PM EMISSION BENEFITS FROM A NEW U.S. LIGHT-DUTY VEHICLE STANDARD

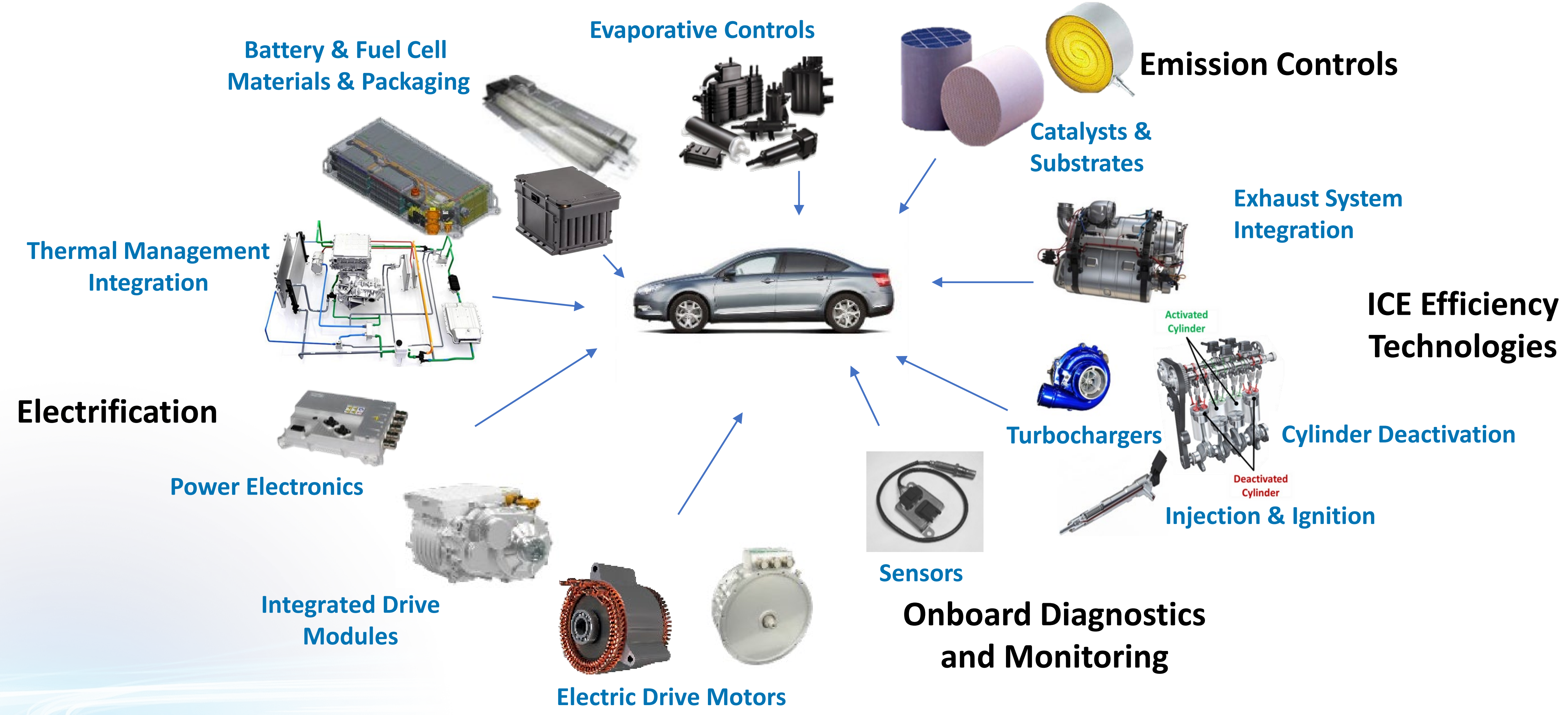
Michael Geller

October 24, 2023

NACAA Webinar

MECA
SUPPLYING CLEAN MOBILITY

MECA – Technologies for Clean Mobility



ADVANCED ENGINE SYSTEMS

48V MILD & FULL HYBRID SYSTEMS

PLUG-IN HYBRID TECHNOLOGIES

BATTERY & FUEL CELL ELECTRIC COMPONENTS

Outline

Introduction

Motivation

Methods

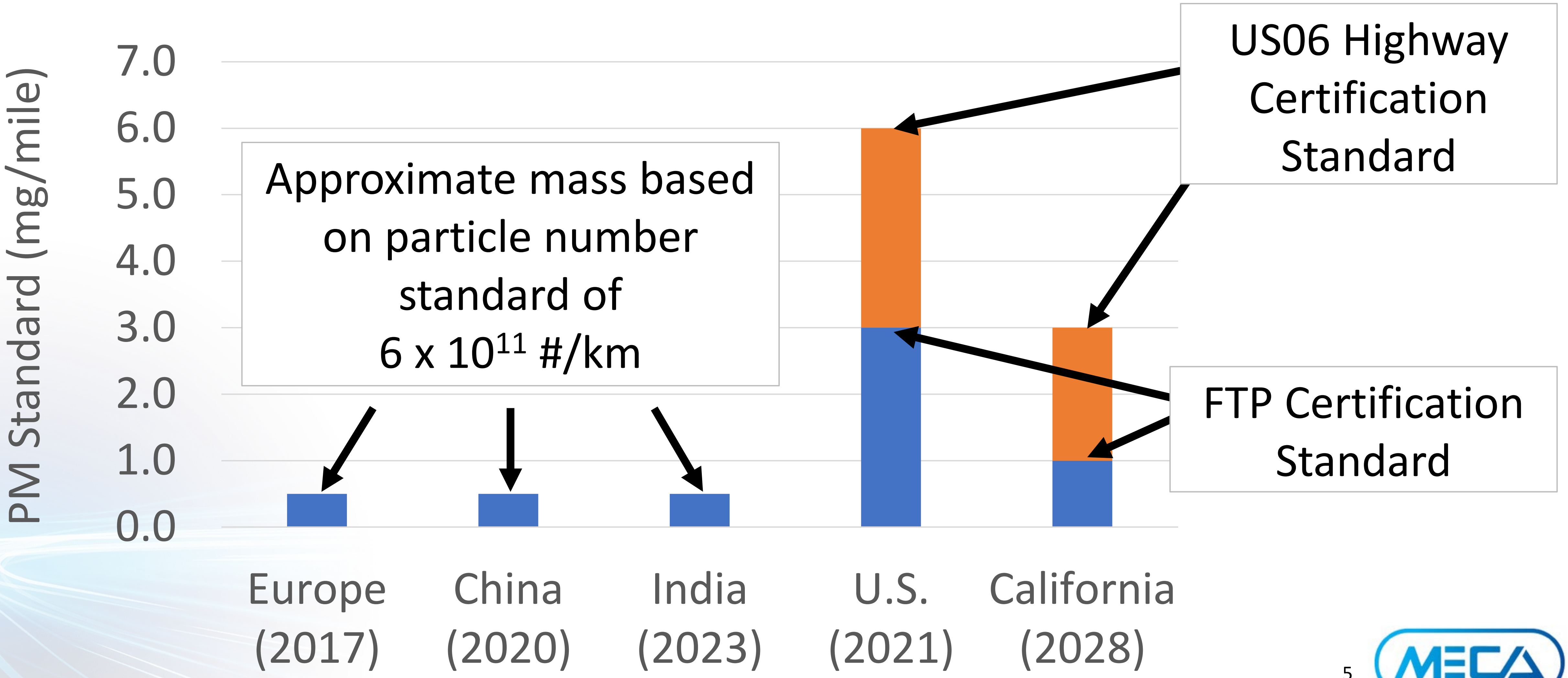
Results

Conclusion

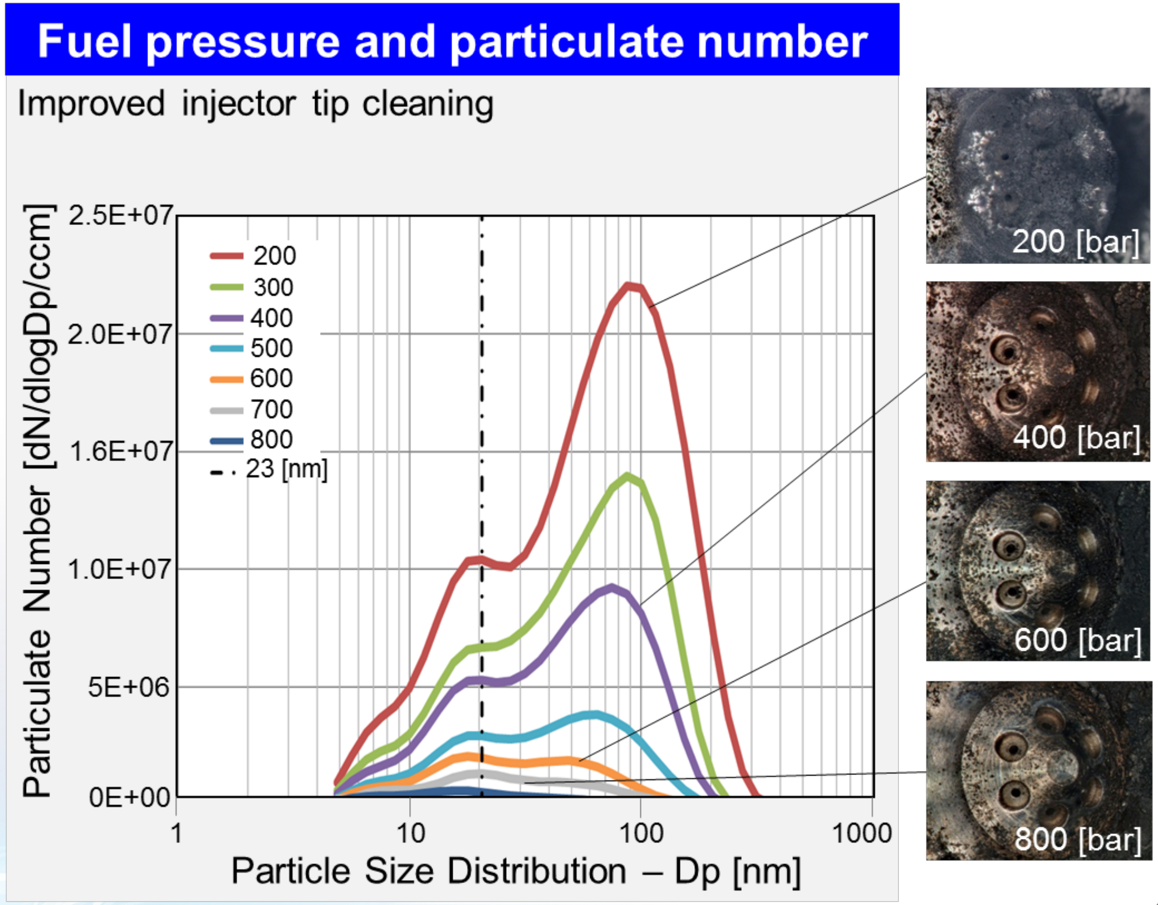
Introduction

- Electrification of the passenger car fleet is projected to increase at a quick pace, but millions of ICE-vehicles will be sold during the transition
- The U.S. EPA will soon finalize new multipollutant standards for light- and medium-duty vehicles
- Particulate limits equivalent to Europe, China and India can be met through a combination of electrification and emission controls on ICE-vehicles
- Significant air quality and health benefits can be achieved from further PM reductions from passenger vehicles

