Evolving Regulatory Landscape

Coleman Jones
American Petroleum Institute
Detroit Advisory Panel
Dearborn, Michigan
April 12, 2022

Agenda

CO2

Hybrids

California

Ambitious Goals

Rocks and Wires

How to Help?

A Little Fun

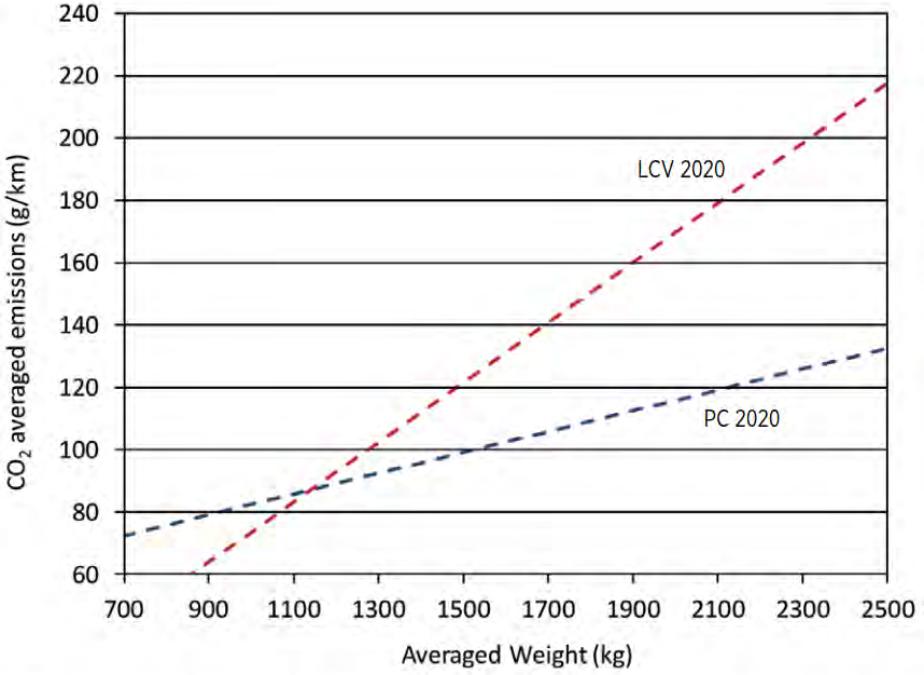
CO2 Emission Standards are Tightening Globally

- EU Fleet Targets
  - 2020 95 gm/km (58 mpg)
  - 2025 81 gm/km (68 mpg)
  - 2030 59 gm/km (92 mpg)

    → 43 gm/km (128 mpg)
  - 2035

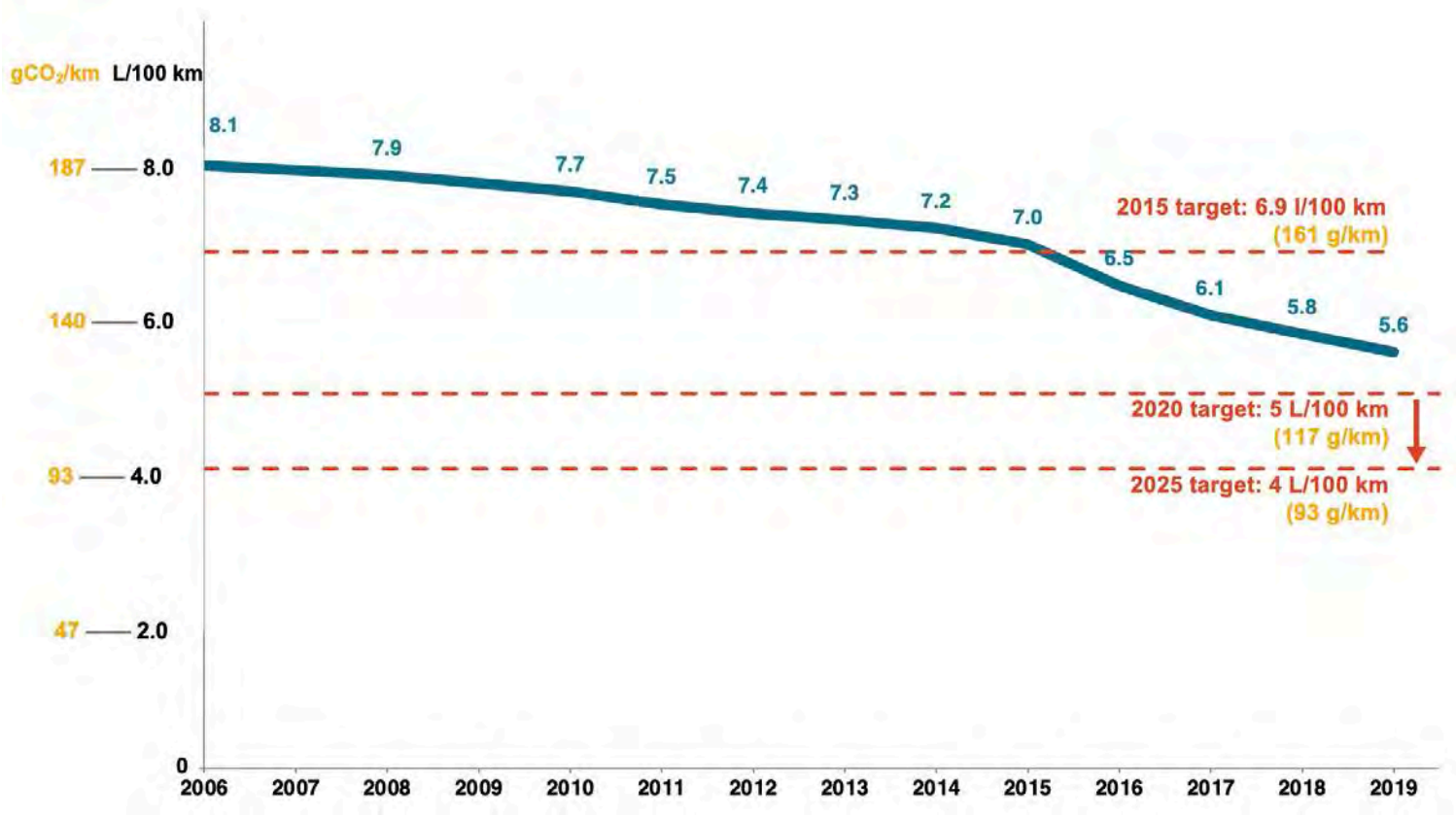
    → 0 gm/km

  - A sliding requirement dependent on vehicle mass is used
  - The Arrowed values are recent proposals

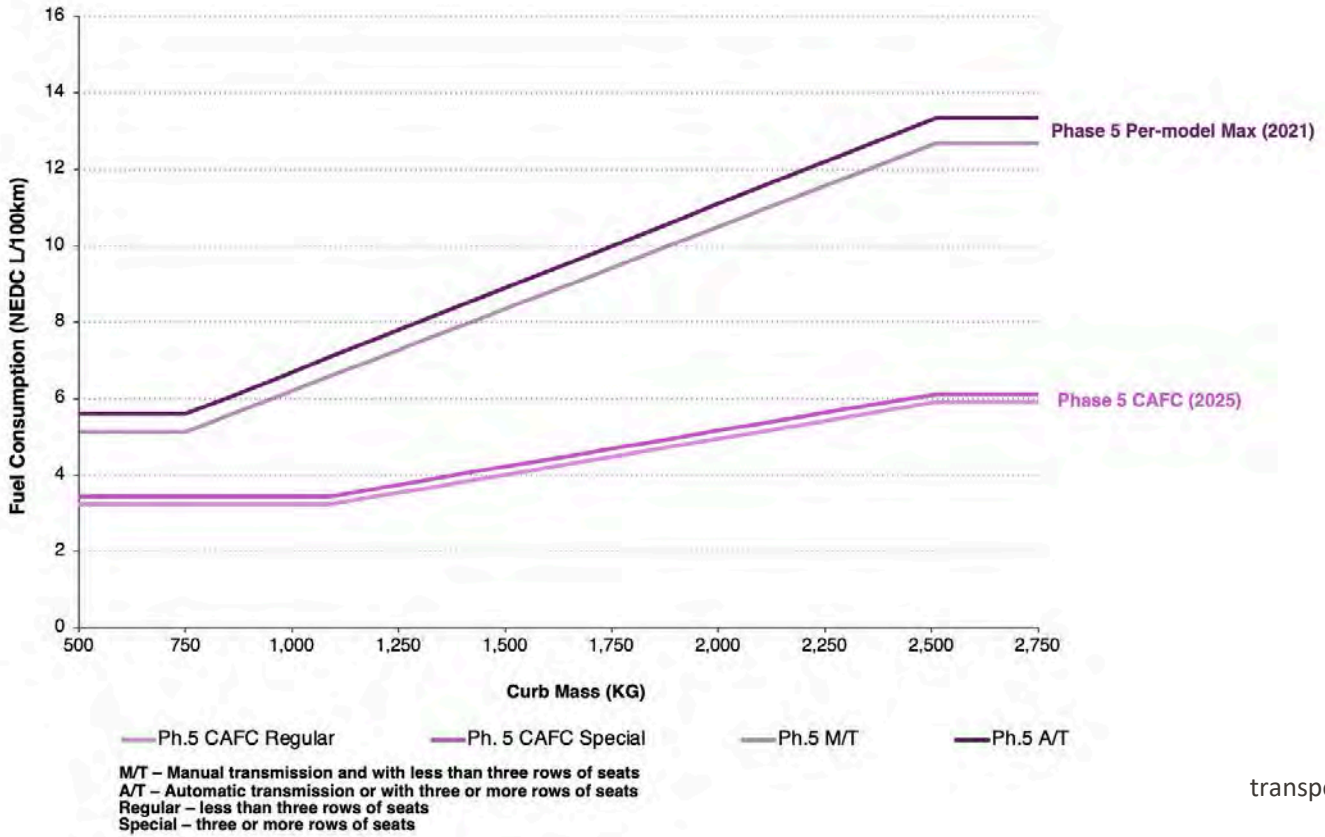


CO_2 emission limit curves for Passenger Cars and Light Commercial Vehicles.

