Paths to Clean Vehicle Technology and Alternative Fuels Implementation in San Bernardino County, California

TRB Annual Meeting

January 29, 2021

Project Purpose and Overview

This project looked at the vehicle-based portion of achieving GHG reduction goals and attaining criteria pollutant standards in the South Coast Air Basin, with a focus on San Bernardino County.

Strategies for achieving these objectives differ in terms of their technological feasibility, emission reduction cost effectiveness, applicability to different segments of the vehicle population, infrastructure requirements, local economic benefits, and other factors. Given all these parameters, what is the optimal path forward?

1st part of this project; focus of this paper

The project also identified appropriate implementation strategies for local and regional agencies seeking to advance the penetration of clean vehicles and fuels.

2nd part of project; not the focus of this paper

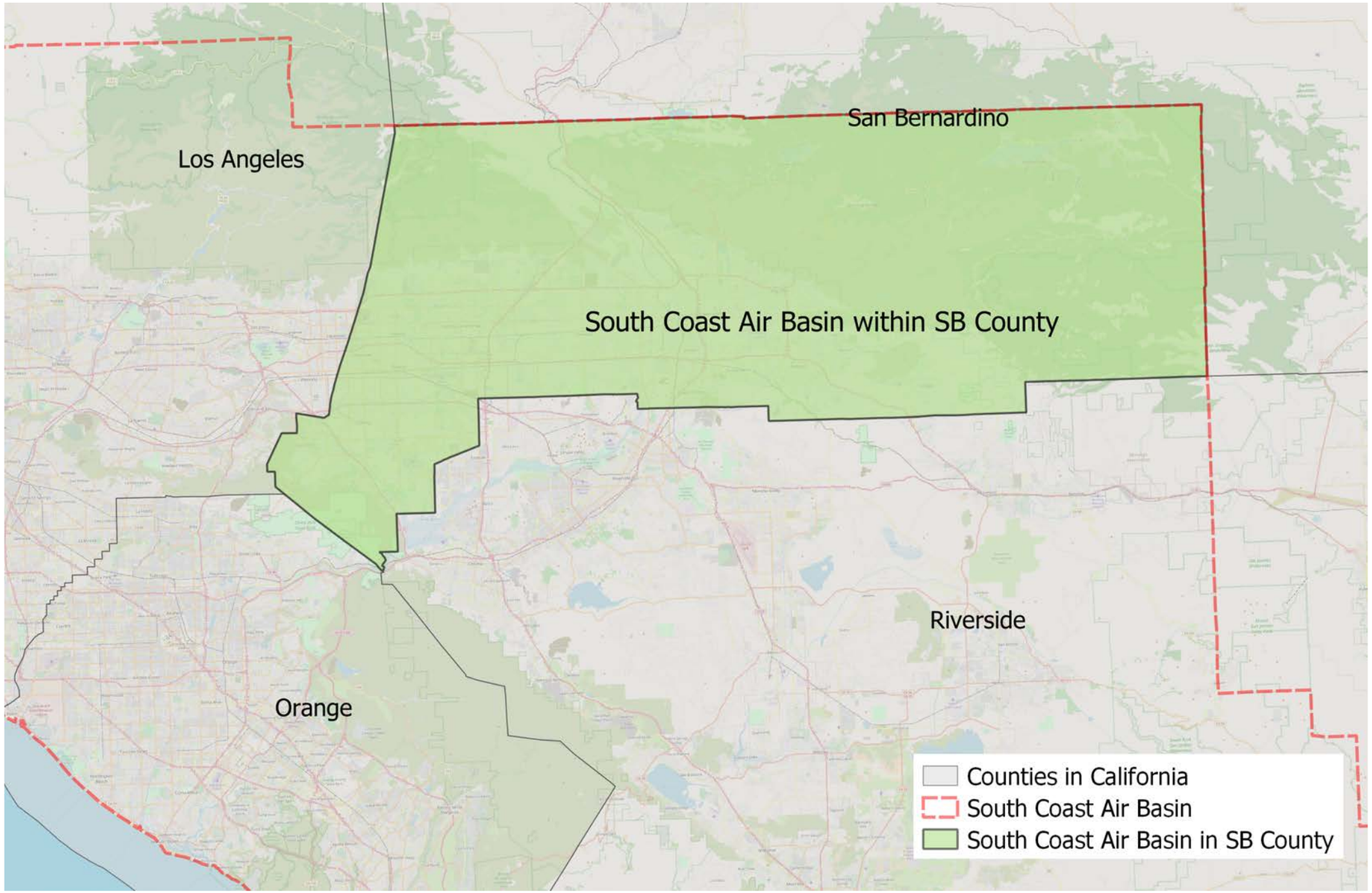
Project Roadmap

Document Existing and Forecast Conditions → Analyze Alternative Paths to Clean Vehicle and Fuels → Implementation Strategies at the Local and Regional Level → Final Report, Action Plan

