



M.J. Bradley & Associates

New Vehicle GHG Emissions Estimates *Under Deep Decarbonization Strategies*

October 2018

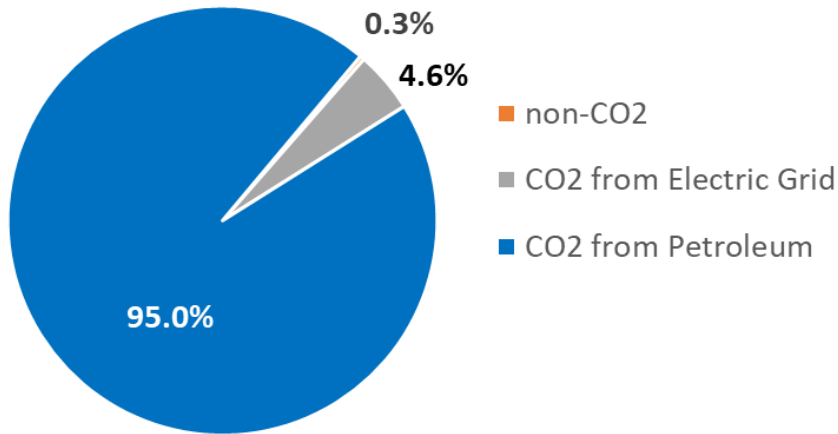
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Purpose

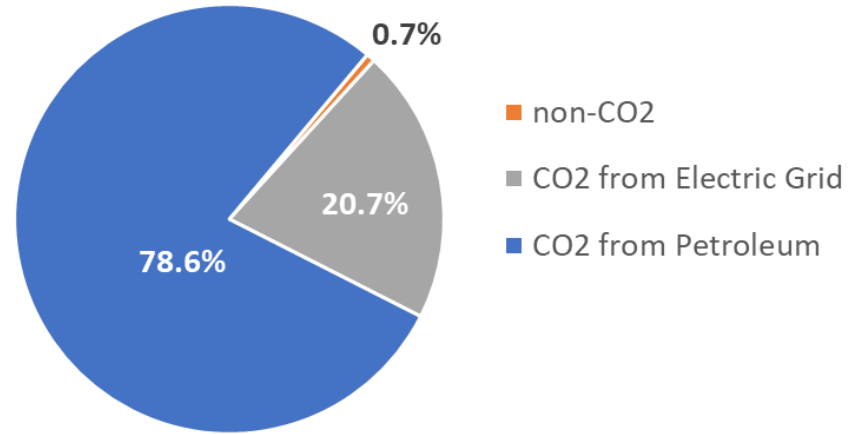
- Estimate the change in US fleet average GHG emissions from new vehicles through 2050, under a deep decarbonization scenario
 - ✓ % of total GHG that is CO₂ from petroleum ← TAIL PIPE EMISSIONS
 - ✓ % of total GHG that is CO₂ from the electric grid } ← NON-TAIL PIPE EMISSIONS
 - ✓ % of total GHG that is non-CO₂
- Non-CO₂ GHG emissions are primarily leakage of refrigerant from air conditioning systems
- CO₂ from the electric grid is from generating electricity used to charge electric vehicles
 - ✓ Results from coal and natural gas generating units
 - ✓ Will become a greater percentage of total vehicle GHG over time as EV sales increase

