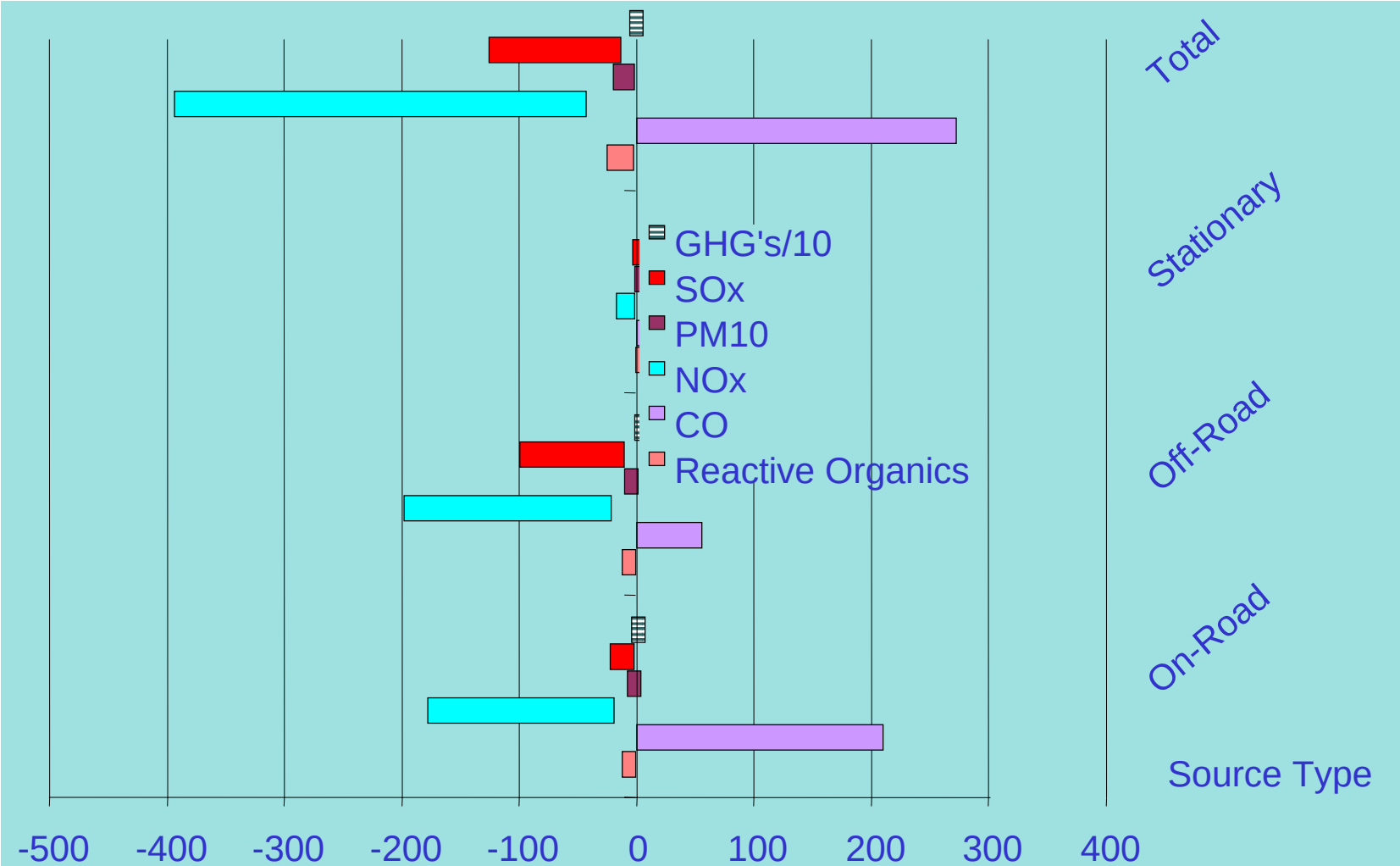
End-use Emission Profile Also Changes (Metric ton/day, 2010)