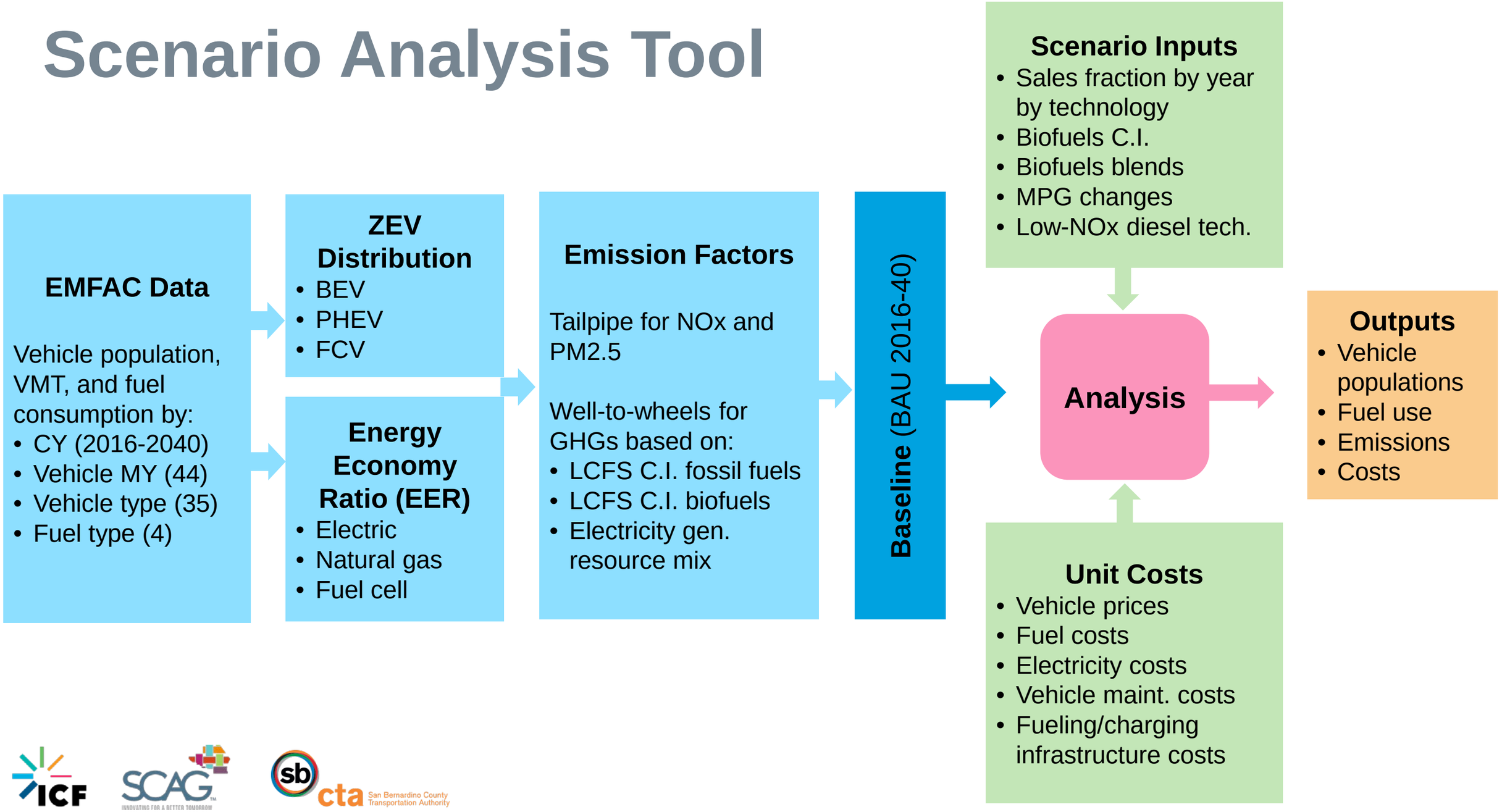
Technical Advisory Committee + Outreach

Methodology and Baseline

Study Area


San Bernardino
Los Angeles
South Coast Air Basin within SB County
Riverside
Orange
Counties in California
South Coast Air Basin
South Coast Air Basin in SB County