Results - % of New vehicle GHG from Different Sources

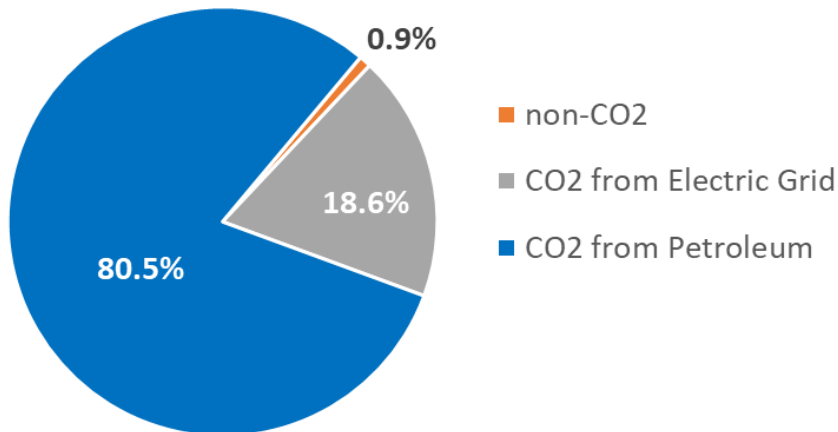
2020 New Vehicle GHG Emissions



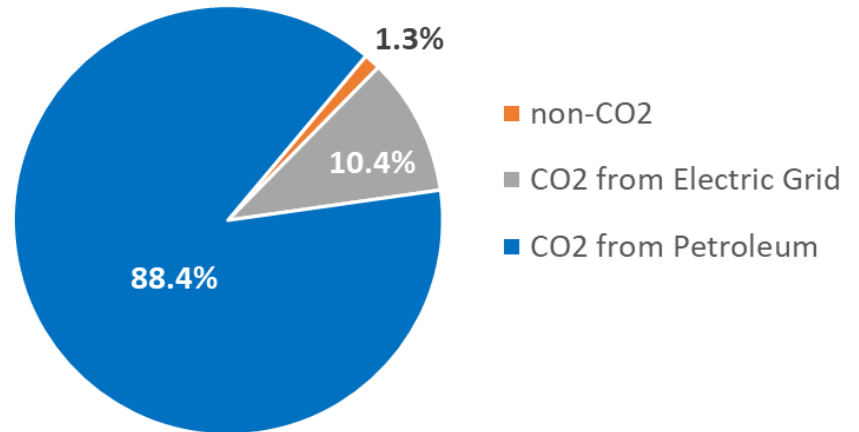
2030 New Vehicle GHG Emissions



2040 New Vehicle GHG Emissions



2050 New Vehicle GHG Emissions



Results Summary

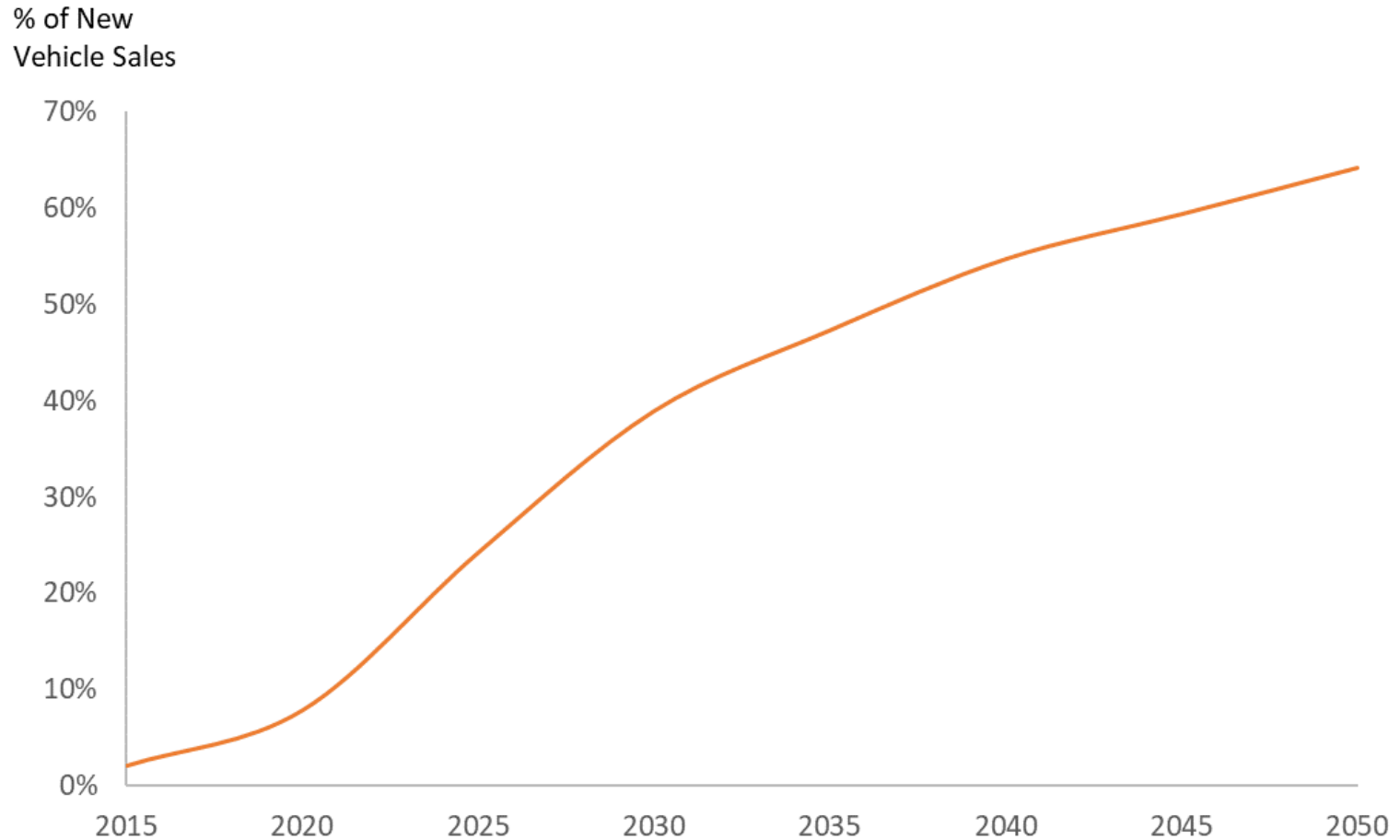
- Under deep decarbonization strategies with high levels of electric vehicle penetration, and aggressive efforts to decarbonize electricity generation, non-tail-pipe emissions will be an increasing percentage of total GHG emissions from new vehicles through at least 2030
 - Non-tail pipe emissions will increase from less than 5% of GHGs today to over 21% of GHGs in 2030
- Despite continued increases in electric vehicle sales, non-tailpipe GHG emissions will fall as a percentage of total GHG emissions after 2030, due to continuing reductions in the carbon intensity of electricity generation

