Clean Mobility Suppliers Supporting EPA's Light-Duty and Medium-Duty Multipollutant Regulation

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Today's Focus

- Clean mobility suppliers represent nearly 300,000 jobs in the automotive industry that contributes more than $100 billion in economic content to the U.S. GDP.
- Performance based standards offer the best opportunity to meet climate goals through multiple technology pathways
- It is critical for suppliers that this rule is finalized in 2024 and implemented in 2027 because
- Suppliers have made substantial investments in new propulsion technologies and infrastructure
- These investments rely on regulatory certainty and are at risk by any implementation delay tied to infrastructure development.

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MECA Members Supplying Technologies for Clean Mobility

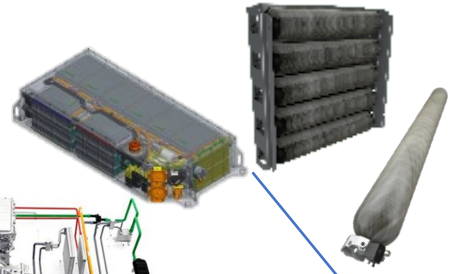
Battery Recycling

Battery & Fuel Cell Materials & Packaging

Evaporative Controls

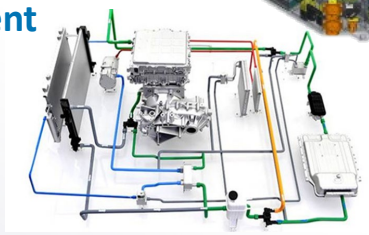
Catalysts & Substrates

Emission Controls



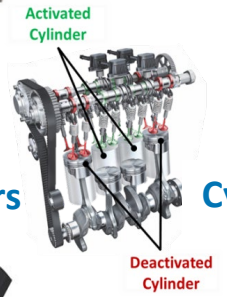
Thermal Management Integration

Exhaust System Integration



Electrification

Turbochargers

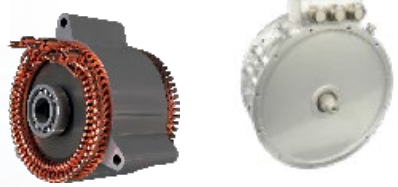


Cylinder Deactivation

ICE Efficiency Technologies

Power Electronics

Integrated Drive Modules



Electric Drive Motors

Sensors

Injection & Ignition

Chargers

Onboard Diagnostics and Monitoring

ADVANCED ENGINE SYSTEMS

48V MILD & FULL HYBRID SYSTEMS

PLUG-IN HYBRID TECHNOLOGIES

BATTERY & FUEL CELL ELECTRIC COMPONENTS

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Advanced Combustion Controls Create a Parallel Path to Compliance

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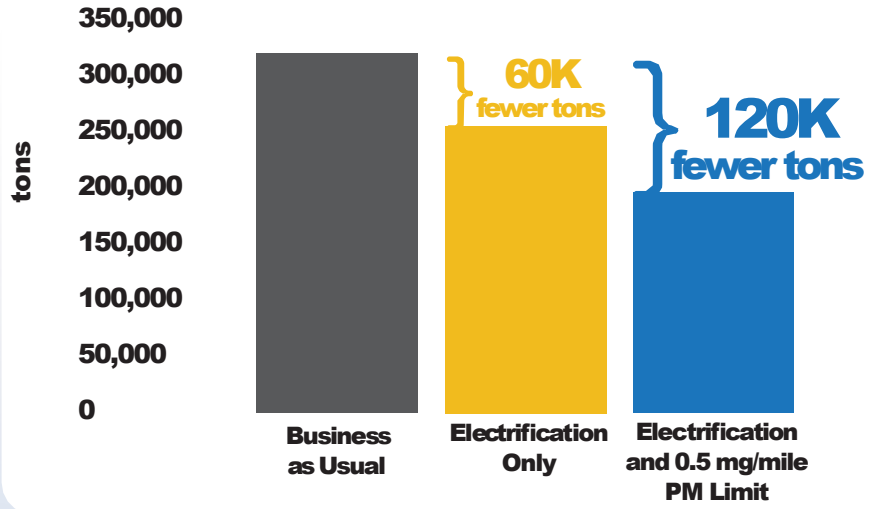
Stringent PM control from ICE Vehicles complements electrification

MECA PM Modeling Study – Quantifies the Health Benefits of Parallel Technology Paths

PM Inventory

Tons of PM Emitted by 2050



Tightening the PM standard and electrification avoids twice the amount of emitted PM by 2050 than by electrification alone!