Scenario Analysis Tool



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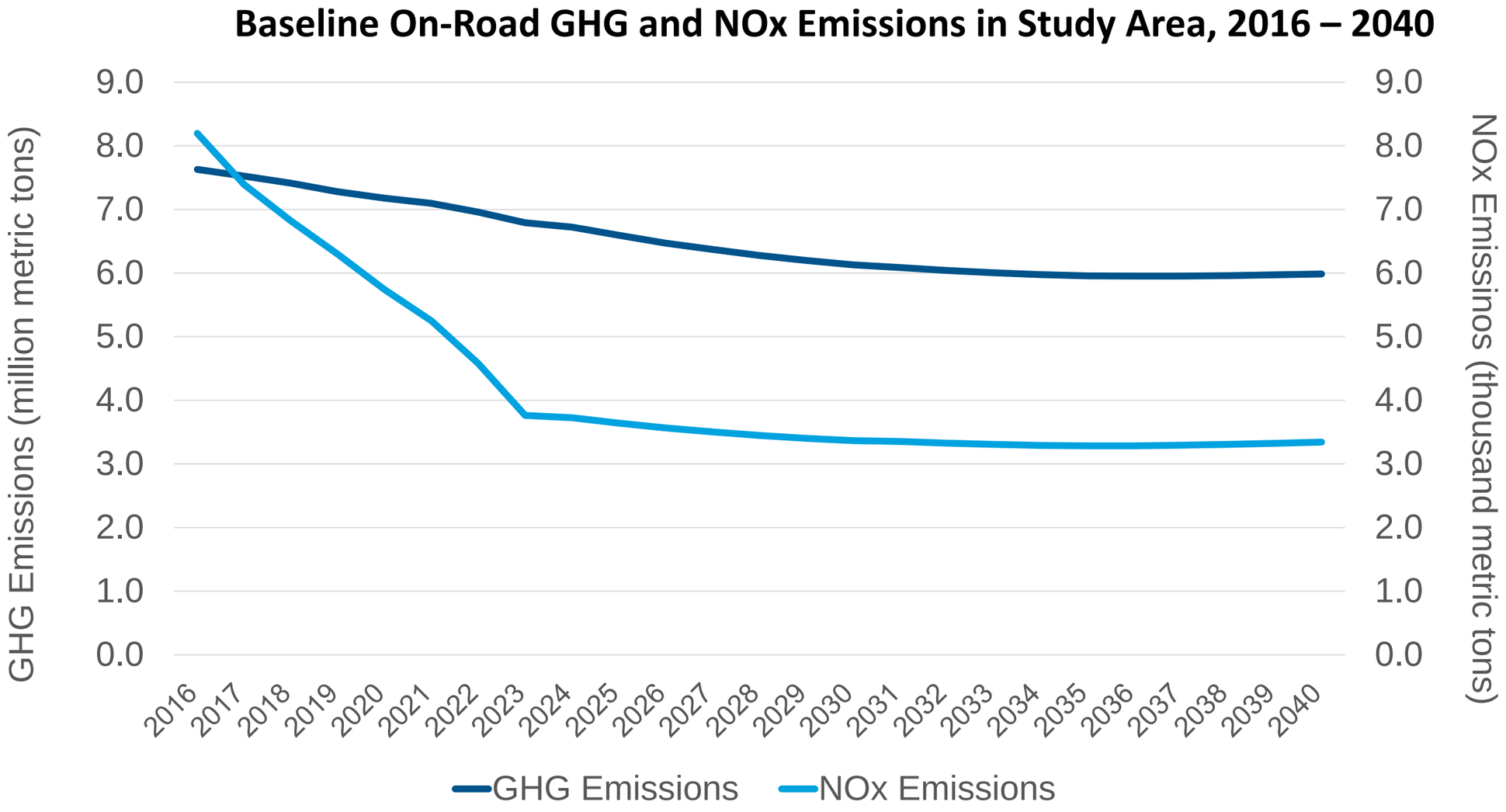
Baseline


Baseline On-Road GHG and NOx Emissions in Study Area, 2016 – 2040
GHG Emissions (million metric tons)
NOx Emissions (thousand metric tons)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
GHG Emissions
NOx Emissions

Baseline

Vehicle Type	2016			2040	
	Vehicle Population (thousand)				
Light Duty	852.5	96%		1314.8	96%
Medium Duty	17.1	2%		25.7	2%
Heavy Duty	17.7	2%		24.0	2%
Total	**887.4**	**100%**		**1364.5**	**100%**
	GHG Emissions (million metric tons)				
Light Duty	6.17	81%		4.60	77%
Medium Duty	0.31	4%		0.31	5%
Heavy Duty	1.14	15%		1.07	18%
Total	**7.63**	**100%**		**5.98**	**100%**
	NOx Emissions (thousand metric tons)				
Light Duty	3.15	38%		0.58	17%
Medium Duty	0.98	12%		0.40	12%
Heavy Duty	4.06	50%		2.37	71%
Total	**8.19**	**100%**		**3.34**	**100%**

Results of Scenarios Analysis

Overview of Scenarios

Scenarios	Brief Description
Baseline	EMFAC Baseline. Includes biofuels volumes and carbon intensity as reported through 2018 (e.g., via LCFS reporting).
Scenario 1 – Electrification 	**Focus on Electrification.** Reflects a future with a faster-than-expected transition towards electrification among all vehicle types. Similar to initial proposed ACT Rule.
Scenario 2 – Aggressive Electrification 	**More Rapid and Intensive Electrification**. For MD/HD, similar to final adopted Advanced Clean Truck Rule.
Scenario 3 – Natural Gas as a Bridge 	**Focus on Natural Gas as a Bridge.** Relies primarily on natural gas (renewable) for heavy-duty vehicle emission reductions through the early 2030s. NGVs serve as a bridge technology until electric truck costs decline sufficiently to warrant significant deployment in MD/HD sectors. For LDVs, assumes electrification identical to Scenario 1.
Scenario 4 – Biofuels 	**Focus on Liquid Biofuels.** Reflects a future with aggressive reductions across the spectrum linked to liquid biofuel consumption—including reduced carbon intensity of existing ethanol and biodiesel plus higher consumption of ethanol in light-duty vehicles and renewable diesel in heavy-duty vehicles.
Scenario 5 – Low NOx Diesel + Biofuels	**Focus on Low-NOx Diesel.** Reflects a future with low NOx-diesel engines in addition to the potential reductions linked to liquid biofuel consumption.