Assumptions & Data Sources

- Estimated CO₂ emissions from electric vehicles are based on model assumptions and output from the benchmark scenario in the U.S. Midcentury Strategy for Deep Decarbonization.
 - ✓ The White House, U.S. Mid-Century Strategy for Deep Decarbonization (2016), online at: https://unfccc.int/files/focus/long-term_strategies/application/pdf/mid_century_strategy_report-final_red.pdf
 - ✓ The White House, "Documentation and Output for the U.S. Mid-Century Strategy" (2016), online at: https://unfccc.int/files/focus/long-term_strategies/application/pdf/us_mcs_documentation_and_output.pdf
- Estimates of non-CO₂ emissions from new vehicles are based on analysis by the California Air Resources Board, which indicates that new vehicles leak 9 grams per year of HFC134a refrigerant, with a GWP₁₀₀ of 1,430
- Real world fleet average annual CO₂ emissions from new conventional vehicles are assumed to be 339 g/mi in 2020, falling to 217 grams/mile after Model Year 2025, for vehicles compliant with California Air Resources Board greenhouse gas emission standards. This is consistent with analysis by ARB, EPA, and the Department of Transportation
 - ✓ *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025*, Office of Transportation and Air Quality U.S. Environmental Protection Agency, National Highway Traffic Safety Administration U.S. Department of Transportation and California Air Resources Board, EPA-420-D-16-900, July 2016

