U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Overview: Advanced Engine and Fuels R&D

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Advanced Engine and Fuel Technologies
Vehicle Technologies Office

Ken Howden, Siddiq Khan, Kevin Stork, Michael Weismiller

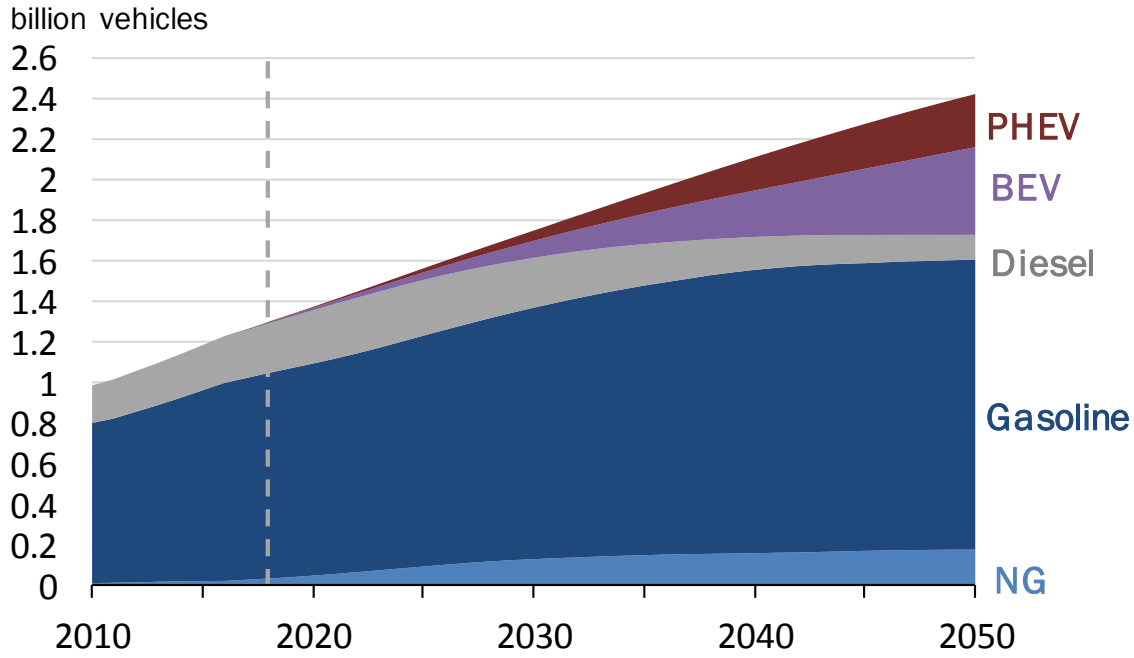




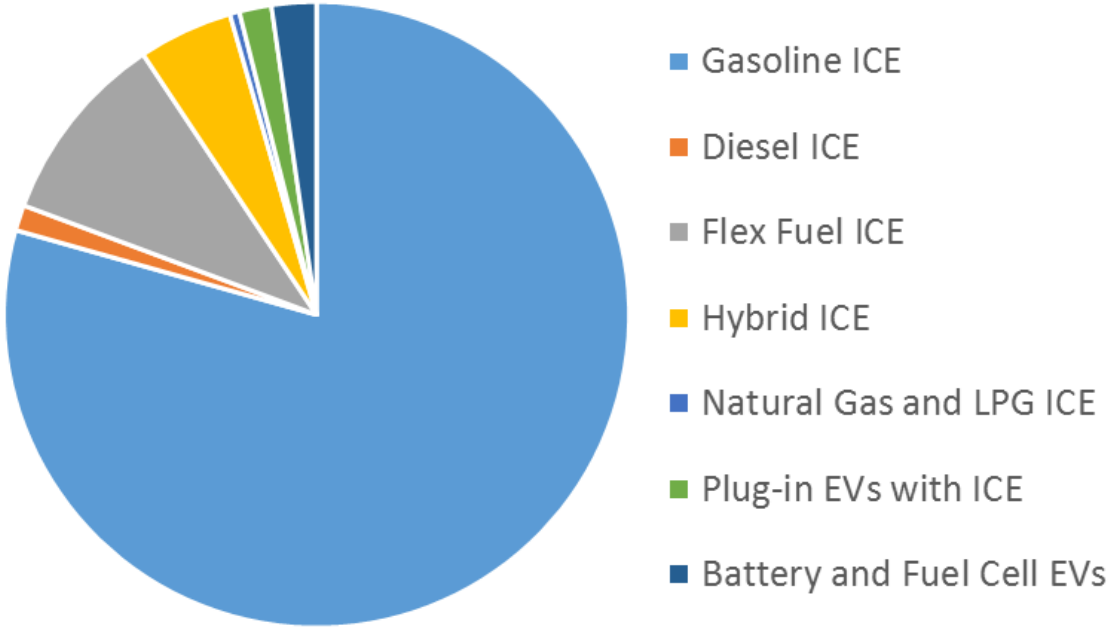

Why Focus on Internal Combustion Engines (ICE)?

- Despite the expected growth in BEV sales, the global as well as the U.S. light-duty fleet will be dominated by vehicles with ICE in the coming decades.
- Improving ICE efficiency is **one of the most promising and cost-effective approaches to increasing the fuel economy of the U.S. vehicle fleet.**
- Advanced fuel formulations that can incorporate non-petroleum-based blending agents could further enhance engine efficiency and energy security even in 2050 timeframe

Global LD Vehicle Stock (AEO 2019)



New U.S. Car and Light Truck Sales Share in 2050 (AEO 2020)



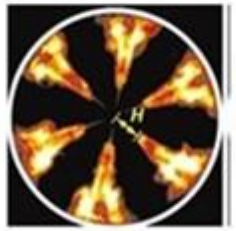