AVOIDED LIVES LOST
9,900 to 22,300

AVOIDED ASTHMA ATTACKS
314,000

AVOIDED LOST WORKDAYS
1,155,000

Deploying GPFs has multiple attributes and co-benefits:

- Simultaneously reducing black carbon will complement the climate benefits of electrification. Estimated 80 million tons of CO_2 equivalent reduced by 2050.
- Filtration efficiency improves with age as engine out emissions increase.
- GPFs offer an insurance policy to achieve PM reductions regardless of EV penetration rate

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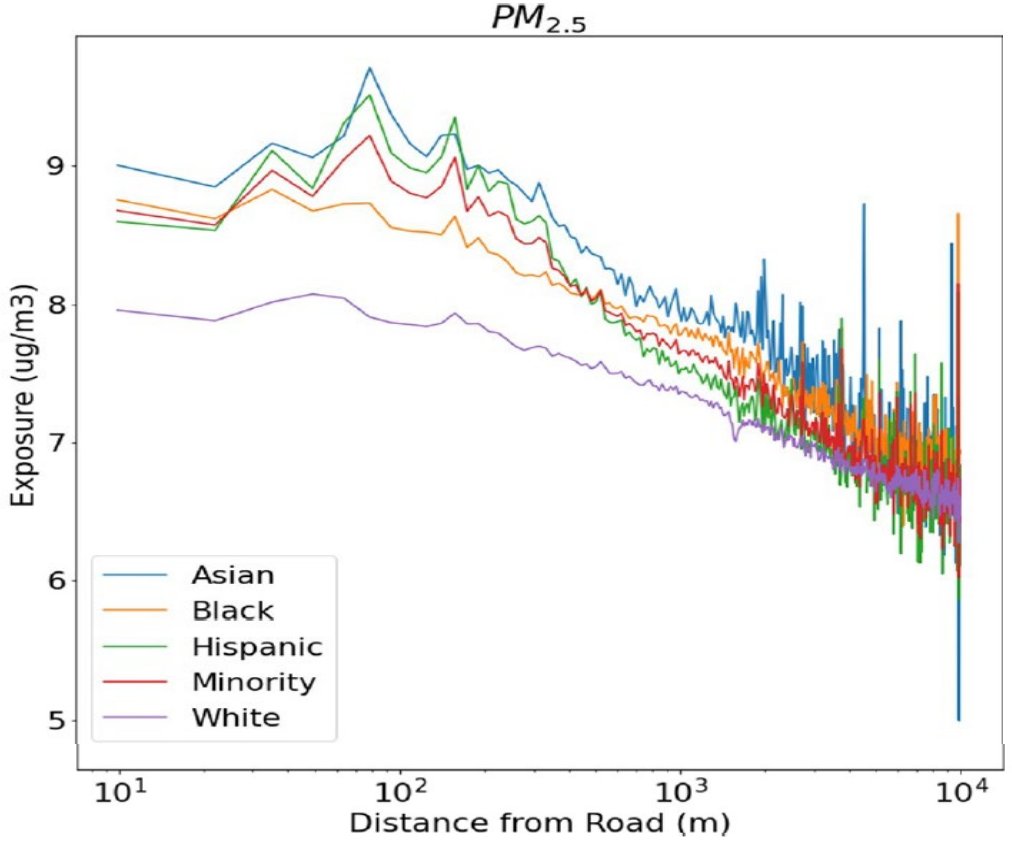
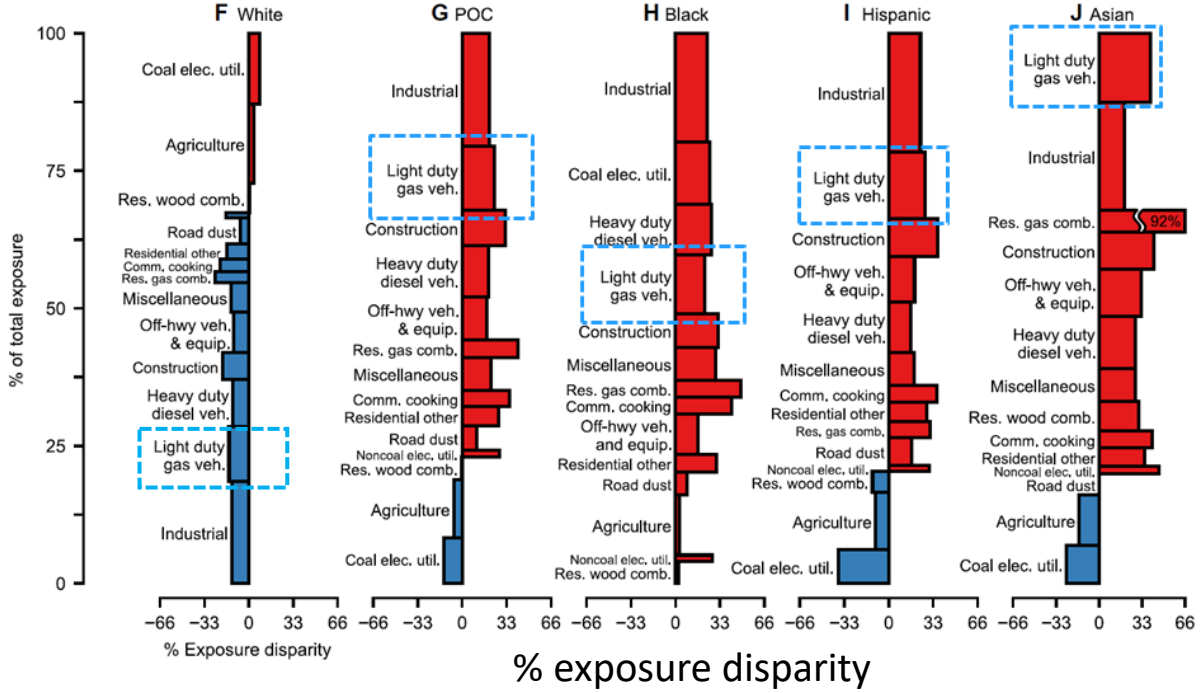
Mobile source particulate emissions disproportionately impact near-road and disadvantaged communities