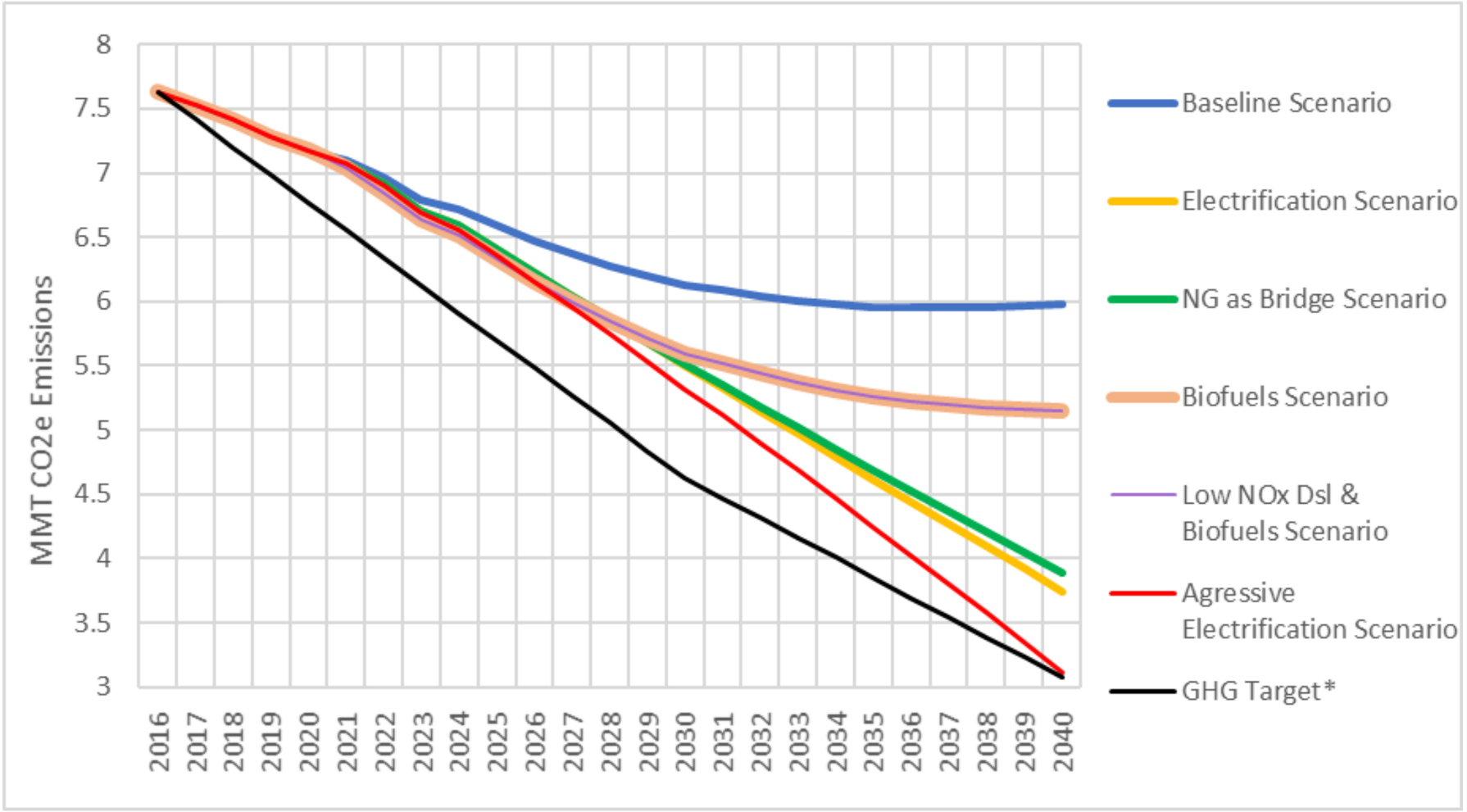
Scenario EV and NGV Sales Fractions

		Electrification Scenario		Aggressive Electrification Scenario		Natural Gas as a Bridge Scenario			
Vehicle Type	FHWA Class	2030	2040	2030	2040	2030 NG	2030 EV	2040 NG	2040 EV
Light Duty	1	41.5%	80%	50%	100%	0%	41.5%	0%	80%
Light Duty	2	15%	50%	25%	75%	10%	5%	10%	25%
Medium Duty	3	15%	50%	25%	75%	10%	5%	10%	25%
Medium Duty	4	50%	75%	60%	80%	25%	5%	25%	50%
Medium Duty	5	50%	75%	60%	80%	45%	5%	35%	35%
Medium Duty	6 (IRP and Ag)	15%	50%	25%	75%	40%	5%	20%	25%
Medium Duty	6 (out of state)	0%	0%	0%	0%	0%	0%	0%	0%
Medium Duty	6 (all other)	50%	75%	60%	80%	45%	5%	35%	35%
Heavy Duty	7 (IRP)	15%	35%	25%	50%	40%	5%	20%	25%
Heavy Duty	7 (out of state)	0%	0%	0%	0%	0%	0%	0%	0%
Heavy Duty	7 (all other)	50%	75%	60%	80%	45%	5%	35%	35%
Heavy Duty	8 (vocational)	50%	75%	60%	80%	45%	5%	35%	35%
Heavy Duty	8 (tractors)	15%	35%	25%	50%	40%	5%	20%	25%
Heavy Duty	8 (out of state)	0%	0%	0%	0%	0%	0%	0%	0%