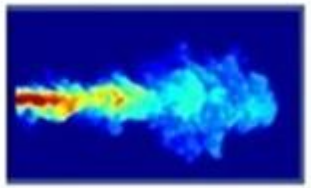
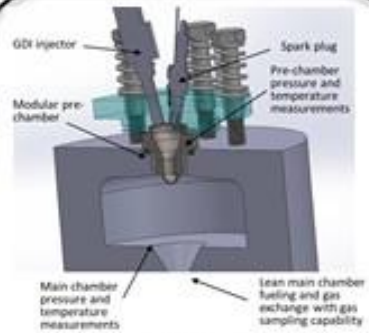
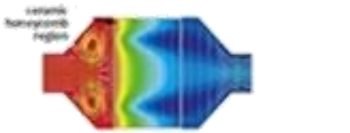
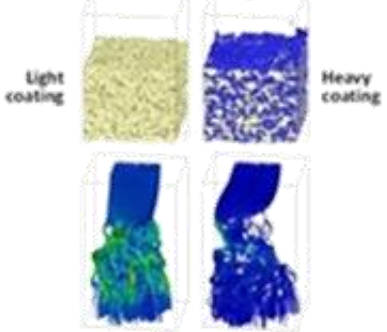
Advanced Engine and Fuel Technologies R&D

Strategic Goal: Improve understanding of, and ability to manipulate, combustion and emission control processes while generating knowledge and insight necessary for industry to develop the ***next generation engines and fuels*** capable of improving the fuel economy of passenger and commercial vehicles.

Program Goals	Light Duty			Heavy Duty	
	2020	2025	2030	2020	2025
Engine Brake Thermal Efficiency	--	--	--	55%	57%
Fuel Economy Improvement*	20%	25%	35%**	30%	35%
Nox & PM Emissions	Tier3/ LEV III	Tier3/ Bin 30	Tier3/ Bin 30	EPA Standards	EPA Standards

*Compared to: LD baseline is 2015 direct-injected boosted gasoline vehicle
HD baseline is 2009 HD diesel engine
**Includes improvement from Co-optimization of Fuels and Engines

Advanced Engine and Fuel Technologies [FY20 Budget: $70M]