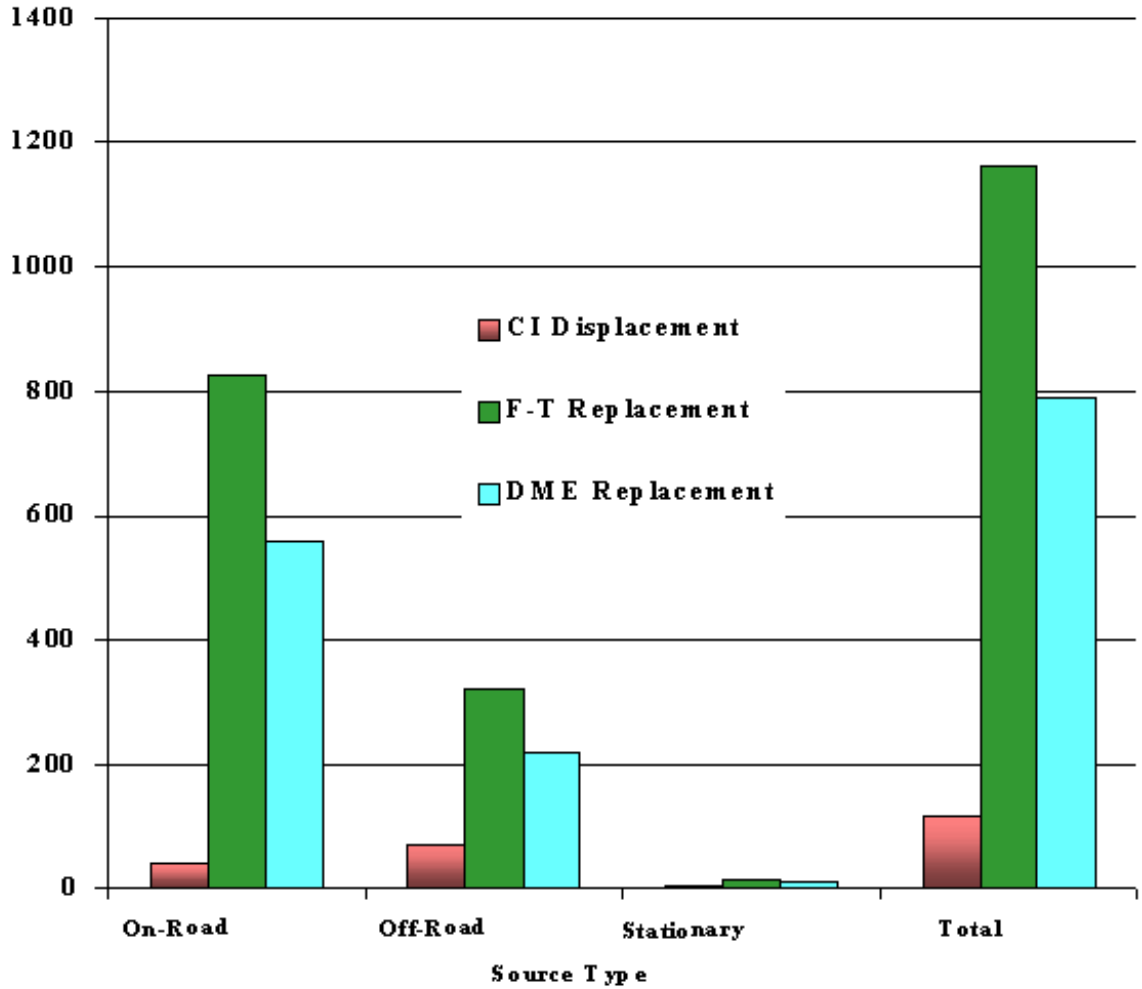
F-T End-Use Emission Change (Metric ton/day, 2010)