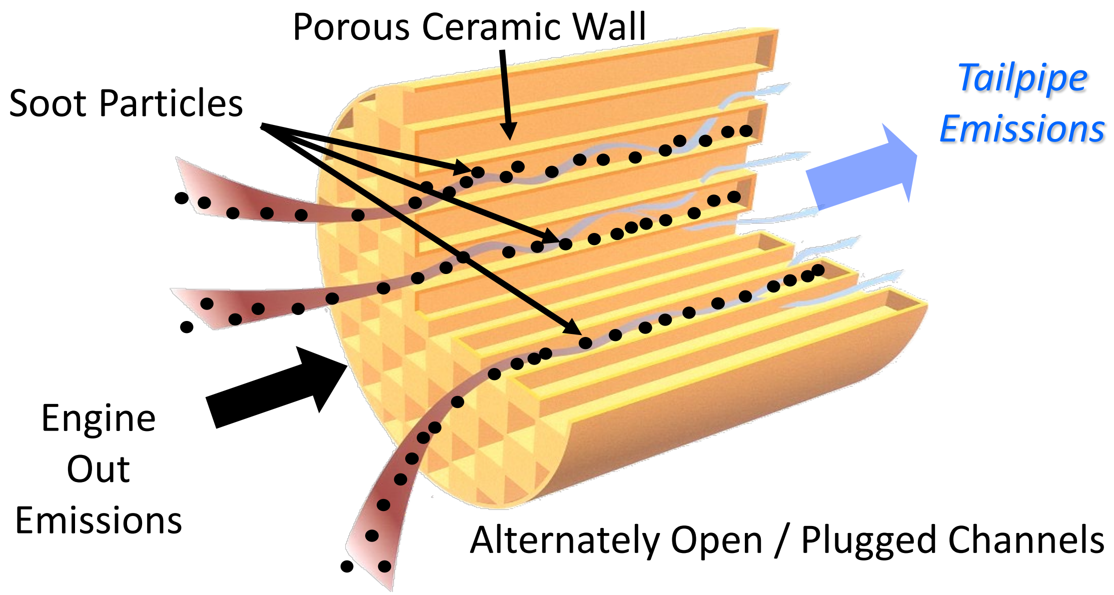
US trails the world on particulate emission standards

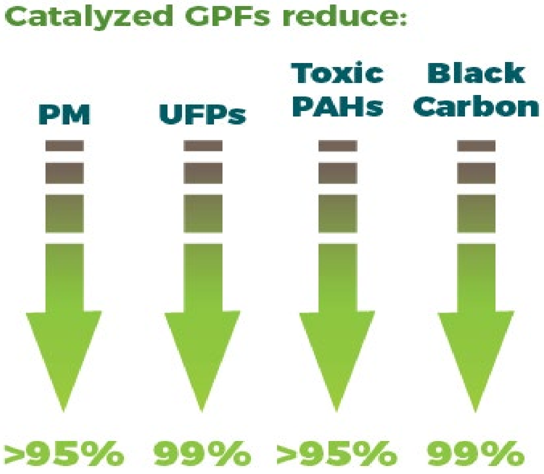


Automakers already produce "best available" PM emission control technology for cars in Europe, China & India



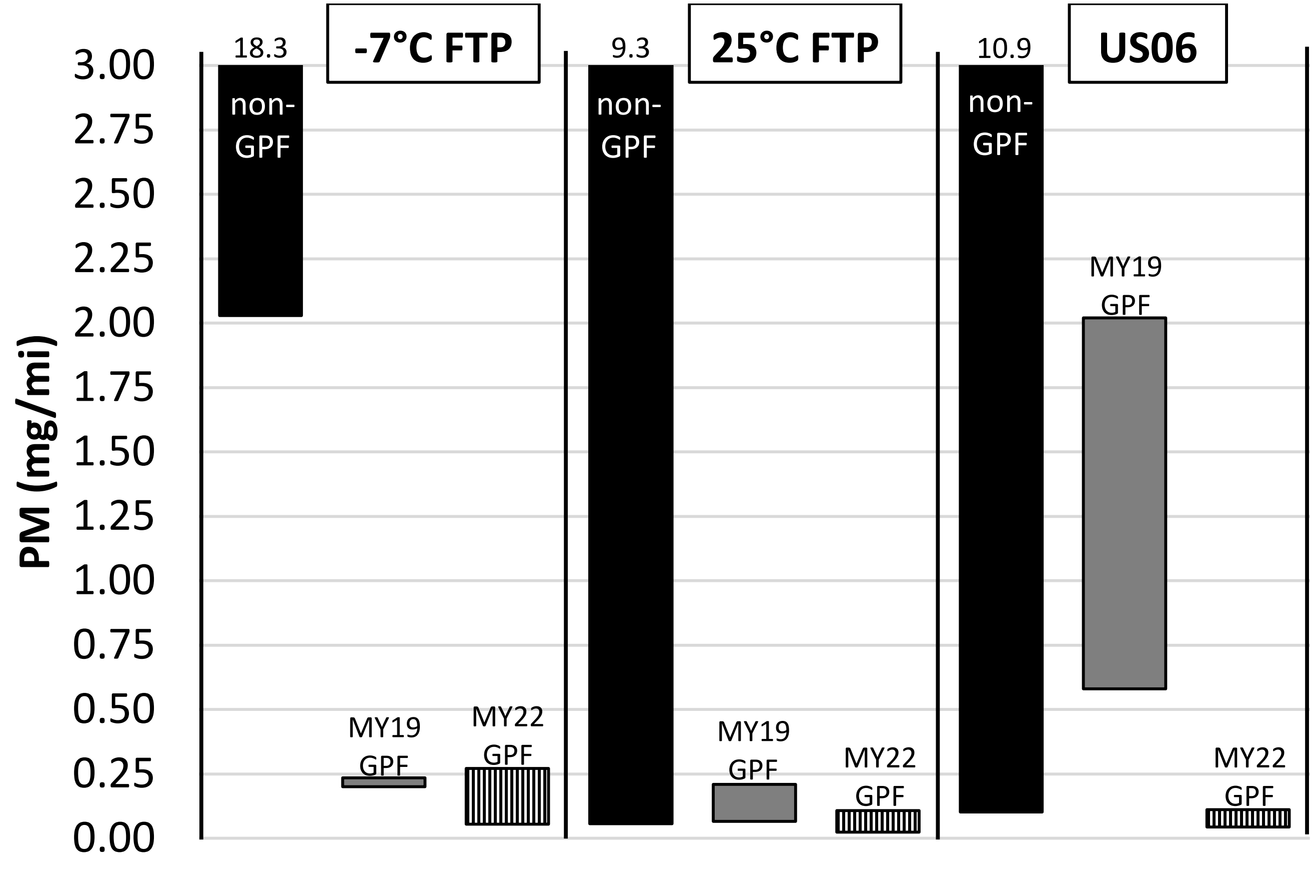
Source: Piock et al., 2019 Vienna Motor Symposium