China


gCO2/km L/100 km
187 8.0
140 6.0
93 4.0
47 2.0
0
8.1
7.9
7.7
7.5
7.4
7.3
7.2
7.0
6.5
6.1
5.8
5.6
2015 target: 6.9 l/100 km
(161 g/km)
2020 target: 5 L/100 km
(117 g/km)
2025 target: 4 L/100 km
(93 g/km)
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

China



transportpolicy.net

USA - EPA

- Revised EPA GHG Rule
- EPA finalized its most stringent proposal
- It catches up to the Obama standards in 2025 and exceeds them significantly in 2026

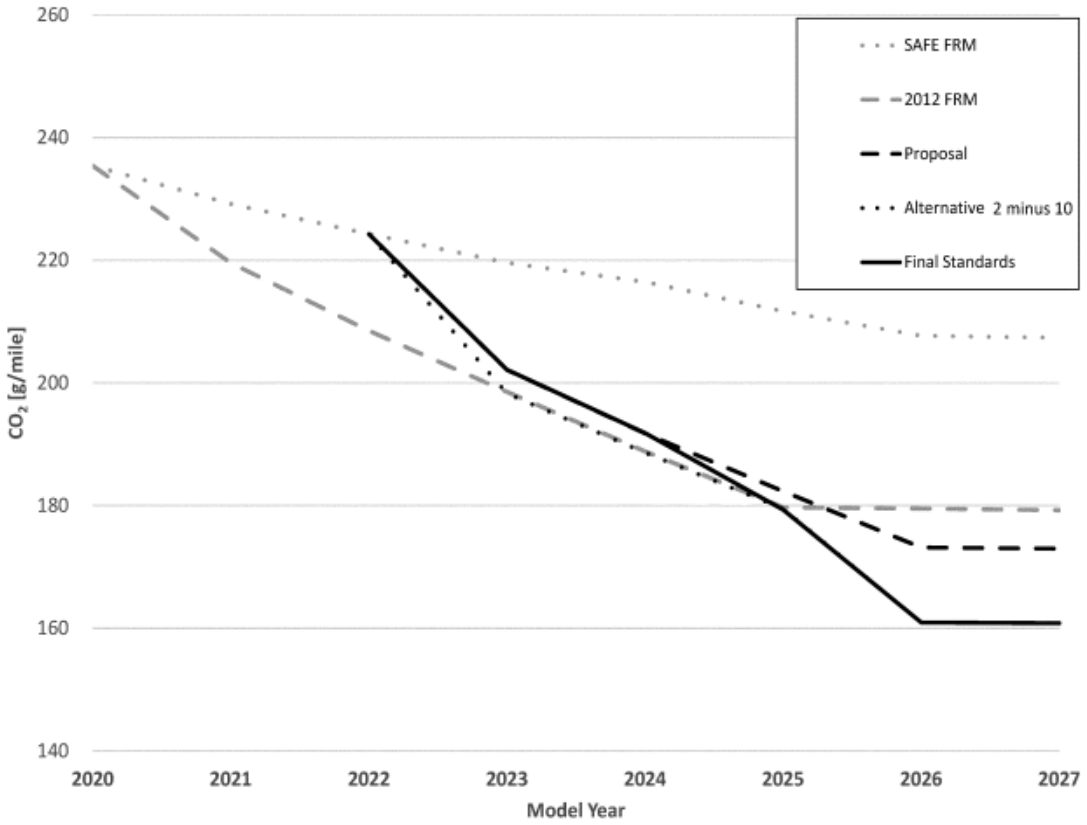
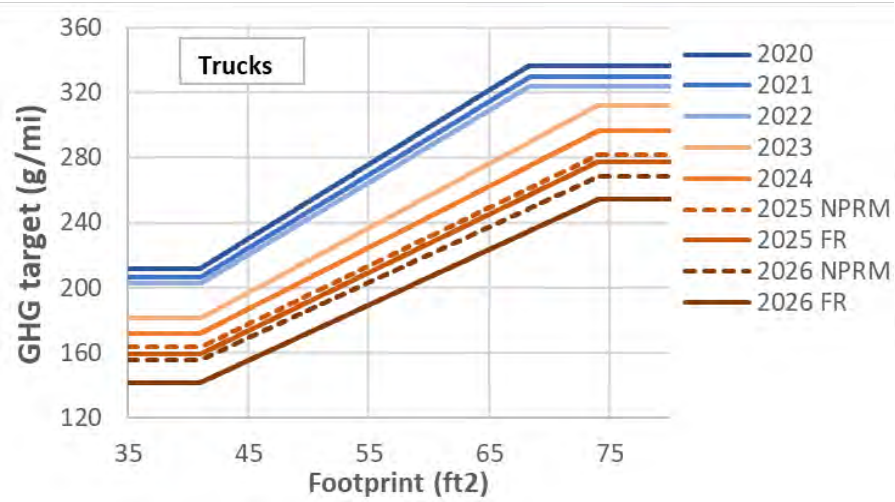
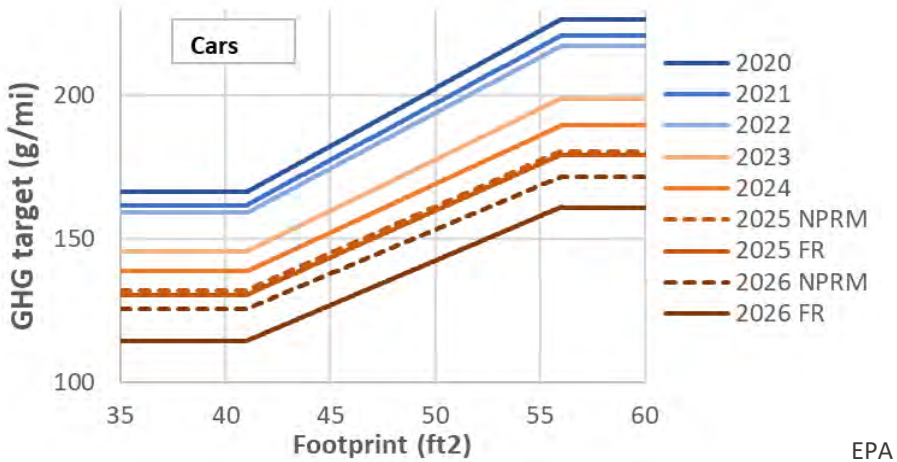


Figure 1 EPA Final Industry Fleet-Wide CO_2 Compliance Targets, Compared to 2012 and SAFE Rules, the Proposal and Alternative 2 minus 10, g/mile, MYs 2020-2026 and later

EPA Footprint Standards

- EPA Footprint (track * wheelbase) based standards become progressively more stringent
- California and Canada to follow



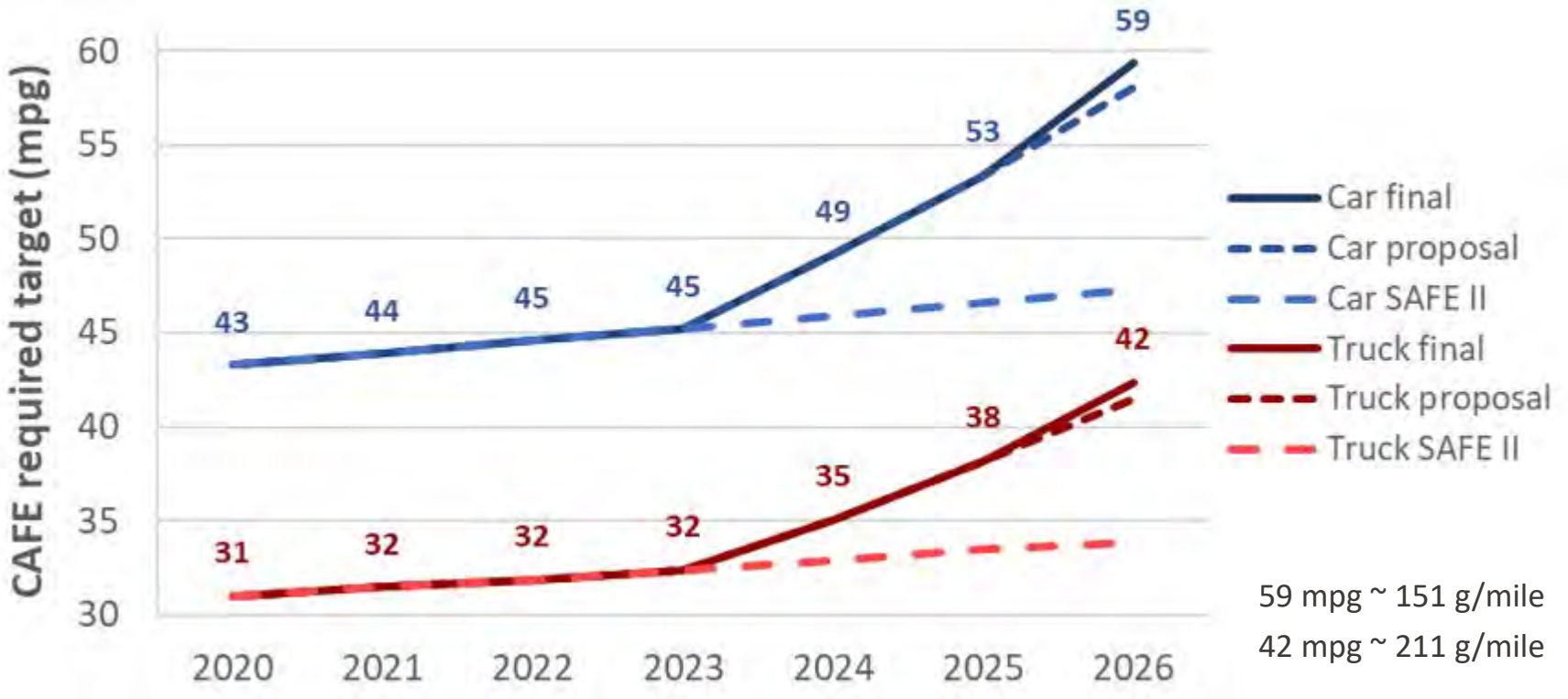


EPA

Uncertainties

- Social cost of carbon
- WV vs EPA
  - Stationary source lawsuit
  - Major questions doctrine
- At least 6 lawsuits challenging the GHG rule