Near-Road PM2.5 Exposure Reveals Inequality



PLoS One; https://doi.org/10.1371/journal.pone.0286406

Gasoline particle emissions is a leading contributor to environmental injustice



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

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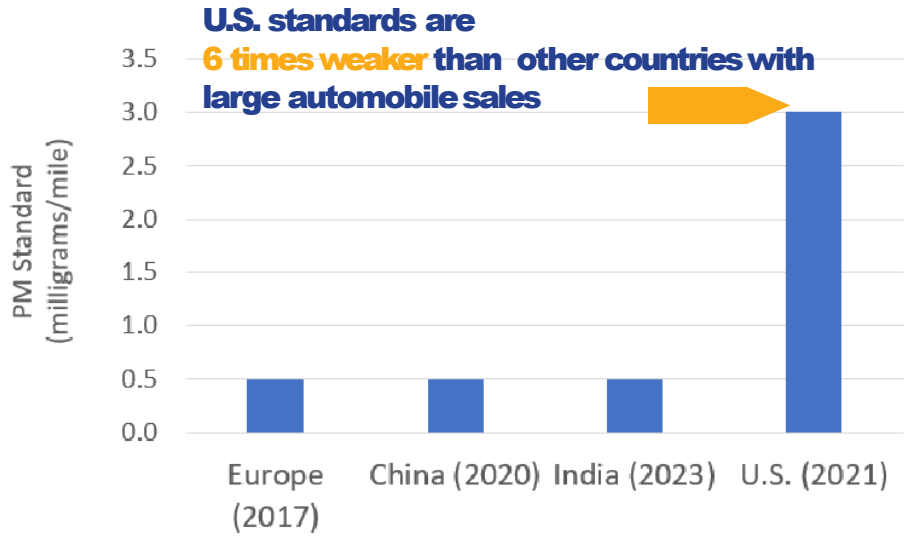
The US has fallen behind Europe, China and India, who all require deploying the best available control technology on gasoline vehicles



**EU, China and India limits estimated as PM mass*

EPA's proposed standards include 3 years of lead time: Phase-in extends that to 4-5 years