Biofuels Scenario Assumptions

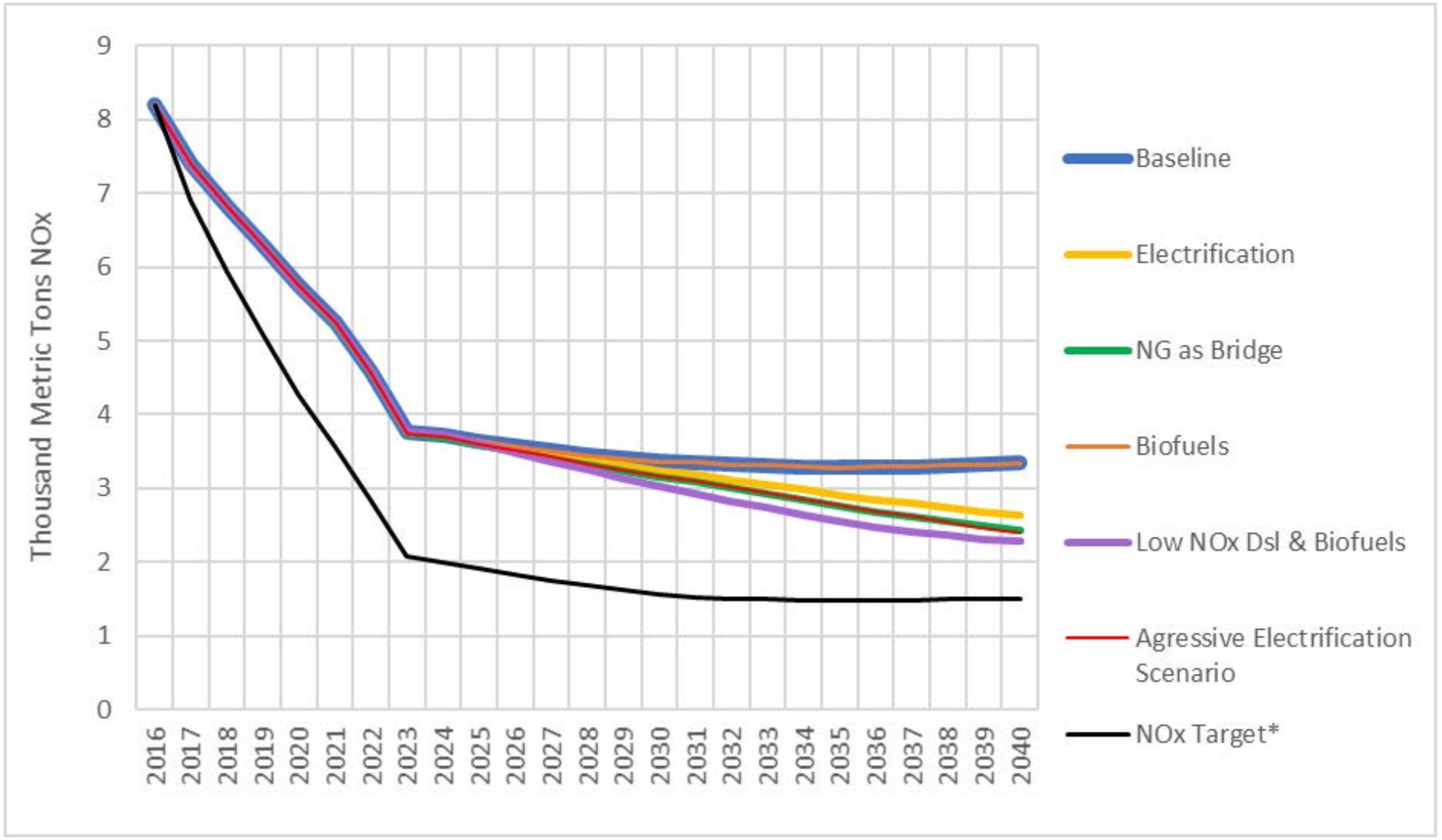
Fuel	Blend Percentage		Carbon Intensity (g CO2e/MJ)	
	Baseline	Scenario (2040)	Baseline	Scenario (2040)
Ethanol	10%	15%	68.6	44.6
Biodiesel	5%	10%	31.05	20.0
Renewable Diesel	10%	60%	32.17	32.17

Summary of Scenario CO2 Emissions Impacts



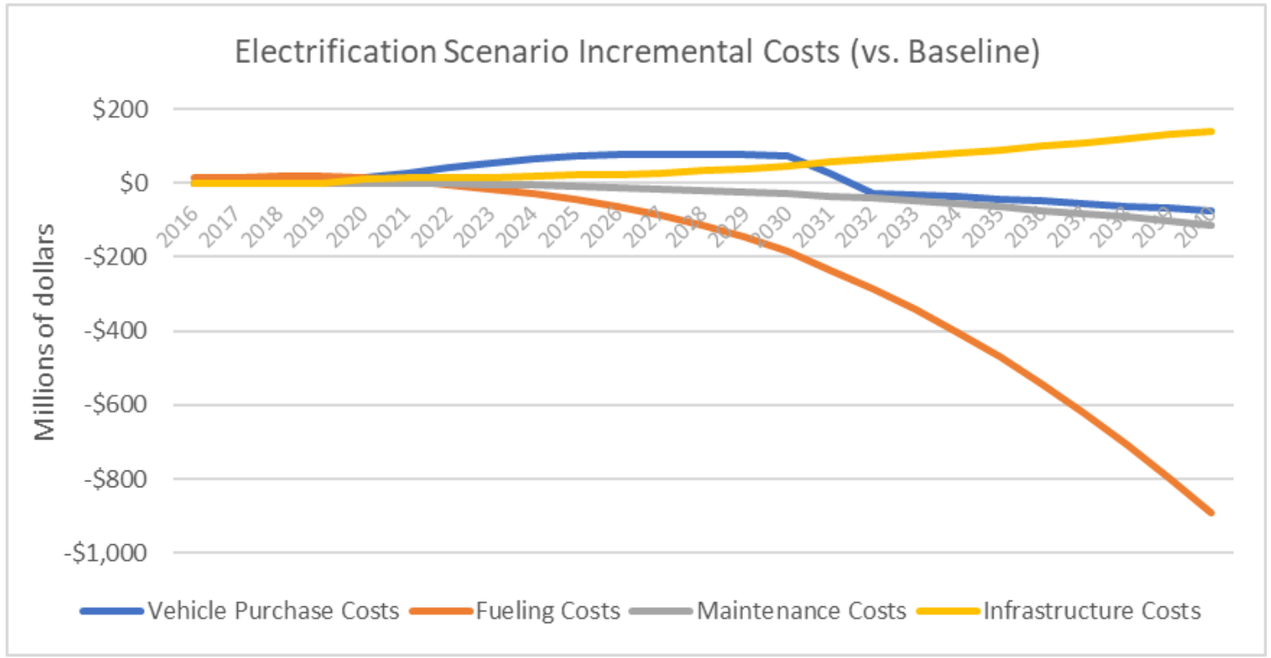
* GHG target reflects the percent reductions needed statewide from all sources to achieve California's 2030 and 2050 emissions targets