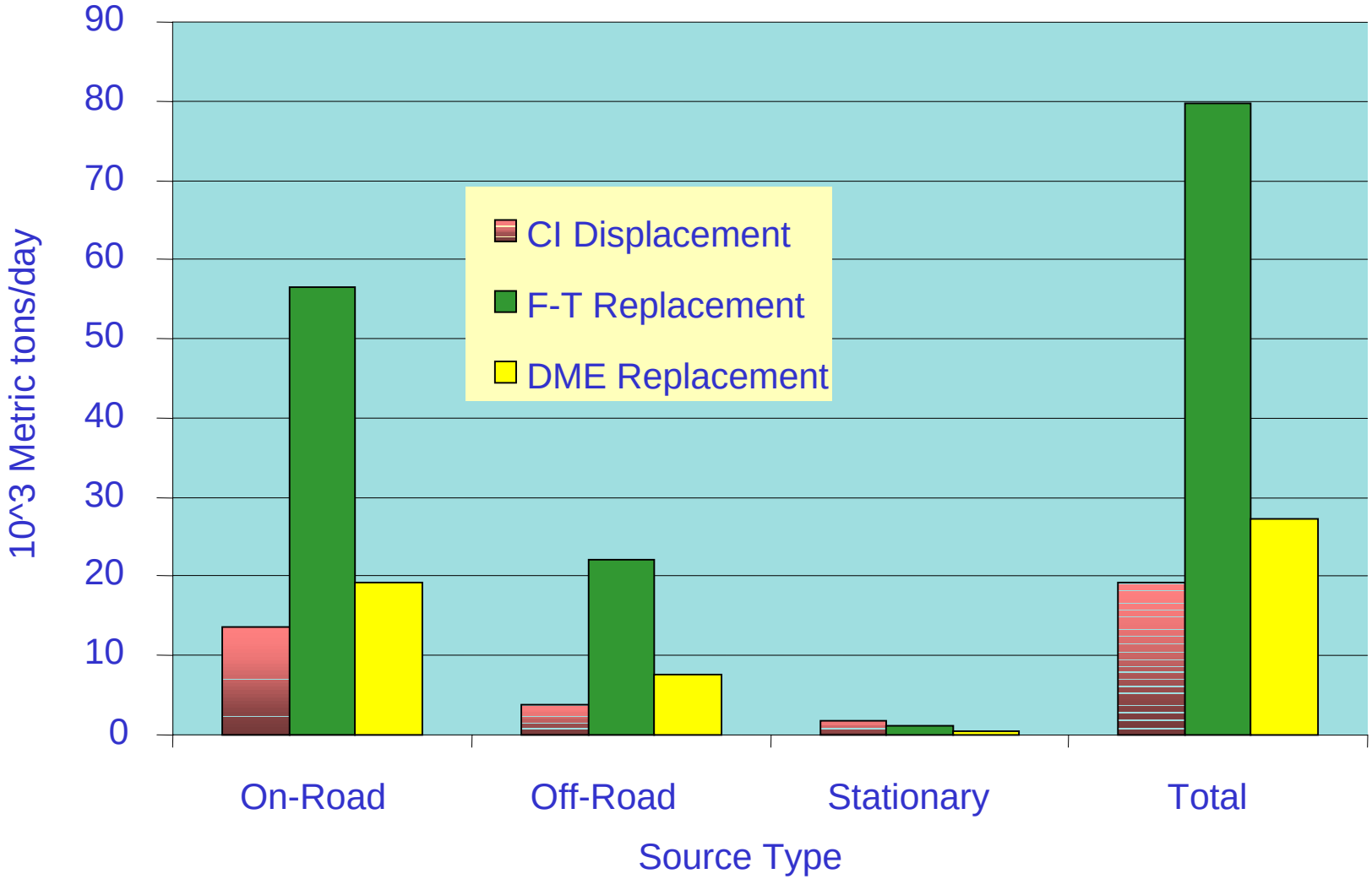
DME End-Use Emission Change (Metric ton/day, 2010)



Changes in Fuel Production Energy (TJ) Reflect Scenario Efficiency Relative to Baseline



Increase in Total GHG--Full Fuel Cycle



Topics in Need of Further Study

- Perform systematic cost-effectiveness and capacity analyses for CI engine displacement and fuel replacement scenarios
- Examine effectiveness of California's clean diesel and LNG initiatives in mitigating diesel exhaust exposures by the public
- Epidemiological studies should begin to focus on fine particle exposure and health impact of gasoline and even NG combustion