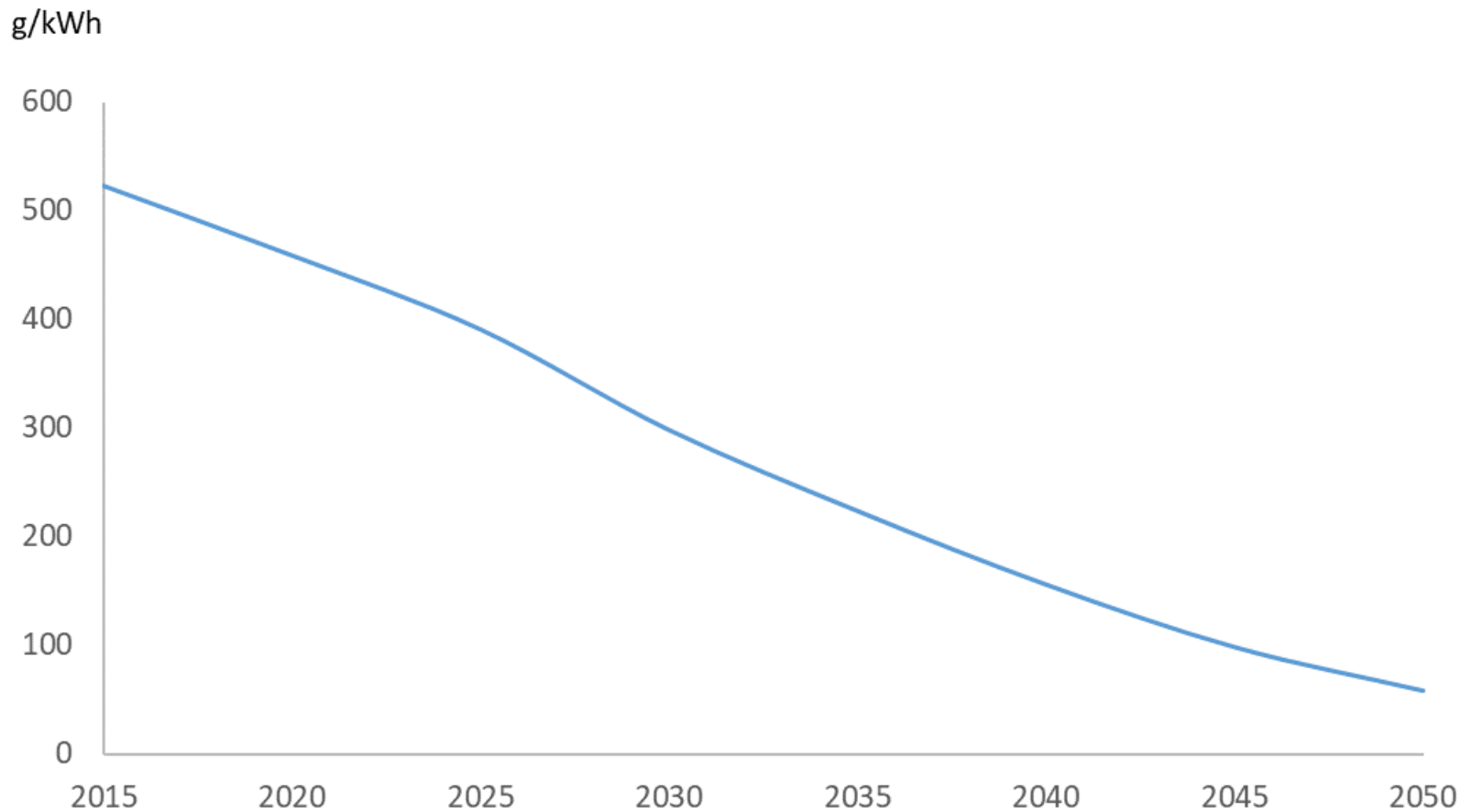
Assumptions: Electric Vehicle Sales

Mid-Century Strategy
Projected Electric Vehicles Sales



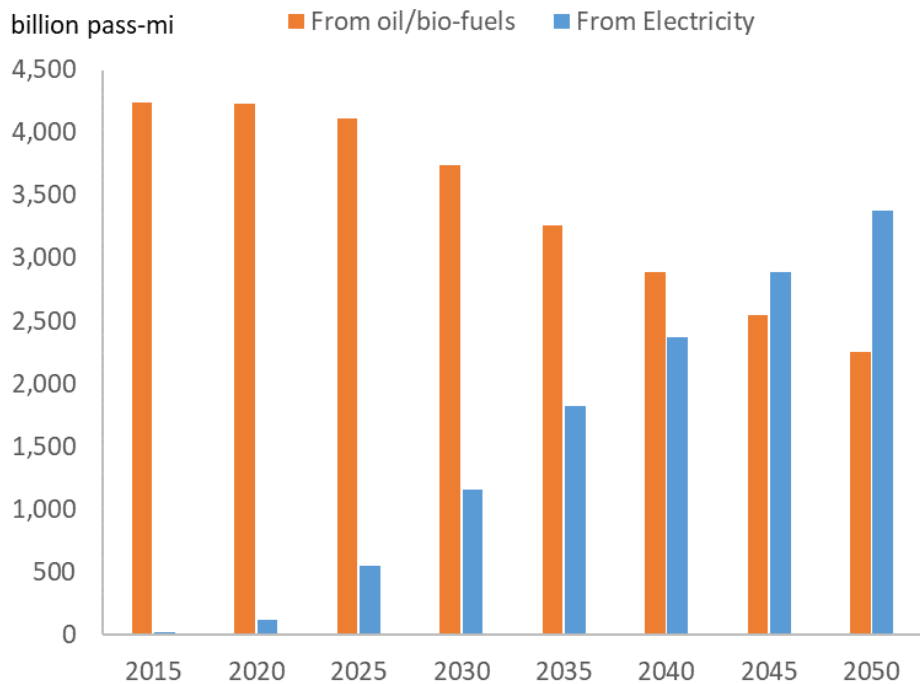
Assumptions: Carbon Intensity of Electricity Generation