MECA SUPPLYING CLEAN MOBILITY

GPFs continue to be improved at low incremental cost to vehicle



U.S. EPA 33rd CRC Real World Emissions Workshop (2023)

EPA demonstrated very low lab-to-lab variability

Range of costs for GPF to meet 0.5 mg standard:

$100 - $400
Based on engine size

Modeled emission standards

Table 1. On-road PM certification standards: current & modeled (mg/mile)									
	LDV, LDT, MDPV			Class 2b			Class 3		
		SFTP			SFTP			SFTP	
Agency, Standard	FTP Limit	Limit	Cycle	FTP Limit	Limit	Cycle	FTP Limit	Limit	Cycle
Current EPA/CARB ACC (2021+ MY)	3	6	US06	8	7/10	Mix	10	7	Mix
CARB ACC2 (2027+ MY)*	1	3	US06	8	6	US06	10	5	Unified Cycle
Modeled EPA (2027+ MY)*	0.3/0.6†	1.0	US06	0.8/1.6†	2.0	US06	1.0/2.0†	1.7	Unified Cycle
EPA Proposed Rule	0.5	0.5	US06	0.5	0.5	US06	0.5	0.5	US06

* Includes 1 mg FTP standard from ACC (starting MY2025) and 25/50/75 % phase in for first 3 model years, 100% thereafter

† FTP standards at 75 / 20 degrees Fahrenheit

MECA SUPPLYING CLEAN MOBILITY

Modeling analysis methods

Evaluation Years:	**2016, 2023, 2025 – 2050, 2060**
Pollutants:	**PM2.5, Black Carbon**
Domain:	**49-States + District of Columbia**
Temporal Basis:	**Annual (Monthly Aggregation)**
Fleet Coverage:	**Modeled standards apply to automobiles and trucks up to 14,000 lbs. GVWR (complete vehicle certifications only)**
Regulatory Context:	**Federal certification region (32 states + DC) Section 177 states (17 states)**
Electrification:	**3 tiers of electrification rates/targets modeled**

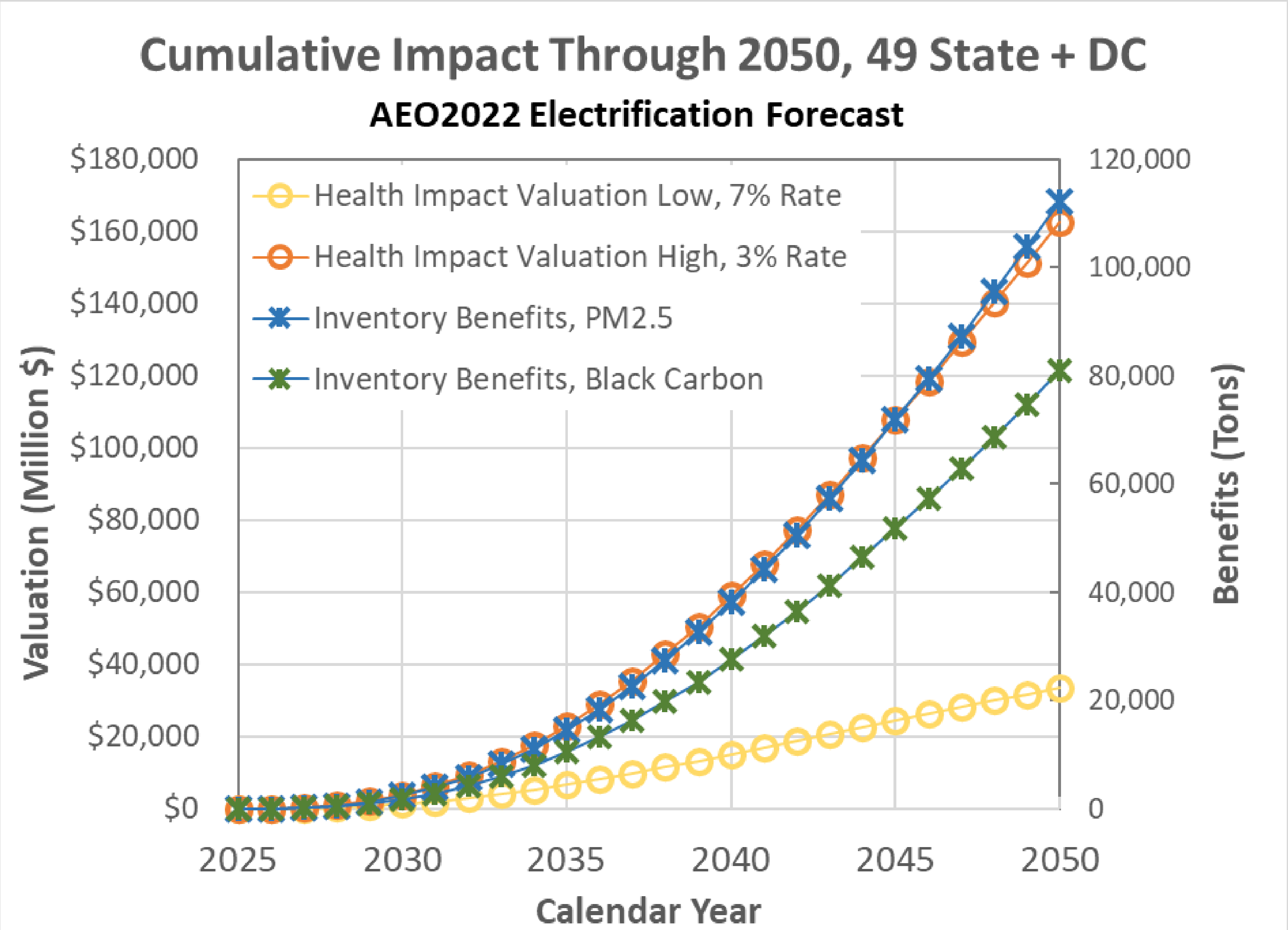
Notes: Black Carbon (BC) not directly reported by MOVES; standard practices are to use Elemental Carbon (EC) as a surrogate for BC.
EMFAC is the official inventory model for California; EMFAC was not applied in this project and thereby CA was omitted from study.