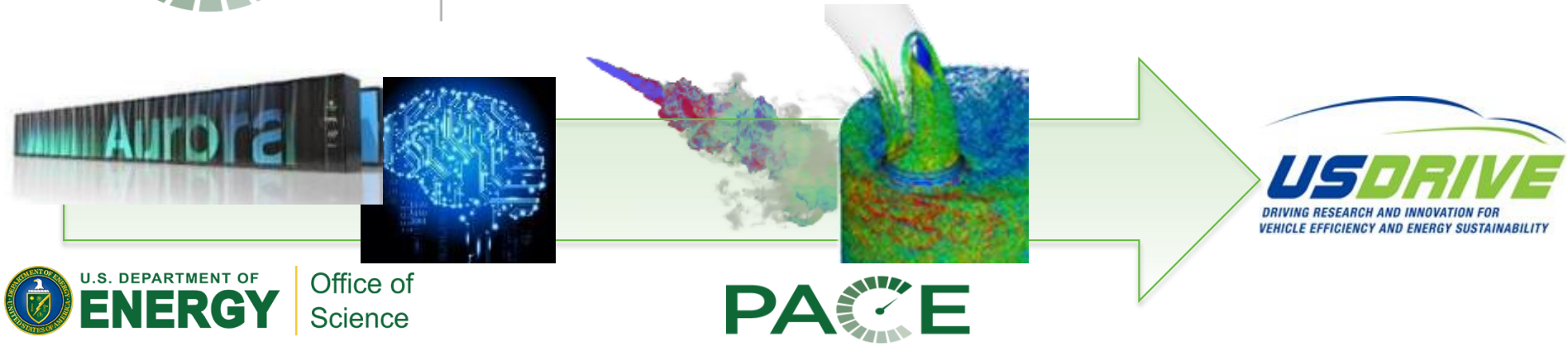
Combustion Research	Co-Optimization of Fuels and Engines	Alternative Fuel Engine R&D	Emissions Control R&D	High Efficiency Engine Technology
 Diesel Combustion  Fuel Spray	 Fuel Effects on Combustion	 Natural Gas Engine  Natural Gas Tank	 Flow and Temperature – Catalytic Converter during Cold Start  Flow simulations SCR-coated PM filters	 Air Handling & EGR, Combustion, Fuel Systems, Aftertreatment, Electronic Controls, Waste Heat Recovery
Leveraging advances in HPC and ML/AI	Cross-office collaboration with BETO	Effective use of abundant domestic fuels	Critical materials issues (PGM)	SuperTruck II, LD/MD and Off-road

Partnership to Advance Combustion Engines (PACE)

Michael Weismiller, TM

PACE — PARTNERSHIP TO ADVANCE COMBUSTION ENGINES

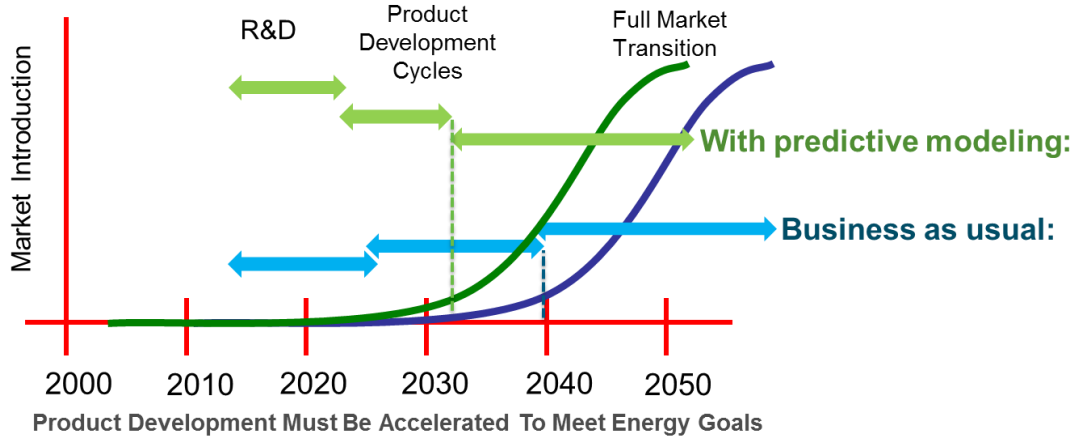
A National lab consortium enabling smarter engine design tools



Leverage DOE investment in HPC/AI to provide knowledge and tools to US OEMs

Predictive simulation tools are needed to accelerate engine development

- Diagnose issues that are opaque to experiment
- Allows rapid iteration of design
- High-throughput simulations enable virtual calibration
- Shortened design cycle = technology on road faster