Mid-Century Strategy
Projected Electricity Carbon Intensity

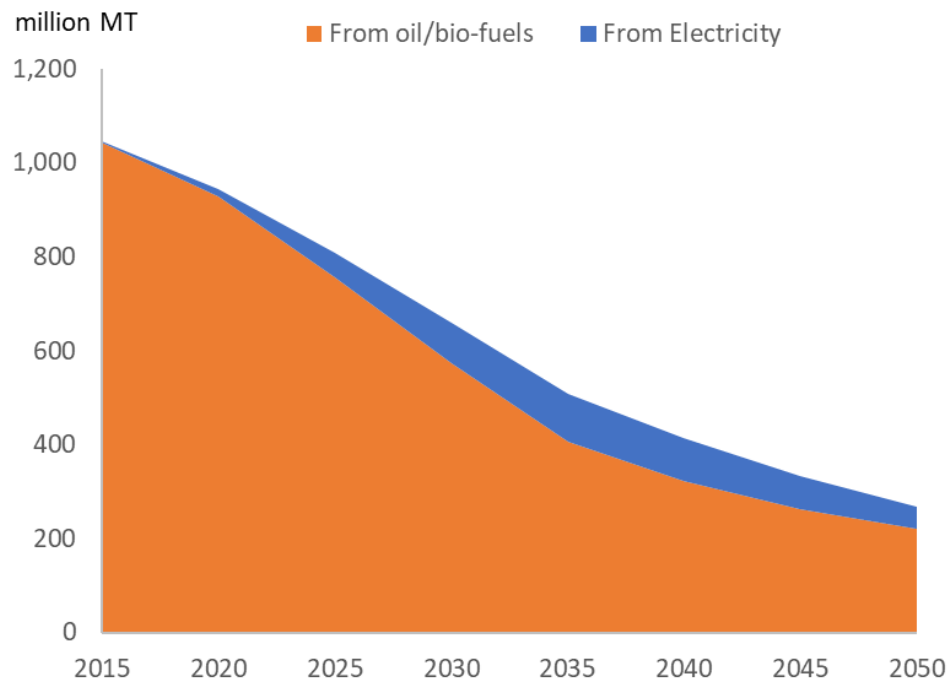


Assumptions: Passenger-miles and GHG by Fuel Type

Mid-Century Strategy
Projected Passenger-miles



Mid-Century Strategy
Projected GHG emissions from Light Duty Vehicles



Projected Fleet Average New Vehicle GHG Emissions

| <i>Grams CO₂-e / mile</i> | 2020 | 2030 | 2040 | 2050 |
|--------------------------------------|--------------|--------------|--------------|-------------|
| Non-CO ₂ GHG | 1.1 | 1.1 | 1.1 | 1.1 |
| CO ₂ from Electric Grid | 15.2 | 34.8 | 22.5 | 9.2 |
| CO ₂ from Petroleum | 312.2 | 132.1 | 97.4 | 77.9 |
| TOTAL | 328.4 | 168.0 | 121.0 | 88.2 |

Fleet Average New Vehicle GHG Emissions

Projected Fleet Average New Vehicle GHG Emissions