Electrification assumptions

Domain	Electrification Case		
	AEO2022	Mid Range	High Range
Section 177 States Following CARB ZEV Mandate	AEO projections assigned to CA+177 States based on 2019 MY sales; CA+177 state share of national EVs increased linearly to 85% by MY2030 and held at 85% thereafter.	Modification of the "High Range" case assuming that 100% electrification will not be met until MY2050.	California ACC II regulation plus linear growth to achieve 100% electric by MY2040; passenger car electrification occurs more quickly than LDT.
Balance of United States (Federal Certification Region)	AEO national projections less vehicles assigned to CA+177 states. EVs account for 13% of passenger cars sales in 2050.	50% of national total sales electrified by MY2035 (5 years after Biden Executive Order); linear growth thereafter to reach 100% electrification by MY2060.	Biden Executive Order of 50% of national total sales electrified by MY2030; linear growth thereafter to reach 100% electrification by MY2050; passenger car electrification occurs more quickly than LDT.

[1] Automobile electrification rate about twice that of light-duty trucks as observed in historic AEO data; faster automobile electrification also agrees with qualitative summary of ARB's ACC II.

Projected benefits from clean ICE vehicles – AEO2022 EV forecast (13% EV sales in 2050)



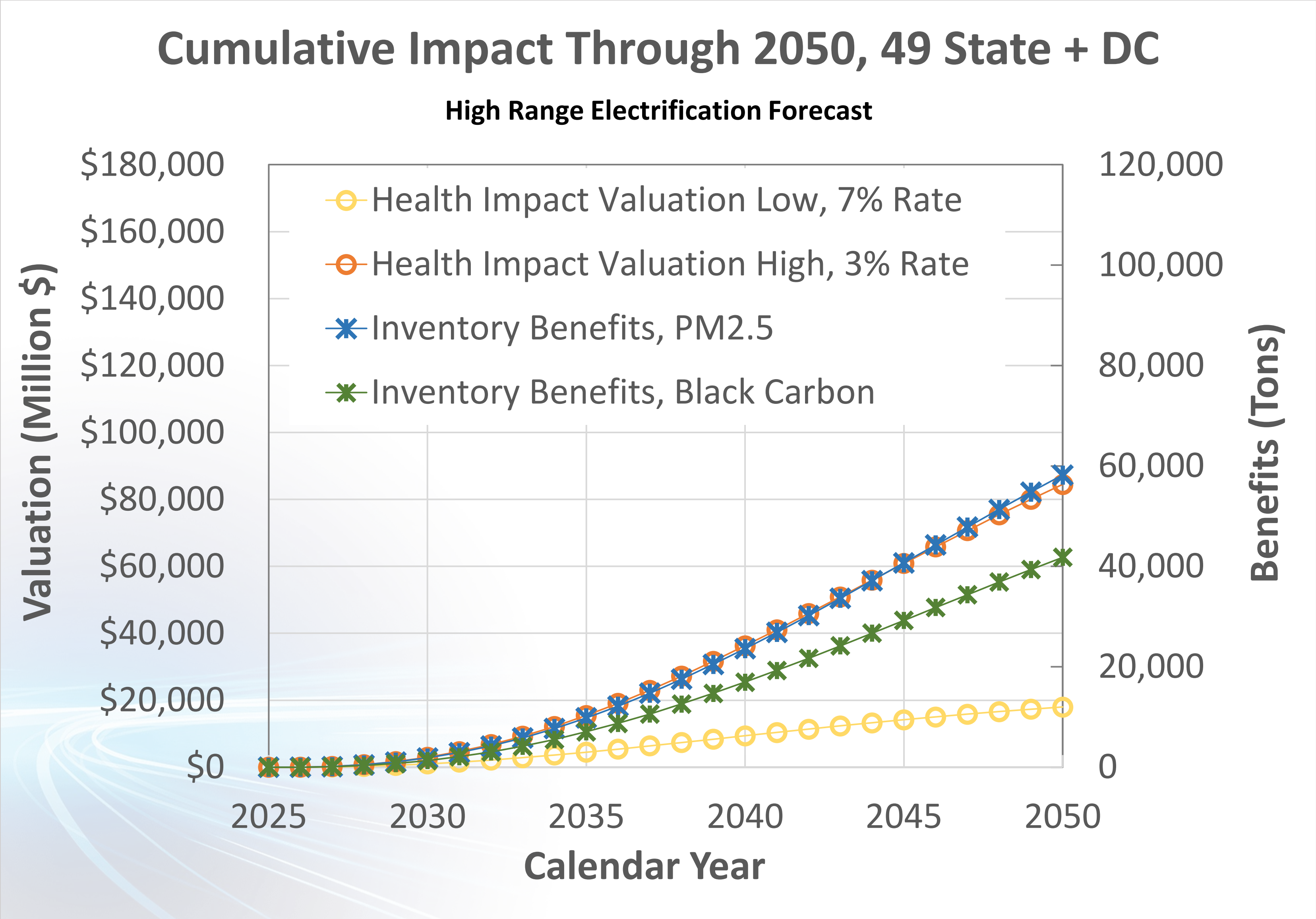
115,000 tons of PM reduced

Avoided Lives Lost: 9,894 - 22,319

Avoided Asthma Attacks: 314,393

Avoided Lost Work Days: 1,154,828

Projected benefits from clean ICE vehicles – high EV forecast (100% EV sales in Section 177 states/rest of U.S. in 2040/2050)



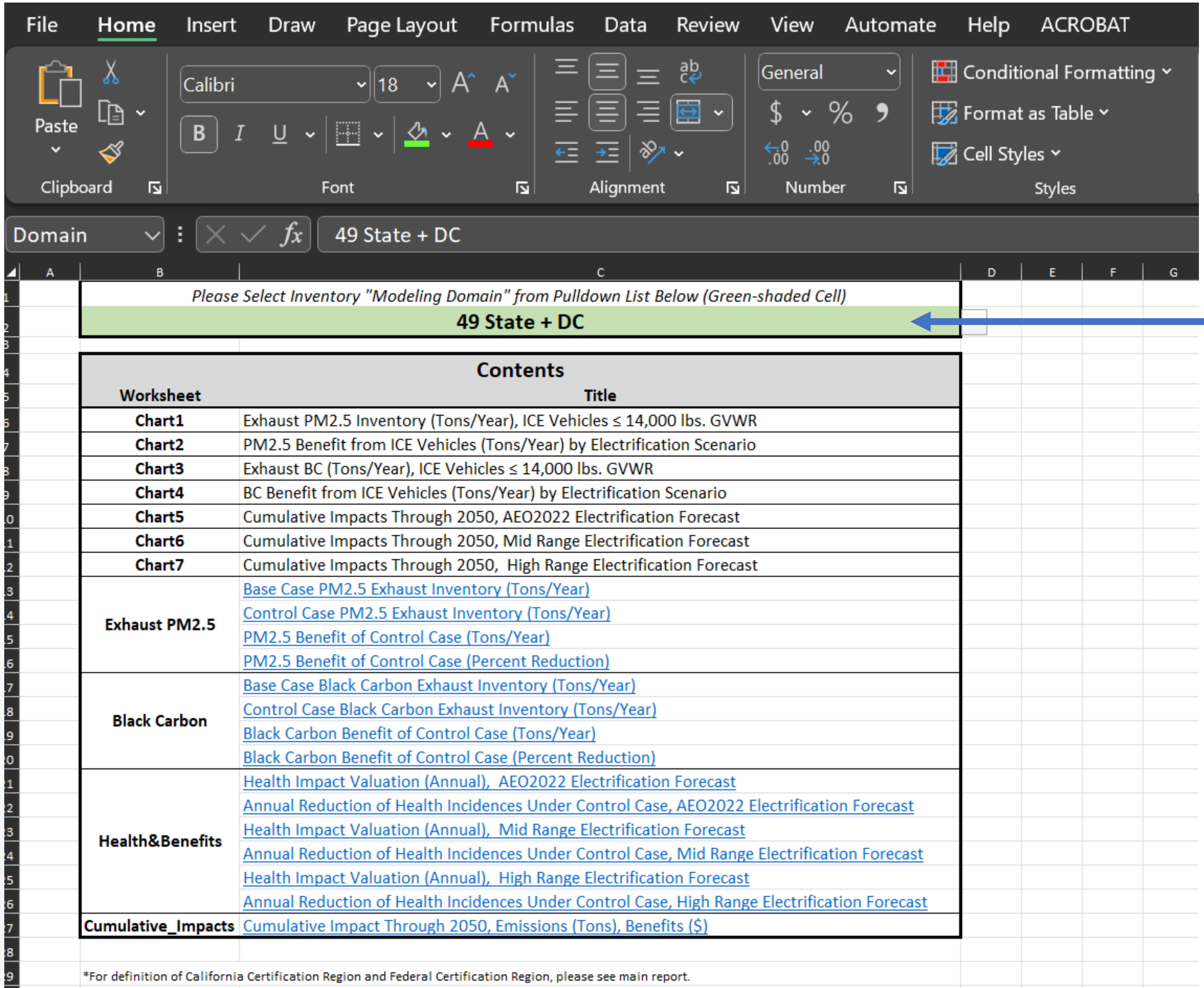
60,000 tons PM reduced

Avoided Lives Lost: 5,026 – 11,340

Avoided Asthma Attacks: 161,048

Avoided Lost Work Days: 589,850

Individual state level results available



Please Select Inventory "Modeling Domain" from Pulldown List Below (Green-shaded Cell)