Model Year	EPA Phase-In	MECA Phase-In
2027	40%	60%
2028	80%	90%
2029	100%	100%
2030+	100%	100%

Millions of vehicles produced with GPFs in the US, since 2022, and shipped to Europe, China!

but without GPFs for the US market

		GPF Installed?		
OEM	**Model**	**Europe**	**China**	**US**
Ford	Mustang 	★	★	X
General Motors	Corvette  Silverado  Escalade 	★	★	X
Stellantis	Jeep Wrangler  Grand Cherokee 	★	★	X
Mercedes	GLE / GLS SUV 	★	★	X
BMW	X-Series SUV 	★	★	X
Audi	Q-Series SUV 	★	★	X

GPFs cost less than 1% of new vehicle price

- In some cases costs may be inflated by indirect and testing costs being allocated entirely to GPF costs
- Three independent cost analyses arrived at the same conclusion
- Incremental OBD and other indirect costs for GPF estimated to add about 10% to hardware costs

Source	Included DMC Costs for GPF on 1.5L to 7L engines	GPF Costs
EPA	Assumed bare GPF as extra component in exhaust (0.55 SVR)	$68 - $155
ICCT (2011)	Detailed bottom-up analysis of DMC costs for catalyzed filter (0.55 SVR)	$80 - $203
ICCT (2023)	Detailed bottom-up analysis of DMC costs for bare filter (1.2 SVR) Detailed bottom-up analysis of DMC costs for catalyzed filter (0.8 SVR)	$87 - $261 $76 - $208
MECA	Bare filter, hardware, including OBD (SVR 1.2) Catalyzed filter incremental costs to replace TWC, hardware, OBD (SVR 0.75)	$106 - $381 $85 - $261
OEMs	Assumptions include upgrading test cells, extensive calibration Engine redesign	$600 - $800 $2,000?

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Multiple Technology Paths Available to Meet Stringent Fleet Average NMOG+NOx Limits

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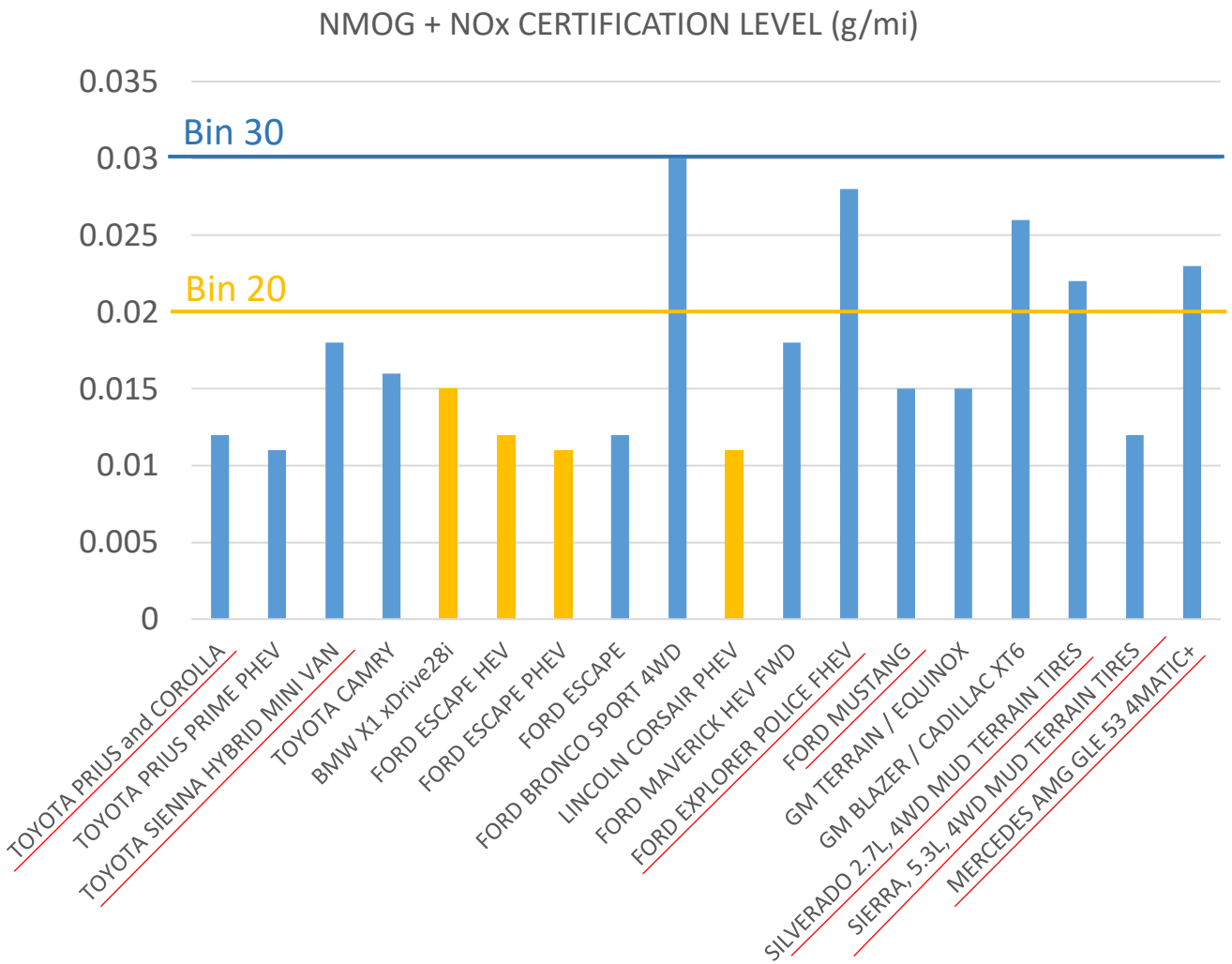
MY2023 & 24 Light-Duty Vehicles Meeting Ultra-Low Emission Limits