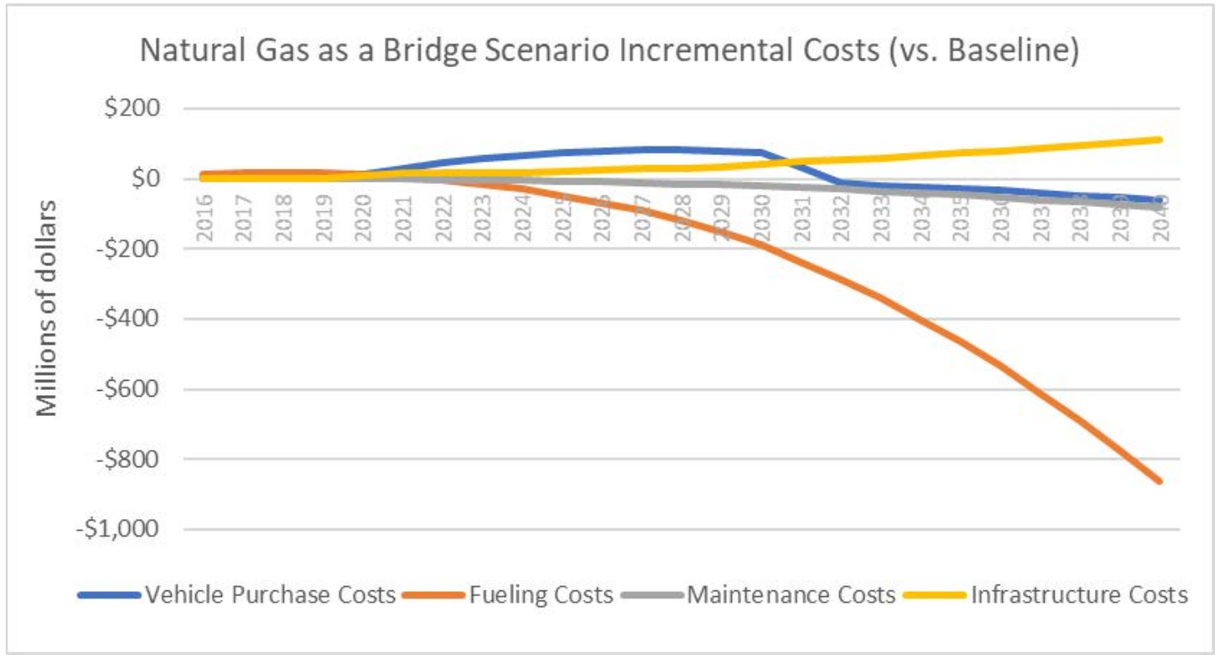
Summary of Scenario NOx Emissions Impacts