49 State + DC

Select state

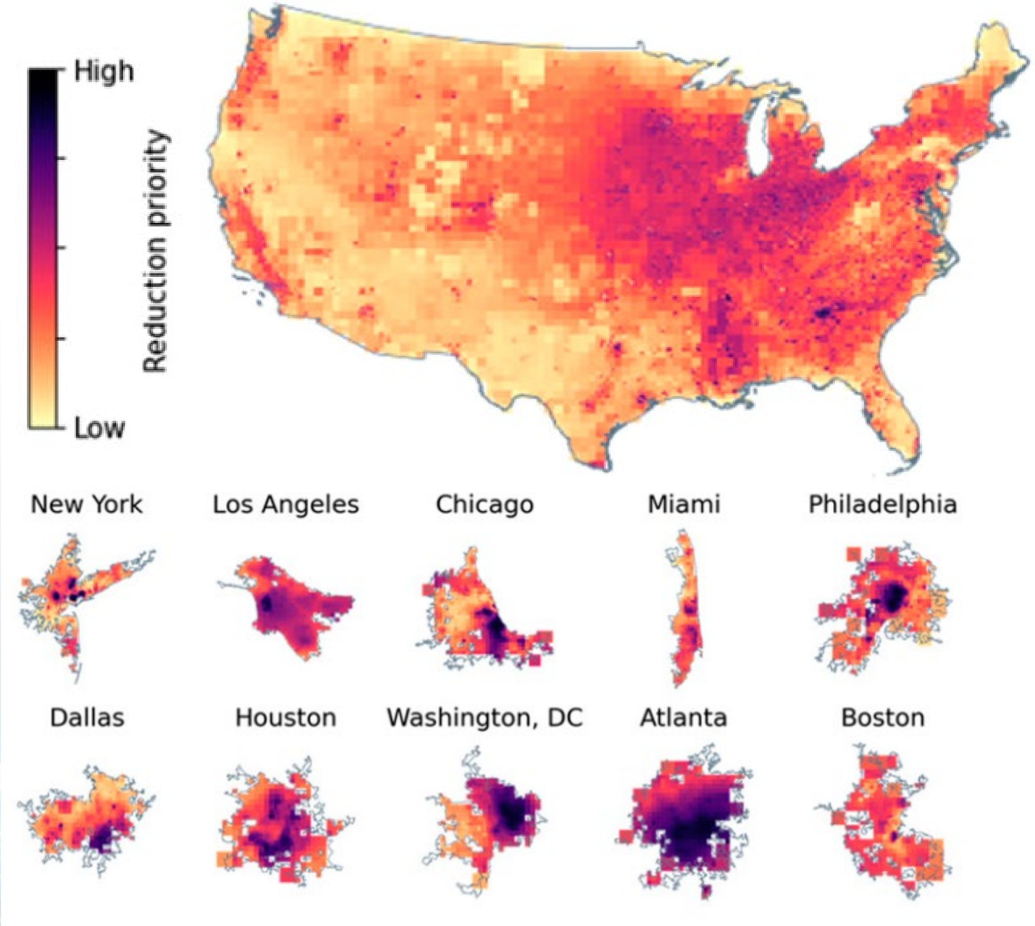
Contents

Worksheet	Title
Chart1	Exhaust PM2.5 Inventory (Tons/Year), ICE Vehicles ≤ 14,000 lbs. GVWR
Chart2	PM2.5 Benefit from ICE Vehicles (Tons/Year) by Electrification Scenario
Chart3	Exhaust BC (Tons/Year), ICE Vehicles ≤ 14,000 lbs. GVWR
Chart4	BC Benefit from ICE Vehicles (Tons/Year) by Electrification Scenario
Chart5	Cumulative Impacts Through 2050, AEO2022 Electrification Forecast
Chart6	Cumulative Impacts Through 2050, Mid Range Electrification Forecast
Chart7	Cumulative Impacts Through 2050, High Range Electrification Forecast
Exhaust PM2.5	Base Case PM2.5 Exhaust Inventory (Tons/Year)
	Control Case PM2.5 Exhaust Inventory (Tons/Year)
	PM2.5 Benefit of Control Case (Tons/Year)
	PM2.5 Benefit of Control Case (Percent Reduction)
Black Carbon	Base Case Black Carbon Exhaust Inventory (Tons/Year)
	Control Case Black Carbon Exhaust Inventory (Tons/Year)
	Black Carbon Benefit of Control Case (Tons/Year)
	Black Carbon Benefit of Control Case (Percent Reduction)
Health&Benefits	Health Impact Valuation (Annual), AEO2022 Electrification Forecast
	Annual Reduction of Health Incidences Under Control Case, AEO2022 Electrification Forecast
	Health Impact Valuation (Annual), Mid Range Electrification Forecast
	Annual Reduction of Health Incidences Under Control Case, Mid Range Electrification Forecast
	Health Impact Valuation (Annual), High Range Electrification Forecast
	Annual Reduction of Health Incidences Under Control Case, High Range Electrification Forecast
Cumulative_Impacts	Cumulative Impact Through 2050, Emissions (Tons), Benefits ($)

*For definition of California Certification Region and Federal Certification Region, please see main report.

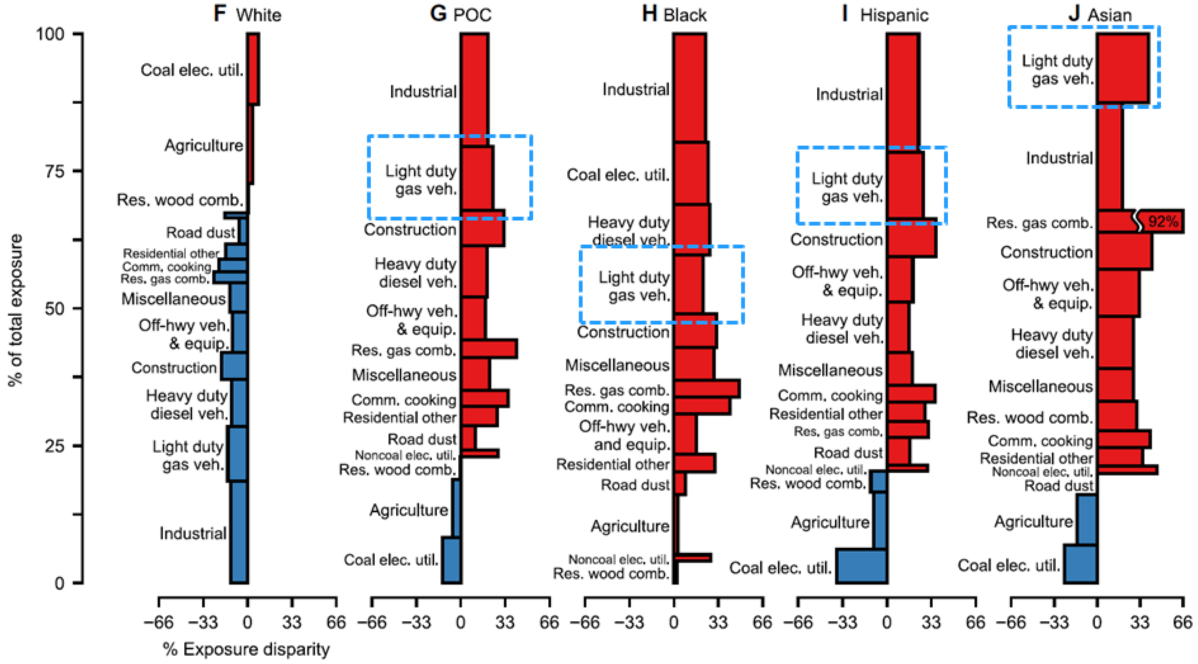
PM emissions greater in urban centers and affects near-road and disadvantaged communities disproportionately