Co-Optima MD/HD Opportunities

Kevin Stork, TM

Fuel-Engine Co-Optimization

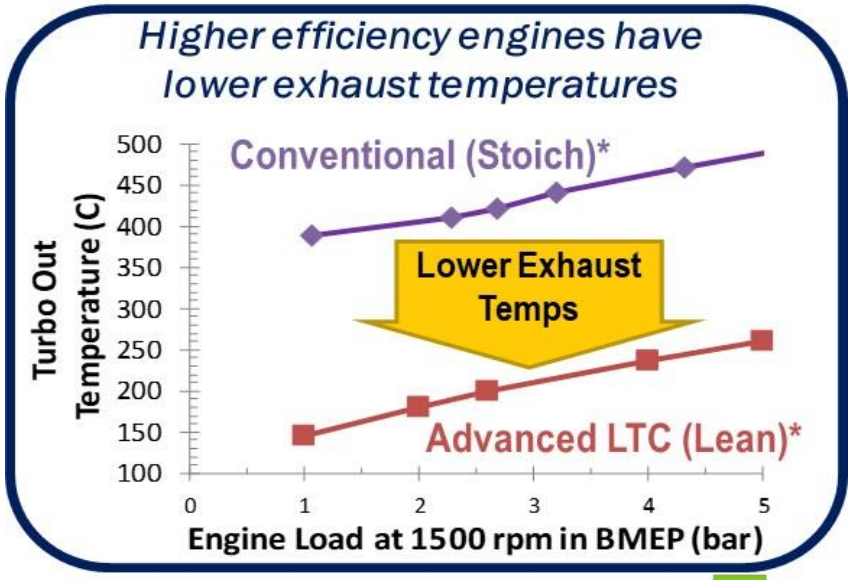
- Fuel impacts on emissions (e.g., low-sooting fuels)
- Improved engine efficiency via full exploitation of fuel properties (e.g., higher octane allows higher compression ratio)
- New distillate fuel sources (e.g., biofuels) and combustion modes can help manage refinery system gasoline/diesel balance

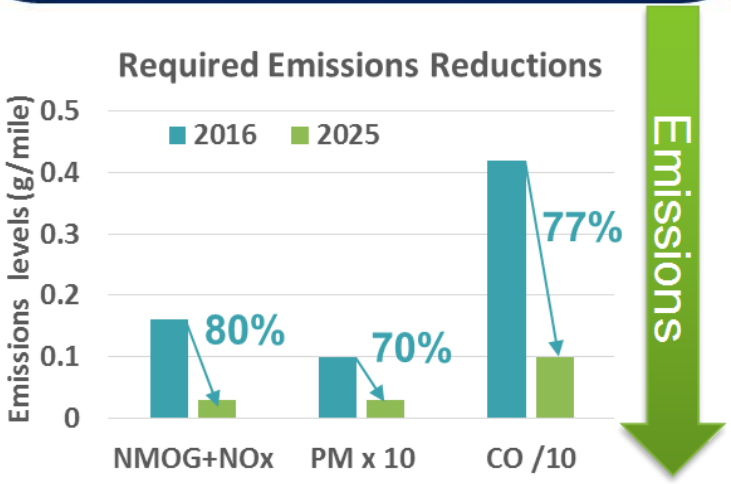
Co-Optima oral presentations – *Wednesday, June 3, 2020, A.M. & P.M.; Thursday, June 4, 2020, A.M.*