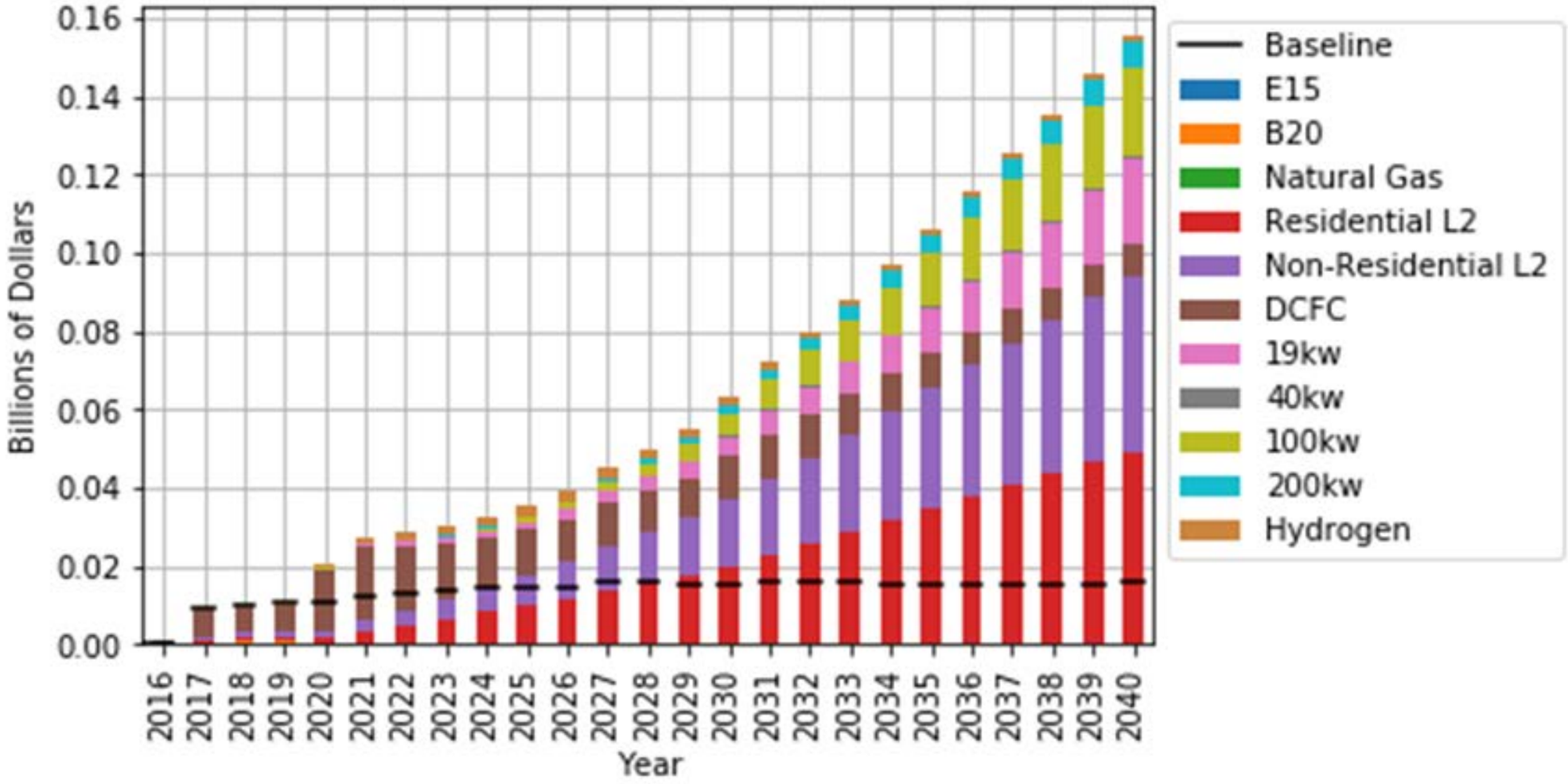
* NOx target reflects the percent reduction in NOx emissions in the South Coast Air Basin from all sources necessary to achieve attainment with the federal ozone standard, as presented in the 2016 Air Quality Management Plan.

Incremental Costs (Relative to the Baseline)