Location-specific strategies can eliminate PM2.5 exposure disparities



PNAS; https://doi.org/10.1073/pnas.2205548119

Gasoline particle emissions is a leading contributor to environmental injustice



% exposure disparity

U. Illinois at Urbana-Champaign, U. Washington, UT Austin, UC Berkeley, U. Minnesota; Sci. Adv. 2021: 7(18).

Near-Road Impacts Study – Methods

EPA began monitoring of sites within 50 m of roadways in 2013

Sonoma Technology (STI) conducted comprehensive evaluation of 49 near-roadway sites in 2017

This study evaluated 5 of 20 suitable locations in greater detail – quantifying the near-roadway impact of a lower PM standard

Each location has a background monitor and near-roadway monitor

Co-located monitors were compared on matched dates to estimate the incremental near-roadway air quality impacts

Near-Road Impacts Study – Results

Distribution of near-roadway incremental PM2.5 in 2017 ($\mu g/m^3$)

Location	Maximum	Mean	50%	75%	90%
Denver	9.8	1.8	1.5	2.2	3.7
Indianapolis	4.5	0.5	0.5	0.9	1.4
Louisville	3.5	0.9	0.9	1.3	1.9
Milwaukee	3.7	0.4	0.5	1.0	1.4
Providence	9.6	2.1	2.1	3.2	4.4

Near-Road Impacts Study – Results

Location	Electrification Scenario	Reduction in Near-Roadway PM2.5 Increment				
		2030	2035	2040	2045	2050
Denver	Low-Range	3%	10%	15%	21%	23%
	High-Range	2%	5%	7%	9%	9%
Indianapolis	Low-Range	4%	13%	22%	30%	32%
	High-Range	3%	10%	14%	19%	19%
Louisville	Low-Range	4%	15%	23%	32%	35%
	High-Range	3%	10%	15%	21%	20%
Milwaukee	Low-Range	6%	20%	31%	43%	46%
	High-Range	5%	14%	20%	28%	27%
Providence	Low-Range	2%	7%	10%	14%	15%
	High-Range	1%	3%	5%	6%	7%

Conclusions

- Emission benefits were modeled based on a potential national light- and medium-duty vehicle PM standard set at 90% below current limits
- Results indicate nearly 120,000 tons of PM benefits (cumulative) from ICE vehicles based on low rates of electrification and 60,000 tons of PM benefits (cumulative) from ICE vehicles based on high rates of electrification
- Valuation of corresponding health benefits ranges from $30-160B and $20-85B for the low and high range electrification cases, respectively
- Application of best available emission controls on passenger cars, light and medium-duty trucks roughly doubles the PM reductions and health benefits from a high rate of electrification alone
- A parallel technology pathway allows all vehicles to meet stringent standards and delivers maximum PM health benefits

Acknowledgements

Rasto Brezny – MECA

Ameya Joshi – Clear Flame (formerly Corning)

Jeremy Heiken – Oak Leaf Environmental

MECA

SUPPLYING CLEAN MOBILITY

THANK YOU.

Mike Geller | mgeller@meca.org

MECA
SUPPLYING CLEAN MOBILITY

Supplemental

Near-Road Impacts Study – Results

Location	Electrification Scenario	Mean Near-Roadway Incremental PM2.5 (μg/m³) Base (left) and Control (right)									
		2030		2035		2040		2045		2050	
Denver	Low-Range	1.53	1.48	1.39	1.25	1.25	1.06	1.12	0.89	1.07	0.83
	High-Range	1.49	1.46	1.28	1.22	1.09	1.01	0.91	0.83	0.85	0.77
Indianapolis	Low-Range	0.46	0.44	0.42	0.36	0.41	0.32	0.39	0.28	0.39	0.26
	High-Range	0.45	0.44	0.39	0.35	0.35	0.30	0.31	0.25	0.29	0.23
Louisville	Low-Range	0.75	0.72	0.69	0.59	0.67	0.51	0.65	0.44	0.64	0.41
	High-Range	0.74	0.71	0.64	0.58	0.57	0.49	0.51	0.40	0.47	0.38
Milwaukee	Low-Range	2.00	1.87	1.88	1.51	1.83	1.26	1.78	1.02	1.76	0.95
	High-Range	1.95	1.86	1.73	1.49	1.54	1.22	1.36	0.98	1.24	0.90
Providence	Low-Range	0.31	0.30	0.27	0.25	0.25	0.22	0.23	0.20	0.22	0.19
	High-Range	0.30	0.30	0.25	0.24	0.21	0.20	0.18	0.17	0.17	0.16