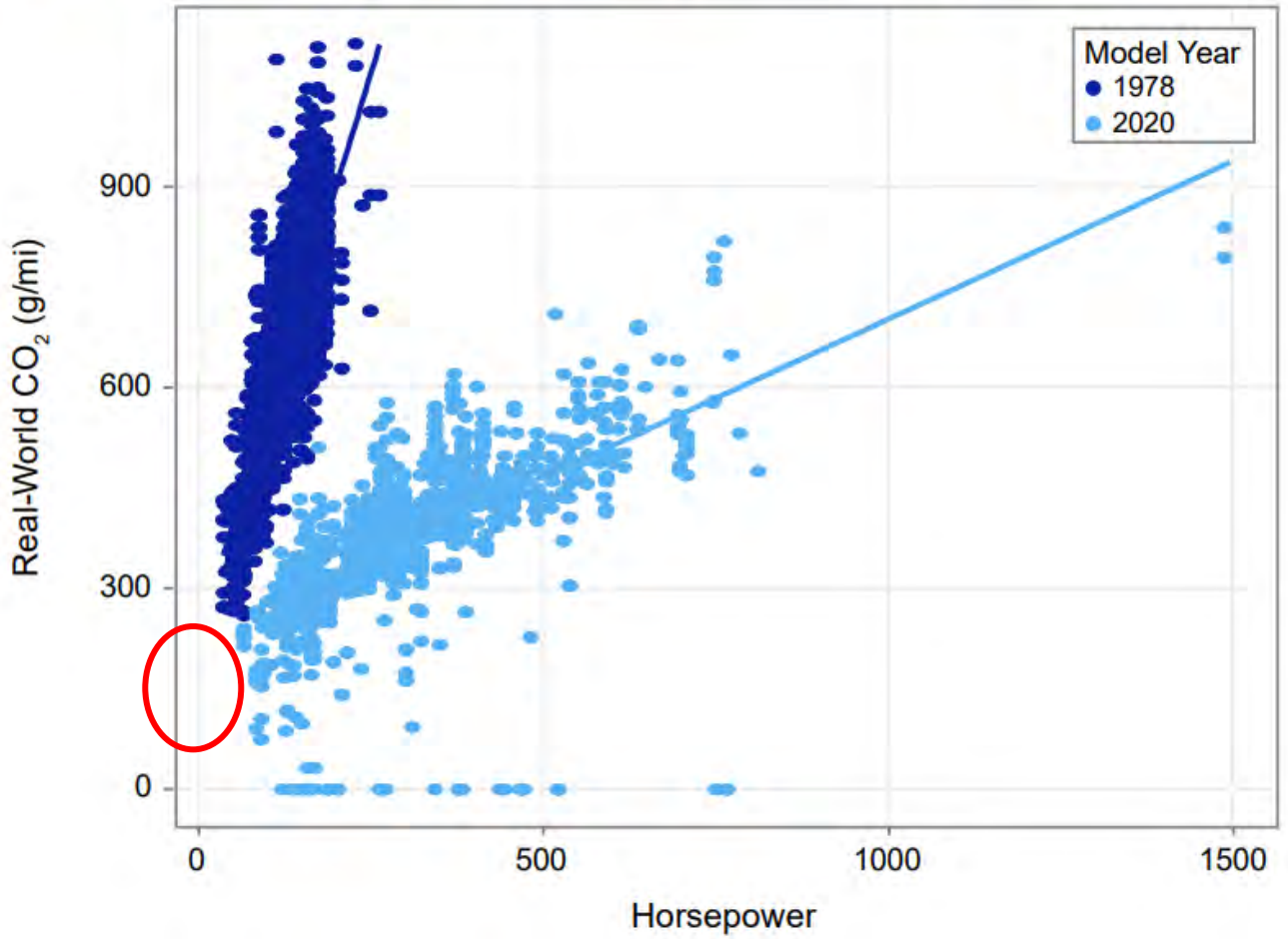
Recently Released NHTSA FE Regulations



59 mpg ~ 151 g/mile

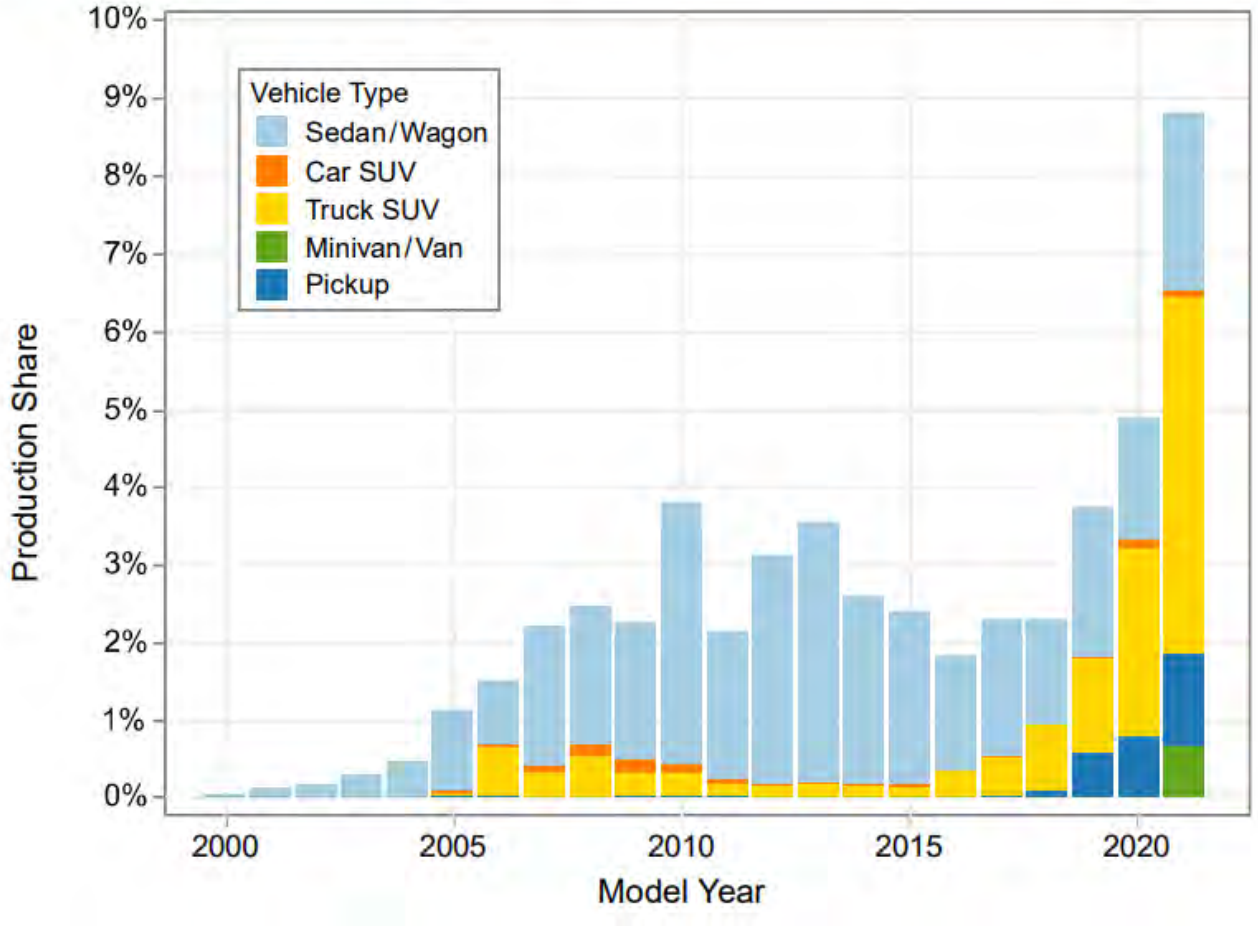
42 mpg ~ 211 g/mile

Relationship of Horsepower and CO_2 Emissions



EPA

Gasoline Hybrid Engine Production Share by Vehicle Type



EPA

Roll over image to zoom in

A1 Cardone 5H-4002 Hybrid Battery (Remanufactured Toyota Prius 04-09 Gen 2)

Visit the A1 Cardone Store

4.5 ratings | 4 ratings | 9 answered questions

$2,564.37

Pay $213.70/month for 12 months (plus S&H, tax) with 0% interest equal monthly payments when you're approved for an Amazon Prime Store Card.

Brand	A1 Cardone
Vehicle Service Type	Hybrid car, Prius 04-09
Size	Stock, approximately 32x14x8
Battery Cell Composition	NiMH
Item Weight	148 Pounds
Item Dimensions LxWxH	45.1 x 25.9 x 18 inches
Terminal	Stock, plug-in connectors plus 2 heavy wires connected with bolts

$2,564.37

FREE delivery **March 14 - 16.** Details

Deliver to coleman - Bingham Farms 48025

Only 9 left in stock - order soon.