Electrification Scenario Infrastructure Costs



Incremental Cumulative Costs (Relative to the Baseline), 2016-2030

Incremental Cumulative Costs (Relative to the Baseline), 2016-2040

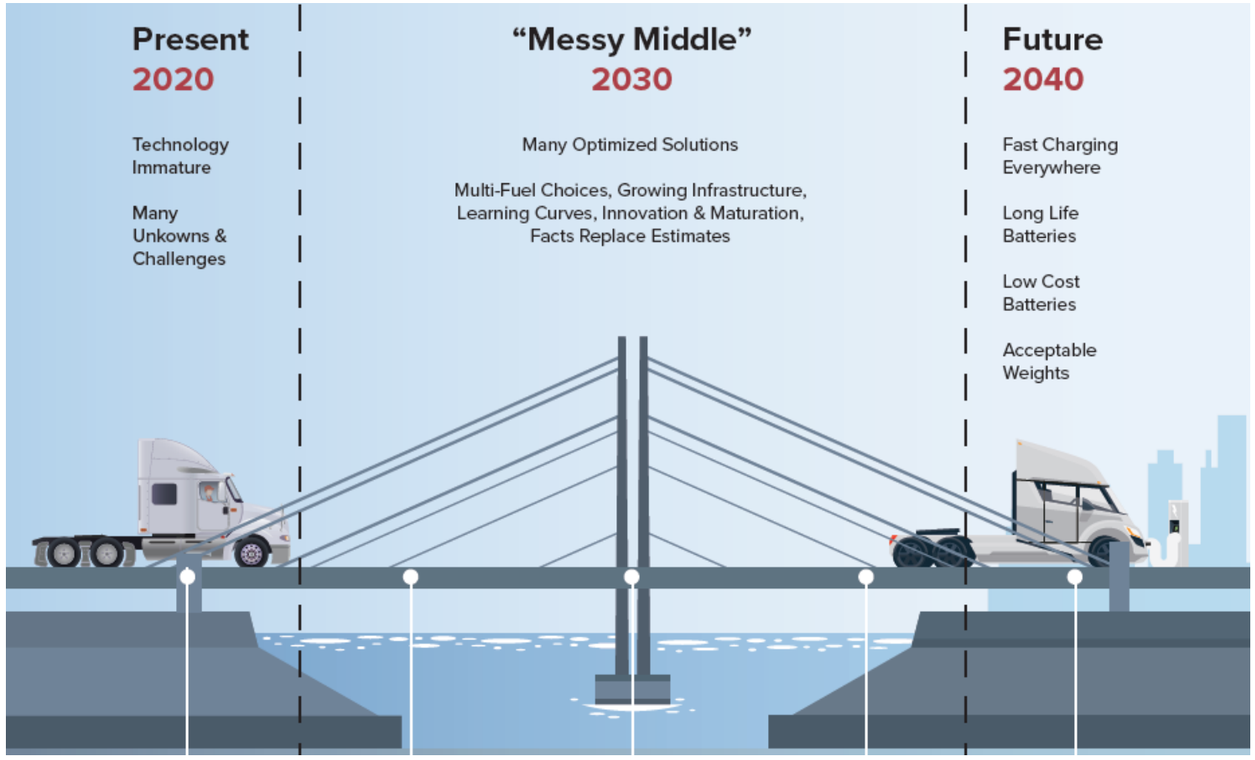
Conclusions

Scenario Model Findings

- Electrification and NG as a Bridge scenarios can achieve large GHG (35-37%) and NOx (21-27%) reductions relative to the Baseline by 2040
- None of the current scenarios hit the NOx reduction targets established as benchmarks. Only Aggressive Electrification hits GHG target.
- Electrification and NG as a Bridge scenarios are similar in their costs
  - Large net cost savings after 2030 due to assumptions about fueling cost savings – this can spur adoption
  - Both scenarios require ~$1 billion in cumulative costs for charging/fueling infrastructure
- Biofuels + low-NOx diesel engines can also achieve significant emission reductions, but without operating cost savings
- Our scenario analysis does not lead us to conclude that either electrification or natural gas is the clear preferred path among MD/HDVs for achieving both NOx and GHG reduction targets

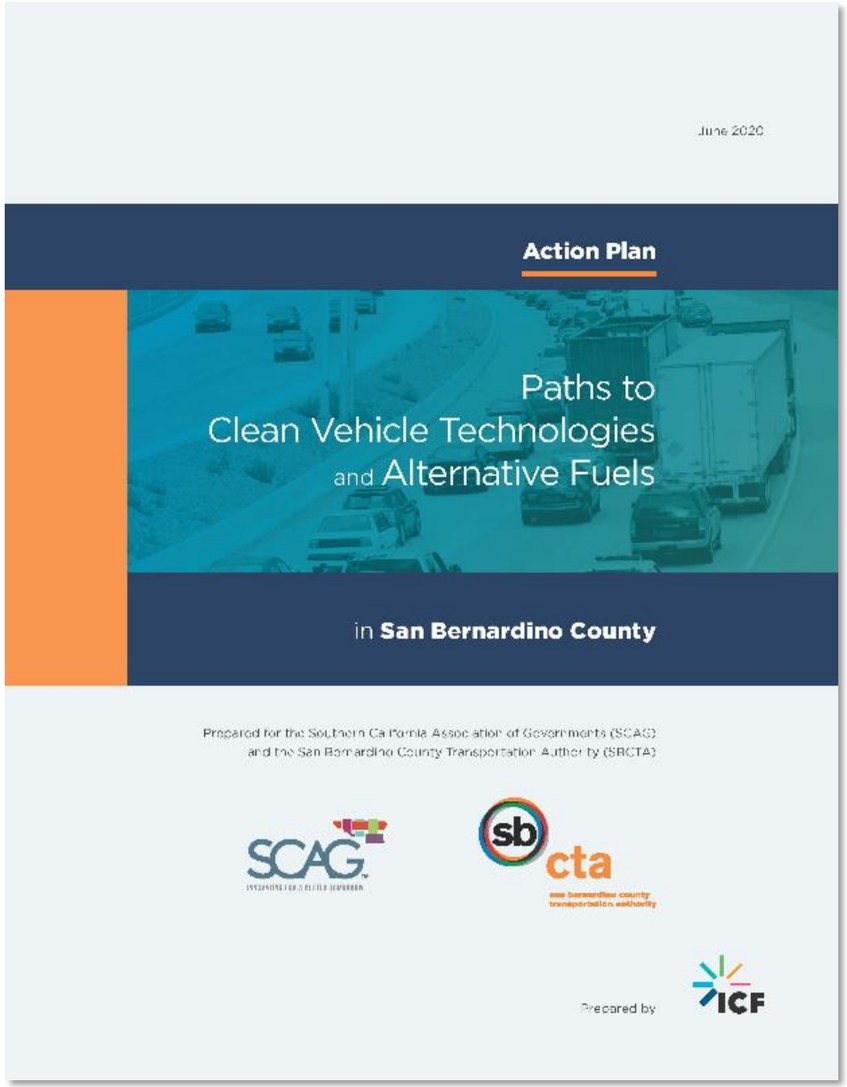
What is the “right” fuel / technology?

- **LDVs: Electric vehicles**
- **MD/HDVs: Multiple options for the next 10-15 years**
  - EVs, NGVs, biofuels, possibly FCVs all can play a role
  - Different technologies and fuels will offer optimized solutions depending on truck size and application
  - Long term (2040+), full electrification is expected



Source: North American Council for Freight Efficiency, *Guidance Report: Viable Class 7/8 Electric, Hybrid and Alternative Fuel Tractors*, 2019. Available at: https://nacfe.org/report-library/guidance-reports/

Final Products



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