89 Engine Families Representing 232 Models
Certified to Bin 30 or Bin 20

43 Light-Truck Engine Families
Certified to Bin 30 or Bin 20

45 Engine Families Representing 94 Models
Hybrids

28 Engine Families
Certification Levels Under 15 mg/mile



Example Vehicle Models

Technologies to enable phase-out of commanded enrichment

EGR

Miller Cycle (Boosted – VNT Turbo with higher temperature metallurgy)

Cooled exhaust manifolds

Larger catalysts with advanced, thermally stable catalyst supports

Downstream catalysts (combined with e-heaters)

Electronic throttle control

Advanced multi-speed transmissions to down speed engine to optimal operating range

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MECA Members are Developing Components for Next Generation Electric Vehicles

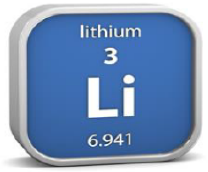
Inverter

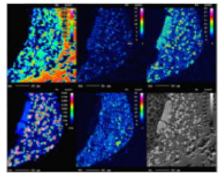
More efficient 800V architectures, electric drive units that combine power electronics with motors, multi-speed transmissions

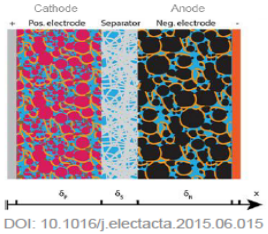
Design flexibility, reduced complexity, simplified vehicle integration, simplified cooling, increased efficiency and reduced cost.

Integrated units

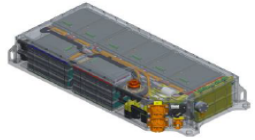
Raw materials → **Cathode materials** → **Electrodes** → **Cells** → **Systems**

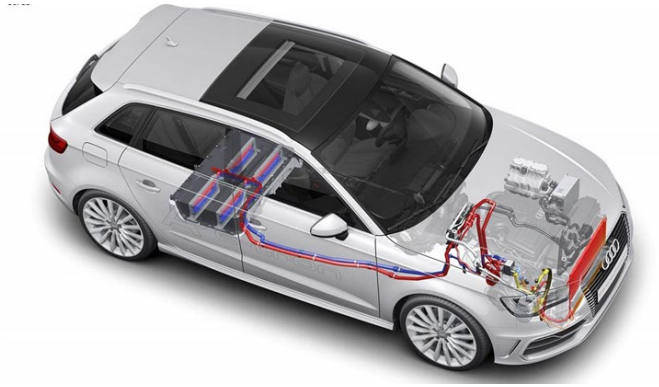






DOI: 10.1016/j.electacta.2015.06.015





Key challenges to address:

- **Raw materials:** Material cost, Energy density, Chemistry, Deactivation
- **Cathode materials:** Electrode cost, Press density, Structure, Degradation
- **Electrodes:** Cell cost, Cell energy, Cell power, Cycle life
- **Cells:** Total cost, Range, Power, Lifetime

New battery materials and thermal management provide higher range, extended battery durability and safety

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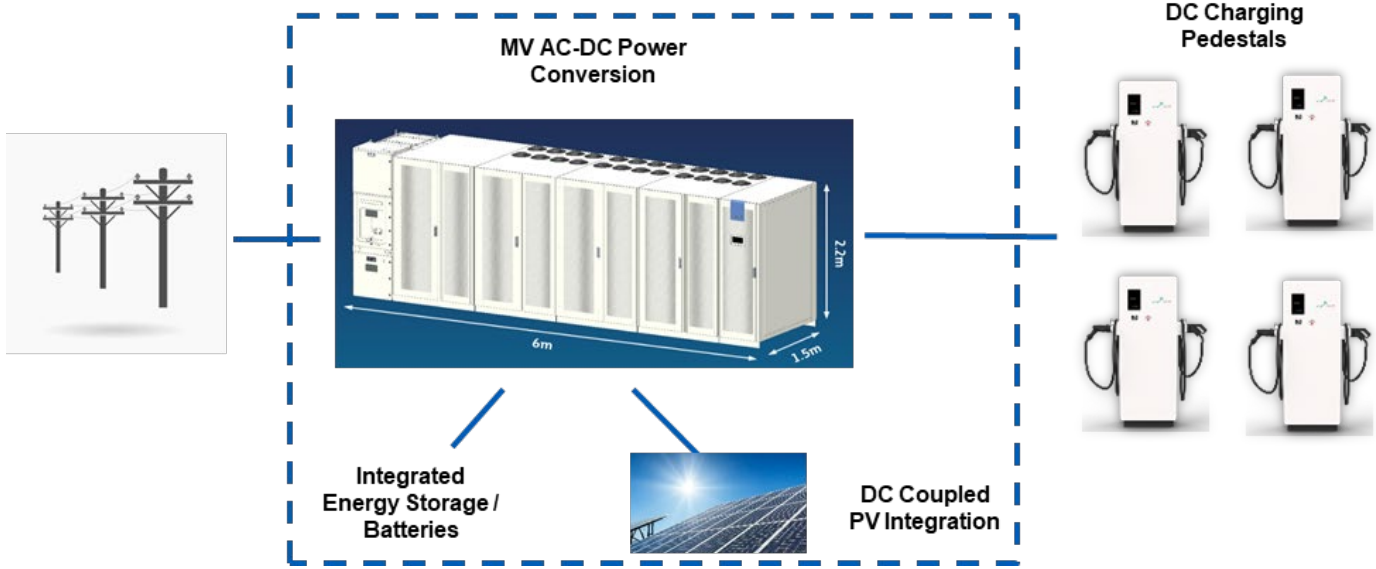
Electric Infrastructure Development is Critical

To serve light-duty sector in 2030:

1.4 million public charging ports (including 341,000 DCFC ports) projected to be needed

- Investment projected near $80B cumulative from 2024-2030
- Annual electricity demand for LDVs is approximately 250 TWh in 2030 and 500 TWh in 2035

Source: https://crcao.org/wp-content/uploads/2023/09/CRC_Infrastructure_Assessment_Report_ICF_09282023_Final-Report.pdf



Integrated charging infrastructure results in:

- **Footprint reduction**
- **Weight reduction**
- **Higher Efficiency (up to 98%)**
- **Lower total deployment cost**
- **Faster all-in-one deployment**
- **Future-proofed: Scaling, Storage & Solar**

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Summary

- It is critical for suppliers that this rule is finalized in 2024 and implemented in 2027.
- EPA's multipollutant approach recognizes technology diversity and vehicle inequality
- Stringent PM control of ICE vehicles complements electrification to ensure PM reduction goals are met
- Deploying U.S. made PM controls preserves U.S. jobs and facilitates the transition of manufacturing and the U.S. workforce
- Advanced combustion technology and electrification offers multiple compliance paths to meet EPA's NMOG + NOx limits
- Medium-duty vehicles can benefit from light-duty experience

THANK YOU.

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