Qty: 1

Add to Cart

Buy Now

Secure transaction

Ships from Newparts

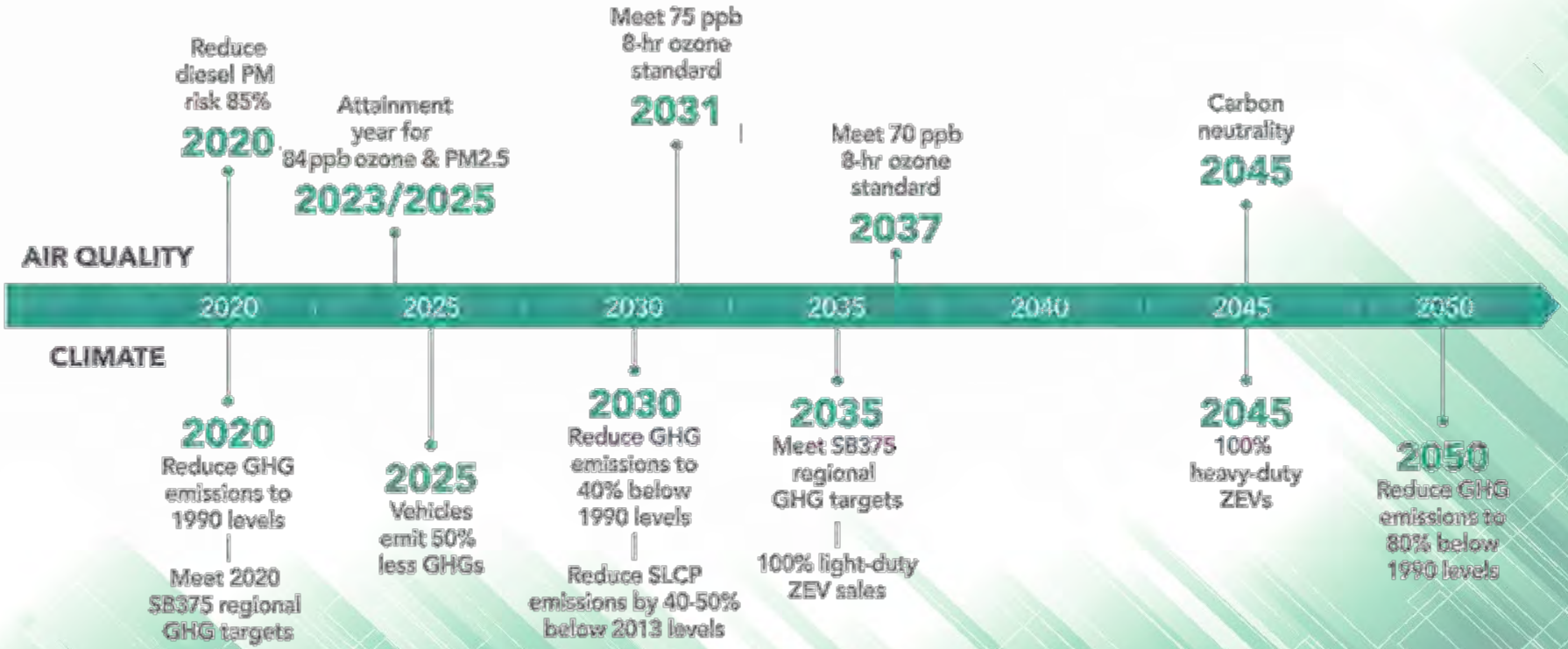
Sold by Newparts

Return policy: Eligible for Refund or Replacement

Add to List

California

Air Quality & Climate Change Goals



CARB

Advanced Clean Cars II Rulemaking

ACC combines control of smog-causing pollutants & a ZEV mandate

ACC II being developed

Ensure emission controls of gasoline vehicles better match driver behavior

Targeting 100% ZEV + PHEV sales by 2035

Requirements for ZEV consumer assurance

CARB

Improving Tools for reducing Heavy Duty Tailpipe Emissions

HD Low NOx Omnibus adopted:

- 75% and 90% lower NOx standards
- Low Load Certification cycle
- Full Duty Cycle In-use Metric (3bin-MAW)
- Longer Warranty Periods & Defect Reporting
- Extended Useful Life Periods
- Enhanced Durability Demonstration

CARB

EMA Comment

- *The proposed Omnibus Regulations are cost-prohibitive, infeasible, unenforceable, and illegal, and, as confirmed by independent expert analyses, fall well short of any reasonable cost-benefit metrics.*
- *CARB has grossly underestimated the costs …*
- *CARB also has ignored the leadtime and stability provisions of the federal Clean Air Act ("CAA"), …*
- *That clear violation of the CAA renders the Omnibus Regulation ineligible for a federal preemption waiver, and therefore invalid and unenforceable.*
- *In addition, CARB's feasibility demonstrations are wholly inadequate, …*

States Leading Transformation

Light Duty Standards

CA + 16 states
(DE & PA LEV only)

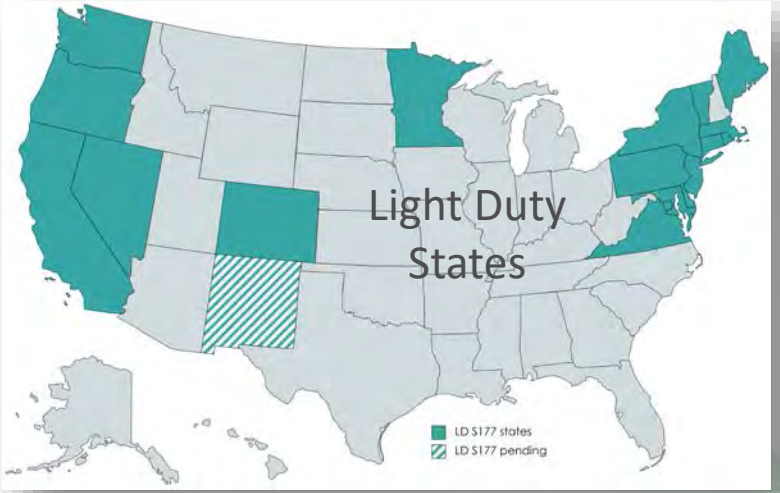
HD Advanced Clean Trucks:
CA + MA, NY, NJ, OR, WA

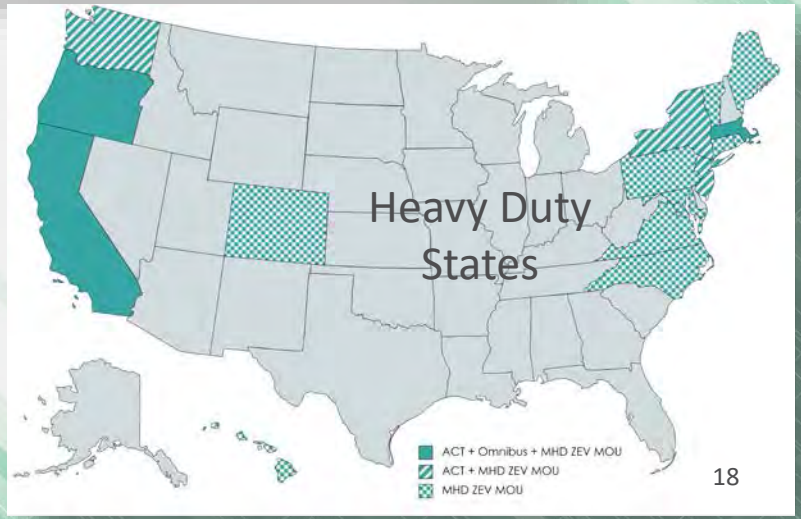
HD Low NOx Omnibus States:

CA + MA, OR

Off Road 100% ZE by 2035 goals: *CA & NY*

Federal Partnership Critical

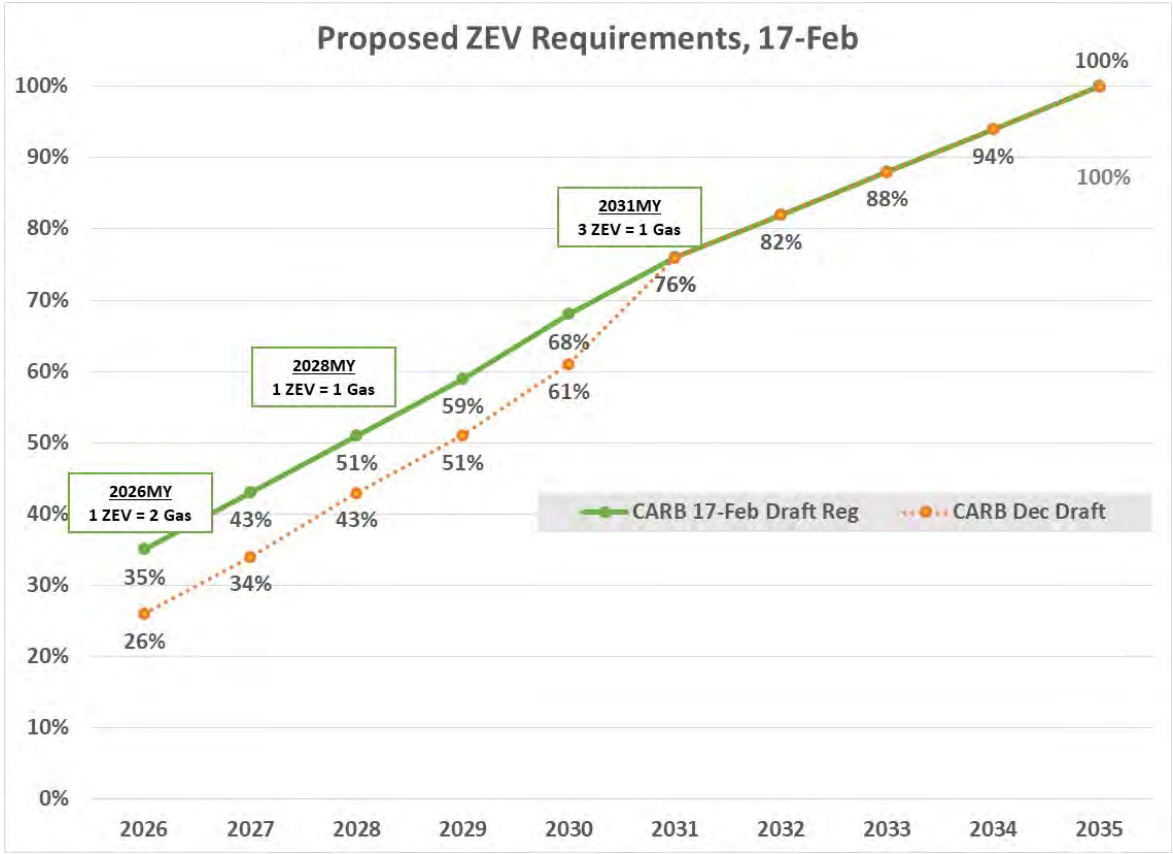




CARB

California ZEV

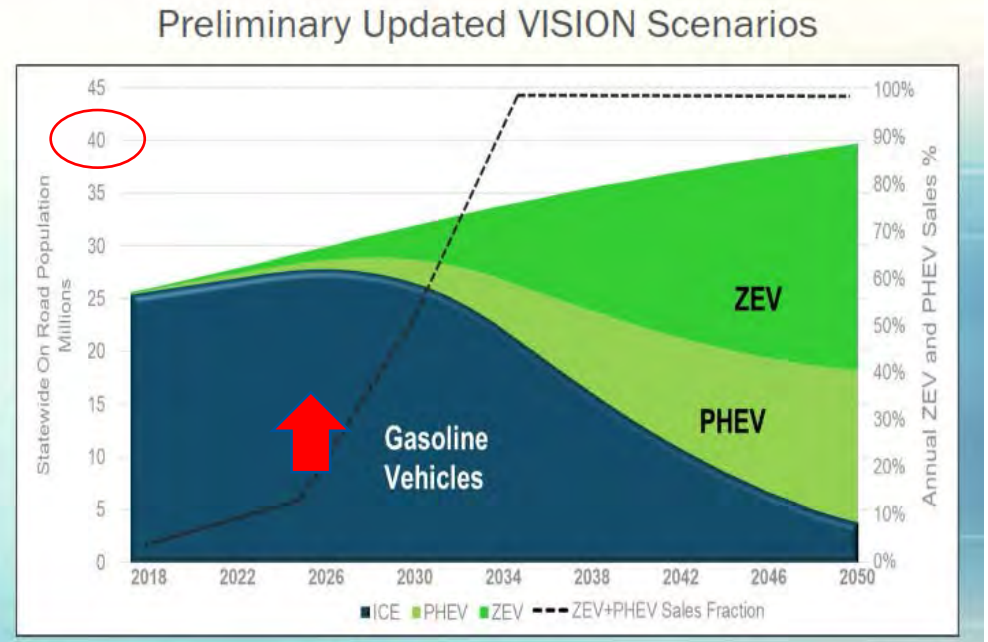
- California has proposed more a more aggressive ZEV mandate
- Note that most 177 states will emulate these standards



CARB

Increase Market Share of ZEVs

- Significantly increase ZEV reg requirements and GHG standards
- Limit ZEV credit life to increase certainty on future sales volumes



CARB

11

California Advanced Clean Trucks

- Applies to manufacturers with >500 annual California sales
- Percent of California sales must be zero-emission
- Use Zero-Emission Powertrain Certification starting with 2024 MY
- Early action credits with 2021 MY
- Partial credit for near-zero emission vehicles (NZEV)

Model Year (MY)	Class 2b-3	Class 4-8	Class 7-8 Tractors
2024	5%	9%	5%
2025	7%	11%	7%
2026	~~7%~~ 10%	13%	~~7%~~ 10%
2027	~~9%~~ 15%	~~13%~~ 20%	~~9%~~ 15%
2028	~~11%~~ 20%	~~24%~~ 30%	~~11%~~ 20%
2029	~~13%~~ 25%	~~37%~~ 40%	~~13%~~ 25%
2030	~~15%~~ 30%	50%	~~15%~~ 30%
2031	**35%**	**55%**	**35%**
2032	**40%**	**60%**	**40%**
2033	**45%**	**65%**	**40%**
2034	**50%**	**70%**	**40%**
2035 and beyond	**55%**	**75%**	**40%**

CARB

ZEV Mandates Elsewhere

- Canada
  - Mandatory 100% ZEV sales target by 2035
  - Quebec following California
  - British Columbia
    - Proposed accelerated ZEV Mandate includes
      - 26% of LD vehicles by 2026 (up from 10% by 2025)
      - 90% by 2030 (up from 30% by 2030)
      - 100% by 2035 (up from 100% by 2040)
- EU
  - Voluntary ZEV targets: 15% of cars by 2025 and 35% by 2030
  - Zero CO2 in 2035 goal is effectively a 100% target
- China
  - Longstanding and steadily escalating targets

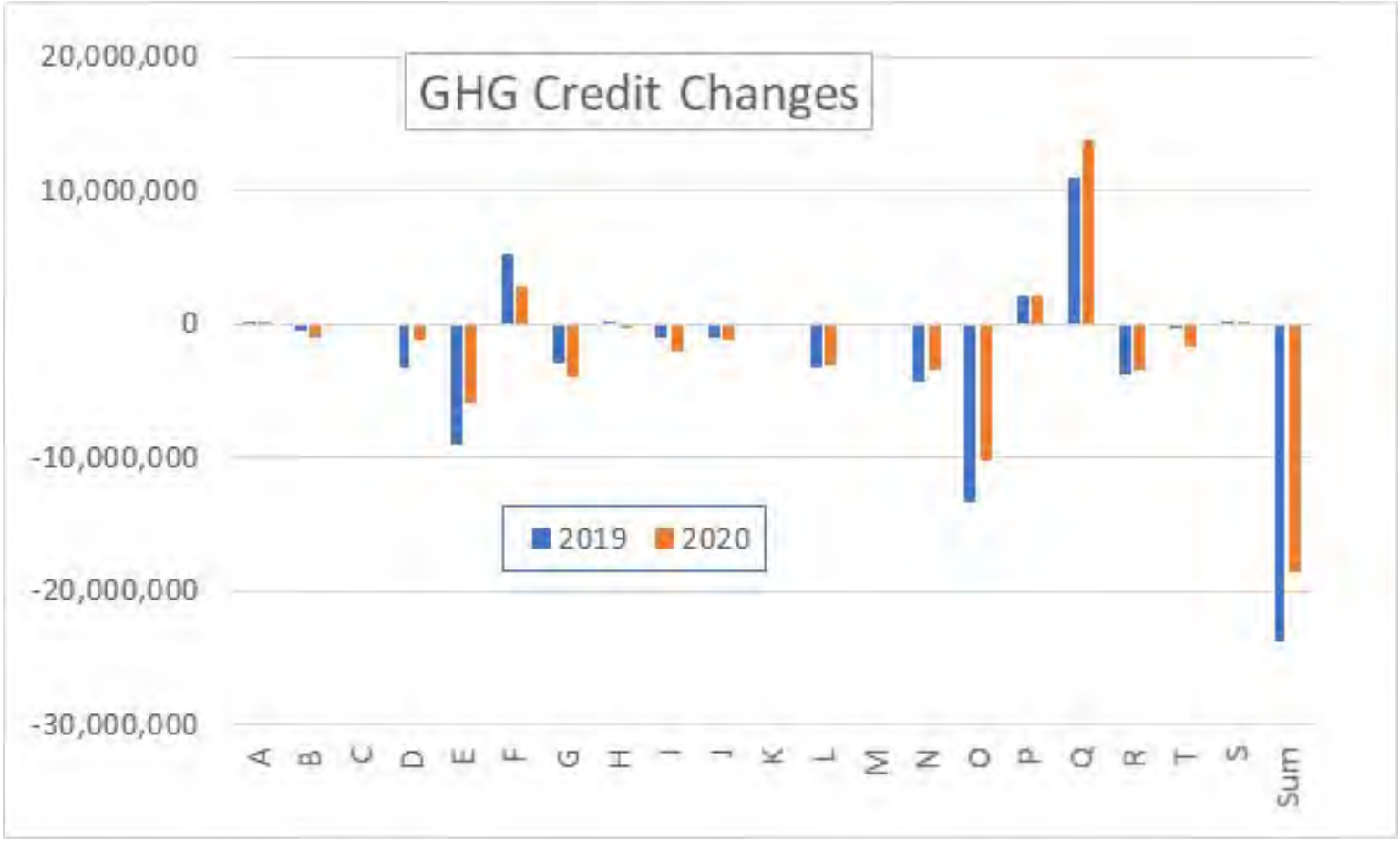
How do OEMs Meet this Myriad of Goals and Targets?

- Increase proportion of electric vehicles
- Purchase credits from other producers
- Reduce sales of conventional vehicles

Credit Trading is Longstanding and Popular

Reported Credits Sold and Purchased as of the 2014 Model Year (Mg)

	Manufacturer	Model Year "Vintage" 2010	2011	2012	2013	2014	Total
Credits Sold		(3,609,383)	-	-	-	-	(3,609,383)
		(200,000)	(1,000,000)	(250,000)	-	-	(1,450,000)
		(35,580)	(14,192)	(177,941)	(1,048,689)	(1,019,602)	(2,296,004)
		(2,507,000)	-	-	-	-	(2,507,000)
Credits Purchaed		265,000	-	-	-	-	265,000
		5,651,383	500,000	-	1,048,689	1,019,602	8,219,674
		435,580	514,192	427,941	-	-	1,377,713


GHG Credit Changes
20,000,000
10,000,000
0
-10,000,000
-20,000,000
-30,000,000
2019
2020
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
T
S
Sum

EPA

Automakers Cannot Create the EV Future Alone

- Automakers need government support
  - Charging infrastructure
  - Supply chain

Infrastructure Bill

Electric Vehicle Charging Action Plan

- Establishing a Joint Office of Energy and Transportation
- Gathering Diverse Stakeholder Input
- Preparing to Issue Guidance and Standards for States and Cities
- Requesting Information from Domestic Manufacturers
- New Solicitation for Alternative Fuel Corridors