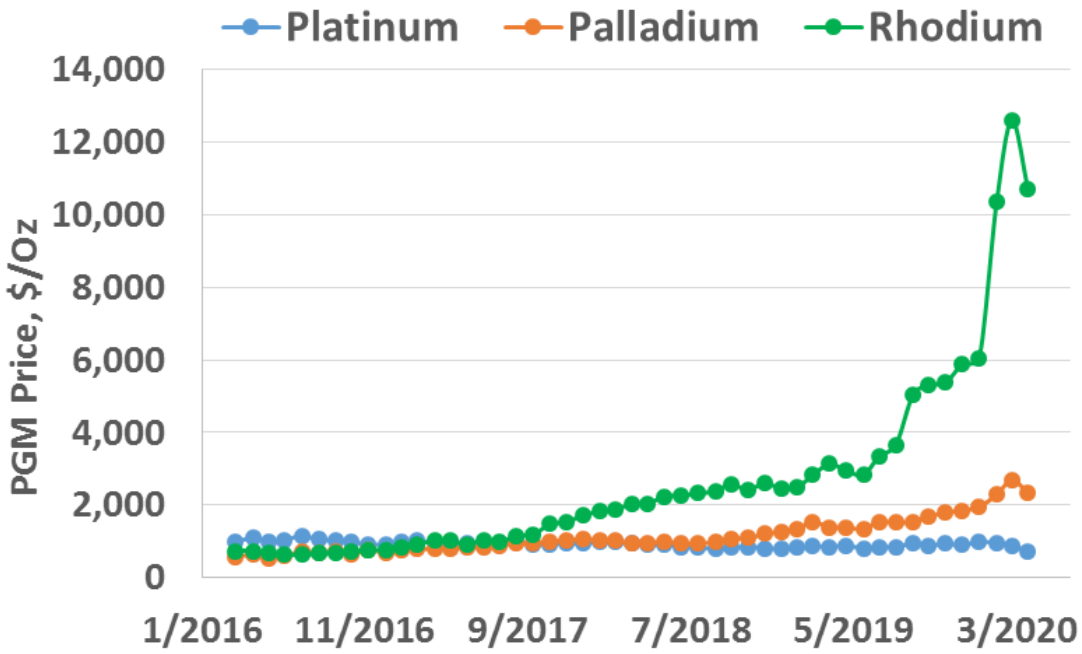
Fuel Efficiency and Emissions Interlinked

Siddiq Khan, TM

more efficient engines = lower exhaust temps = catalyst challenges







PGM Price data from http://www.platinum.matthey.com/prices/price-charts May 15, 2020

Emissions Control Oral Presentations on June 03, 2020 from 10-am to 6-pm

Advanced Technologies for Heavy-Duty Vehicles - SuperTruck II

Ken Howden, TM

Goal: Demonstrate a 55% or greater engine brake thermal efficiency in real-world operation, greater than 100% improvement in freight efficiency (ton-mpg) relative to a 2009 baseline, and a payback period of less than 3 years to foster more rapid market adoption of new energy efficient technologies.

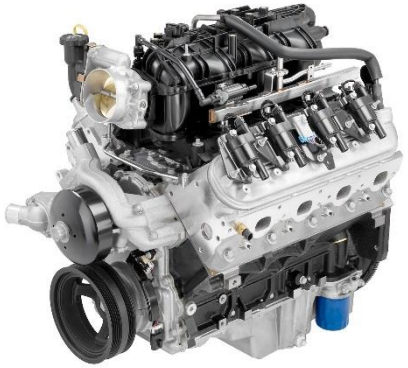
- The five SuperTruck II teams
  - Have completed their analysis, and developed and tested their subsystems.
  - Initiating the assembly of prototype Class-8 tractors and trailers.
  - Will conduct iterative testing and design optimizations to achieve engine and vehicle freight efficiency goals in 2021.

Oral Presentations on Thursday, June 4, 2020.

New Material and Engine Technologies for High Efficiency Powertrains

Ken Howden, TM

Combining new materials that reduce weight and achieve higher combustion temperatures and pressures with new high-efficiency engine combustion strategies



Low-Mass and High-Efficiency Engine for Medium-Duty Truck Applications – General Motors

- Develop a high performance gasoline engine equipped with advanced materials and combustion technologies capable of ≥10% fuel efficiency improvement and ≥15% engine weight reduction when compared to the baseline 2015 L96 VORTEC 6.0 Liter V8 engine.

Next Generation High Efficiency Boosted Engine Development – Ford Motor Company

- Design, evaluate, build and test an engine that will achieve 23% fuel economy improvement and 15% weight reduction relative to a 2016MY 3.5 Liter V6 EcoBoost F-150 baseline.

Thank You

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Web site:

Vehicle Technologies Office

www.vehicles.energy.gov

http://energy.gov/eere/vehicles/vehicle-technologies-office