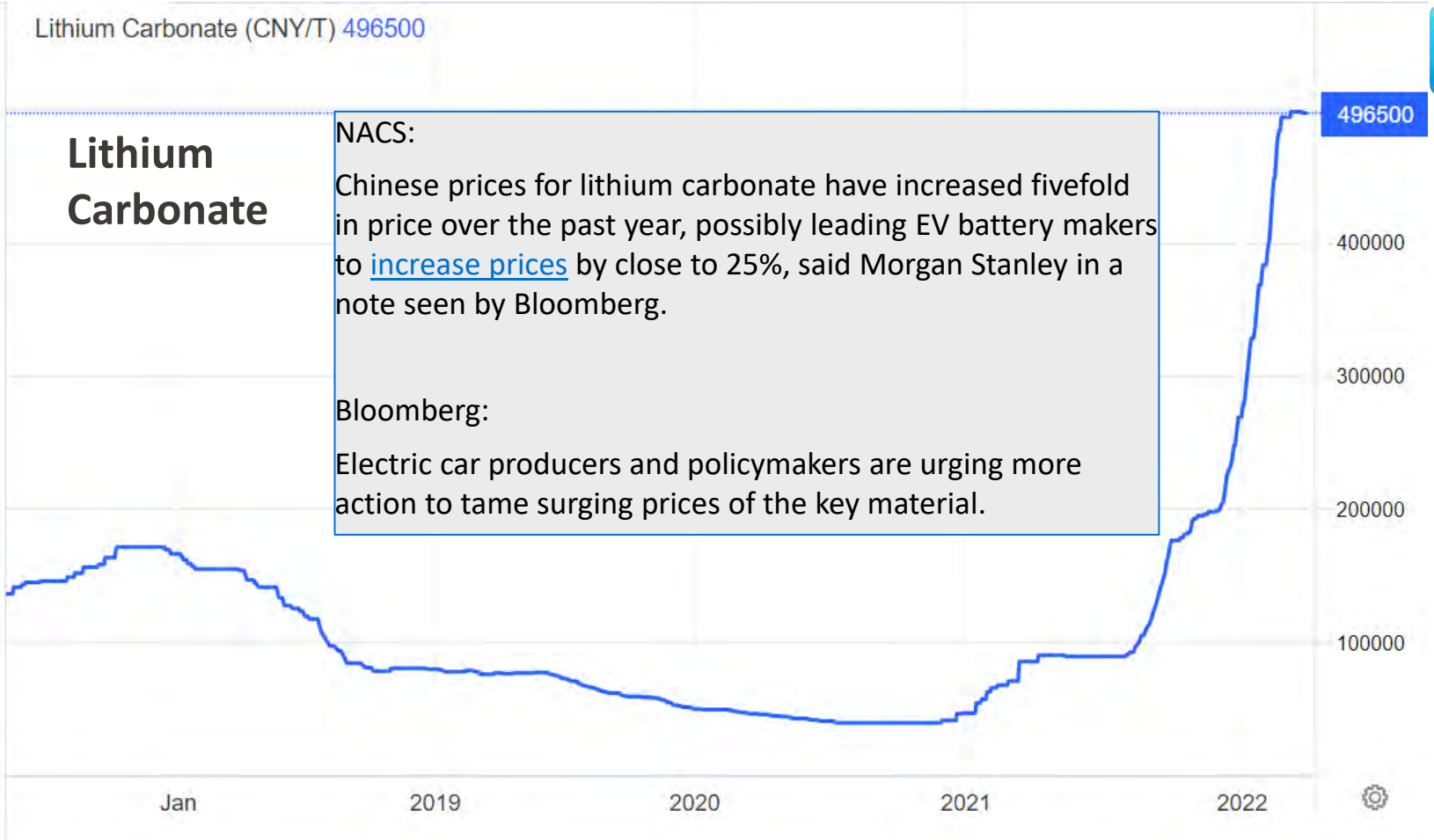
- $7.5 Billion for charging infrastructure
  - $0.0375 per rider (one daily round trip with one driver)

Rhodium


Rhodium (USD/t oz.) 19000.00 -700 (-3.55%)
30000
25000
19000
15000
10000
5000
Jan
2019
2020
2021
2022


Copper (USD/Lbs) 4.7240
Copper
5
4.7235
4.5000
4
3.5000
3
2.5000
2
Jan
2019
2020
2021
2022

Lithium Carbonate



NACS:

Chinese prices for lithium carbonate have increased fivefold in price over the past year, possibly leading EV battery makers to increase prices by close to 25%, said Morgan Stanley in a note seen by Bloomberg.

Bloomberg:

Electric car producers and policymakers are urging more action to tame surging prices of the key material.

Is it a Surprise that the Cost of EVs is Rising?

March Automotive News:

- The most inexpensive Model 3 in the U.S. reached $48,440 with shipping, after a series of price hikes over the past year that added about $8,500 to the sticker.
- Tesla's most popular vehicle, the Model Y crossover, saw its base price increase to $64,440, with shipping, after two price increases this month alone.
- The Model X crossover that now starts at $116,440 with shipping.
- Rivian increased prices for the launch editions of its R1T pickup and R1S SUV by $12,000 this month.

Reuters:

- California EV startup Lucid said it also is looking at future price hikes for its recently launched Air sedan, but would spare current reservation holders.

Domestic Supply of Critical Minerals

- MINNEAPOLIS (AP) — The Biden administration on Wednesday canceled a move by former President Donald Trump to renew mineral rights leases for a proposed Twin Metals copper-nickel mine in northeastern Minnesota.
- TUCSON, Ariz. (CN) – A federal judge blocked a plan for a copper mine south of Tucson, Arizona, halting a decade-long process for a Canadian company that hopes to extract copper from a valuable deposit in the Santa Rita Mountains.
- The Biden administration plans to use a Clean Water Act provision, called Section 404(c), with the intent of stopping the controversial mine from ever being built. Groups opposed to the copper and gold project in Southwest Alaska have been calling on the federal government to do so for years
- Feb 25 (Reuters) - Lithium Americas Corp on Friday said it expects a U.S. federal court to rule by the end of September on whether it can build the Thacker Pass lithium mining project in Nevada.
  - The court's ruling had been expected early this year, but was delayed by the filing of additional documents. Opponents of the mine are asking the court to overturn former President Donald Trump's approval of the mine.
  - The Vancouver-based company also said on Friday it has now received all necessary state permits.

How to Help

- **Help Automakers Comply**

- Support HR5089
- *Next Generation Fuels Act*
  - Moves to higher octane, first 95 RON, then 98 RON
  - Completes transition to Tier3 test fuel

Time for a Little Fun

2023 CHEVROLET CORVETTE Z06

CORVETTE Z06

NEW SMALL BLOCK LT6 ENGINE

INTRODUCING THE SMALL BLOCK GEMINI LT6 ENGINE

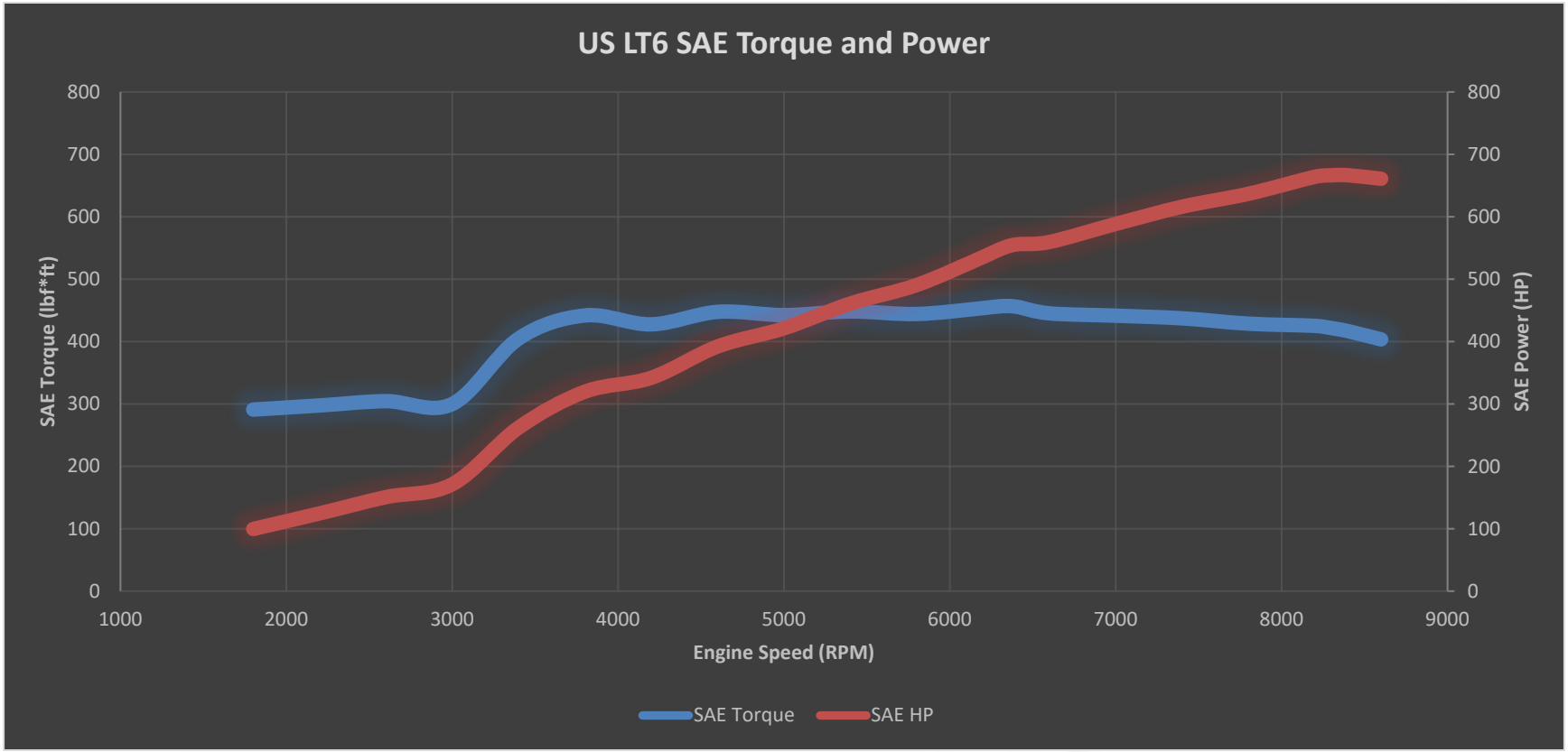
World's most powerful naturally aspirated V8 in a production car

- 5.5L displacement to provide low end torque and exhilarating power
- Flat plane crank configuration to maximize volumetric efficiency / power delivery
- Exhilarating engine sound: Intensive engineering effort on sound character of induction and exhaust systems
- Intensive lube system development
  - Dry sump lube system with 6 scavenge pumps and 1 pressure pump
- Distinct and unique engine character that is fitting and complimentary of another historic Corvette Z06

LT6 5.5L DOHC V8 – Heart of the Z06

- **670 hp @ 8,400 / 460 lb-ft @ 6,300**
  - Tested per SAE J1349
- **8600 rpm redline**
- **Light weight / low inertia crank train**
  - Fast Revving to Red Line
- **Base Engine Weight**
  - ~1kg heavier than LT2 with 175 more hp
  - ~14kg lighter than LT4 with 20 more hp
- **Signature sound**

POWER AND TORQUE



KEY SYSTEMS THAT DEFINE THE LT6

Cranktrain

- Lightweight / low inertia flat-plane crankshaft
- Paired with a short stroke of 80mm vs 92mm
- Enables very rapid engine acceleration and high engine speeds

Lubrication

- Racing inspired 7 stage dry sump system
- Capable of achieving up to 75kpa of vacuum in the sealed main crank bays

Induction

- Highly tuned through extensive analysis-based resources
- Achieves volumetric efficiency over 110%

Valvetrain

- Light weight and rigid to match the high speed and quick revving cranktrain

Cylinder Heads

- High flowing fully CNC ported intake and combustion chambers

ENGINE BUILD AND DYNO RUN IN

The LT6 is assembled at the Performance Build Center in Bowling Green alongside Corvette manufacturing

Each engine is hand assembled by a single builder

- A build plaque with the signature of the specialist who assembled it is in clear sight on the intake

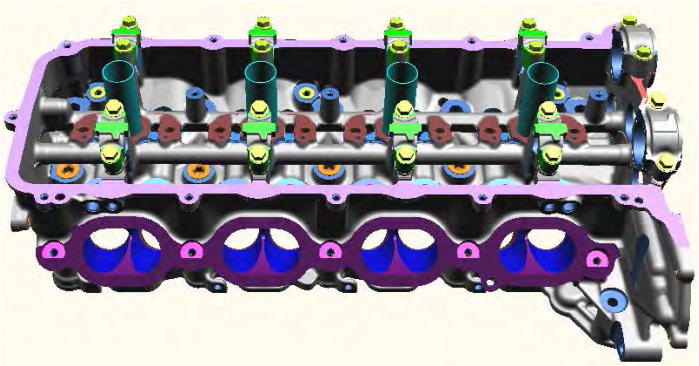
Every LT6 is shipped to a local dyno facility for a 20-minute run in procedure

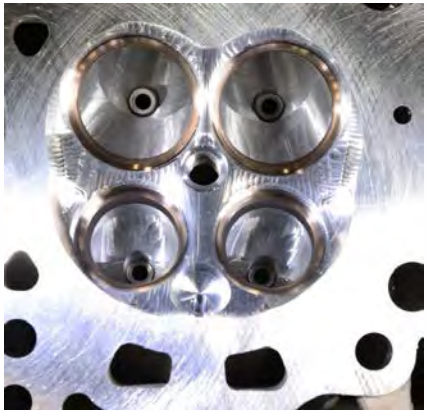
- Full load and high-speed operation to ensure quality

PHOTOS BY BRIAN WALKER OF THE PBC

PHOTOS BY BRIAN WALKER OF THE PBC

CYLINDER HEADS





- Dual Overhead Cam
- Port designs and valve position create high tumble of the air charge as it mixes with the fuel
- Works with the exhaust side injection
- Full combustion chamber and intake port CNC machining for consistent and optimized airflow and combustion
- Each combustion chamber is laser scanned for consistency

CONNECTING RODS & PISTONS

	LT6	LT5
Rod length (center-to-center)	145 mm	154.9 mm
Rod Mass	364 grams	644 grams
Piston Length	47.14 mm	62.1 mm
Piston Mass	446 grams	545 grams

Forged Titanium Connecting Rods

- 43.4% lighter than the LT4 rods
- 21% lighter than the LS7's Ti rods – C6 Z06
- Piston guided – friction & mass reduction

Forged Aluminum Pistons (racing piston supplier)

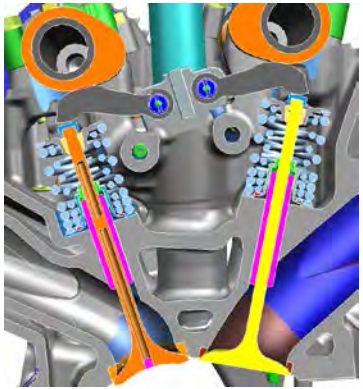
- Lightweight and high strength (many design iterations)
- Comparatively short height of 47.14mm
- 18% lighter than the LT4 pistons
- 8% lighter than the LS7 pistons
- DLC and PVD coated rings (1.0, 0.8, 1.5 height)
- Mass C.G. centered both side to side and front to rear to reduce piston rocking from inertia (different designs RH and LH)
- Polymer coated / asymmetric profile skirts reduce friction and wear

CRANKSHAFT / ROTATING ASSEMBLY

- **Lightweight / low inertia flat-plane crankshaft**
  - Forged steel construction
  - 33% lighter than the LT2's crankshaft
- **Short stroke: 80mm vs 92mm**
  - Enables very rapid engine acceleration and high engine speeds
- **Firing order 1-4-3-8-7-6-5-2**
  - Vs 1-8-7-2-6-5-4-3 for the LT4
- **Even firing bank to bank**
  - Balanced air and exhaust flow
  - Helps produce the LT6's unique sound
- **Viscous torsional damper to further reduce torsional inertia**

VALVETRAIN

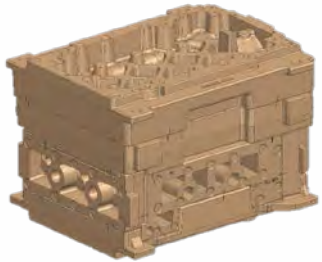
- **Dual overhead cam / four valves per cylinder**
  - 42mm lightweight titanium intake valves
  - 35mm dual hollow cavity sodium filled nitrided steel exhaust valves
  - Dual coil valve springs
  - Low mass machined and surface treated valve spring retainers
- **Dual independent hydraulic cam phasing system**



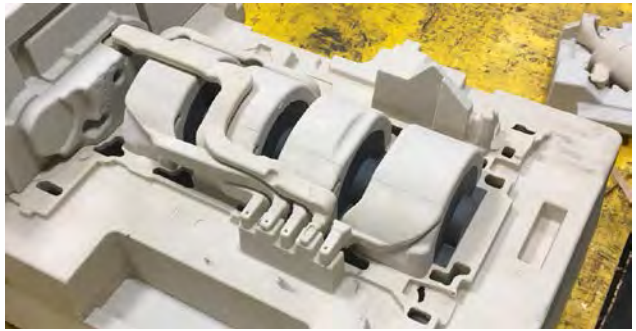
PRECISION SAND CASTING

Block Core Package:
(22) Cores … 675 lb

LCC Core Package:
(25) Cores … 845 lb



(16) of (25) LCC cores shown



Precision Sand Cast (PSC) aluminum Block + Lower Crankcase (LCC)

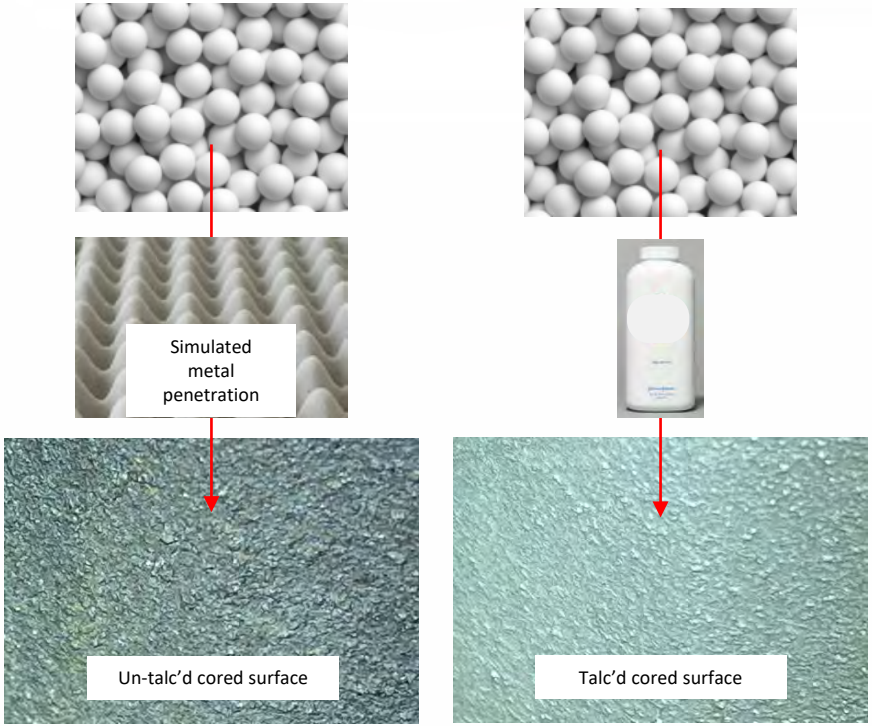
- Liquid polymer resin-cured sand cores offer good core strength, dimensional stability, surface finish and design flexibility (elaborate internal passages and cavities can be as-cast)
- Hybrid 319 aluminum alloy
- T7 heat treatment for excellent mechanical properties and dimensional stability

Internal and external cores are assembled like a 3D jigsaw puzzle into massive core packages

- Block package: (22) cores … 675 lb (empty)
- LCC package: (25) cores … 845 lb (empty)

Fill with molten aluminum at 730°C

PRECISION SAND CASTING

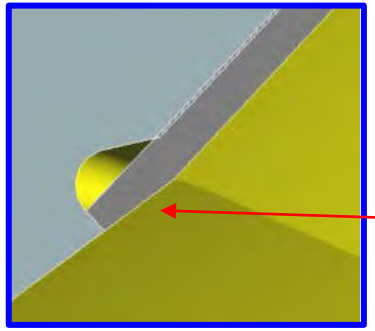


AS-CAST (NOT SHOT BLASTED)

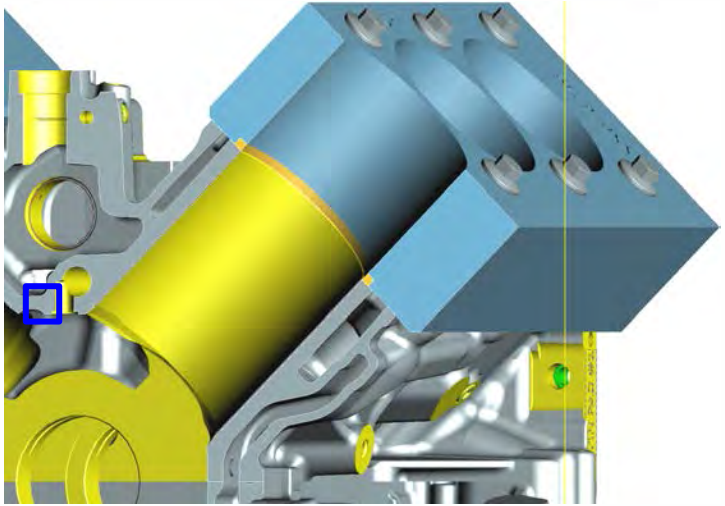
Talc'd Internal Cores

- Raw sand castings are inherently rough due to molten aluminum penetration between the sand grains on the surface of cores
- Steel shot blasting has limited benefit on internal passages
- To make smoother, cleaner, and less restrictive as-cast passages, we added a talc'ing process to all oil and coolant cores
- The fine talcum powder fills the voids in between the sand grains on the core's surface and reduces the amount of aluminum penetration into the core

KEY FEATURES



(Deckplates are not installed during cylinder liner fitment)



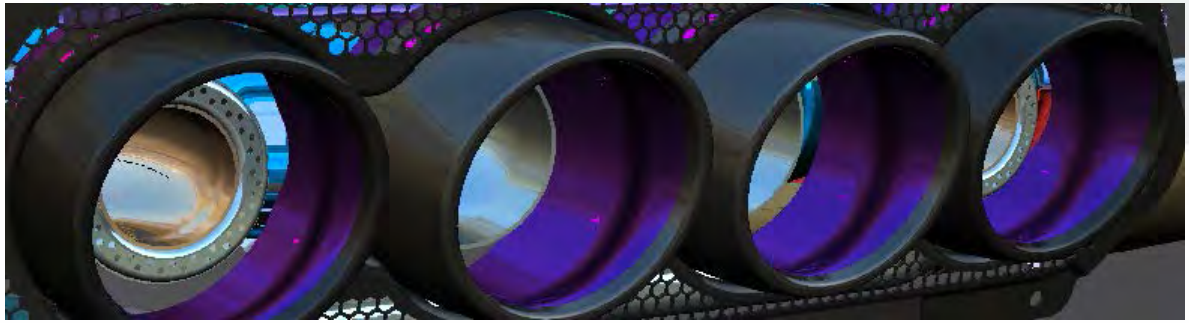
Thin-wall, flangeless Press-In-Place (PIP) cylinder liners

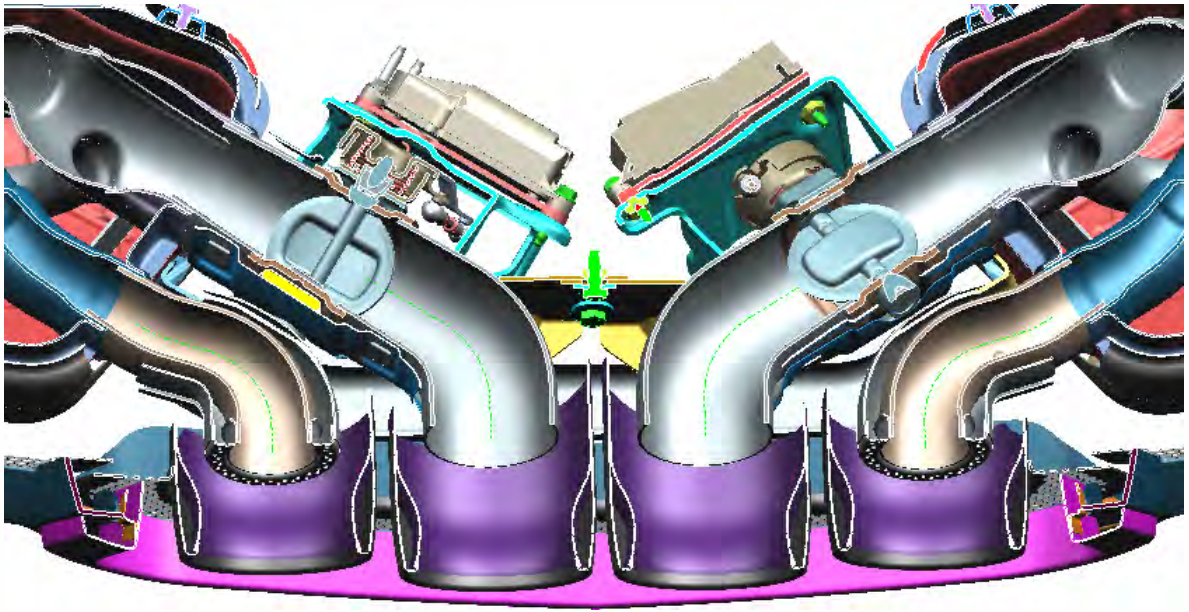
- Gray iron
- 1.0mm finished thickness
- Press-In-Place is a misnomer … the flangeless liners are retained in the block by a shelf at the bottom of the bore and a shrink-fit process

Cylinder bores & crank bores are deck plate bored & honed

- A racing engine best practice
- Billet aluminum deckplates simulate cylinder heads during final boring and honing
- Eliminates the (-) effects of head assembly-related bore distortions
- Results in rounder, truer cylinder bores and crank bores, better piston ring sealing and piston fits, reduced blowby and friction, and optimum performance
- Honed crank bore diameters are encoded in a laser-marked 2D data matrix applied to the block for the Engine Plant to use to select-fit main bearings for optimum bearing clearance

ENGINE EXHAUST AND INDUCTION





Center exhaust enabled:

- Decrease of engine sound orders we didn't want dominant in our noise character (example 2nd order)
- Increased of engine orders we did want - and lots of it, giving the American flat plane sound (example 4th, 8th order)
- Increased left and right muffler separation reduced crosstalk between the muffler cans, providing more high frequency detail to the sound we desired

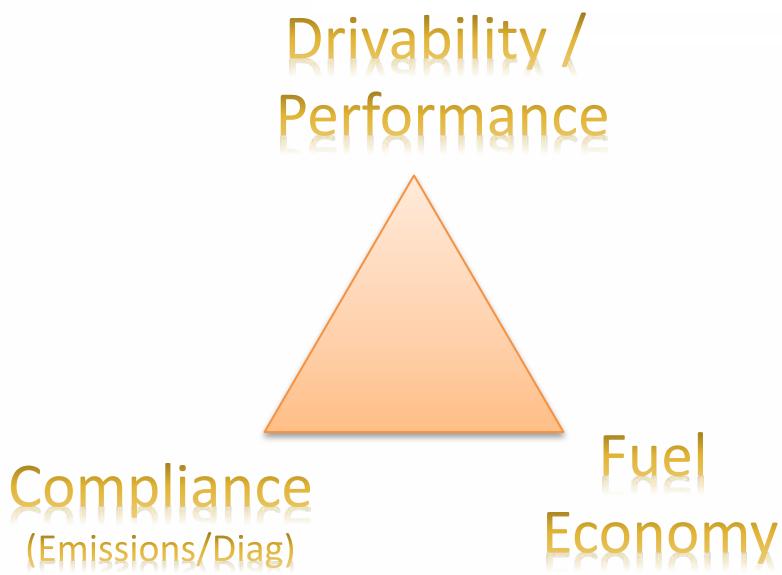
Driver's ear and outside the vehicle sound quality was studied closely

"Parabolic reflection" concept used

Tuning knobs:

- Pipe engagement into bezel
- Pipe end cut profile
- Bezel profile

CHALLENGES OF LT6 FROM CONTROLS PERSPECTIVE



- **Engine Controls Team must balance:**
  - Drivability / Performance
  - Compliance (Emissions / Diagnostics)
  - Fuel Economy
- **Custom software tailored specifically for LT6**
  - High RPM = high throughput
    - At 8600RPM, cylinder event every 1.75msec
  - Unique control system
    - Dual throttle / dual motor IMTVs – GM First
- **Flat-Plane Crank vs. Cross-Plane Crank**
  - Unique Torque Curve drove DCT integration / strategy challenges
  - Engine Overspeed control / misfire detection

ONE TEAM APPROACH

Transmission Controls

- Drive Quality
  - DCT integration
- Pedal Progression / Shift Pattern

NVH Integration

- Variable Exhaust Valve Tuning
- Noise Passby Compliance

Chassis Control

- Stability Control Torque Request
- Performance/Custom Launch Control

Energy Team

- Fuel Economy
  - Idle speed / DFCO
- Driver Mode Determination


zero crashes


zero emissions


zero congestion

Additional

- CARB issued their ACC 2 ISOR, which was indirectly referred to in the presentation.

- All of the ACC 2 documents can be found here:

➢ https://ww2.arb.ca.gov/rulemaking/2022/advanced-clean-cars-ii?utm_medium=email&utm_source=govdelivery.