U.S. DEPARTMENT OF
ENERGY

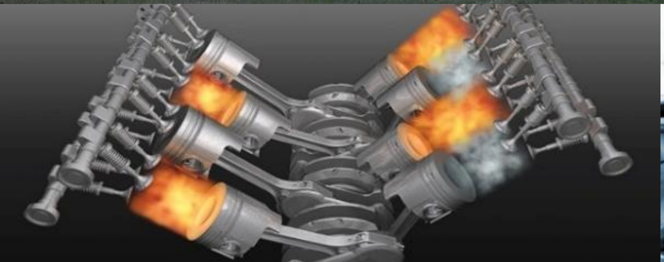
Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Vision for Electrification

Michael Berube, Director

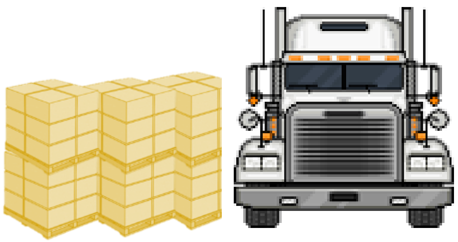
Vehicle Technologies Office



Transportation is a Large Part of our Energy Economy

Annually



11 billion

Tons goods

Over **3** Trillion

Miles

Transportation is the 2nd largest expense for U.S. households

70% **of total U.S. petroleum usage is for transportation**

On-road vehicles account for **85%** **of transportation petroleum usage**

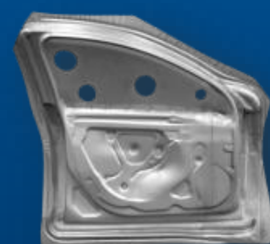
EERE's Vehicle Technologies Office (VTO)

Vehicle Technologies Office

Electrification

Advanced Combustion Systems and Fuels

Materials Technology



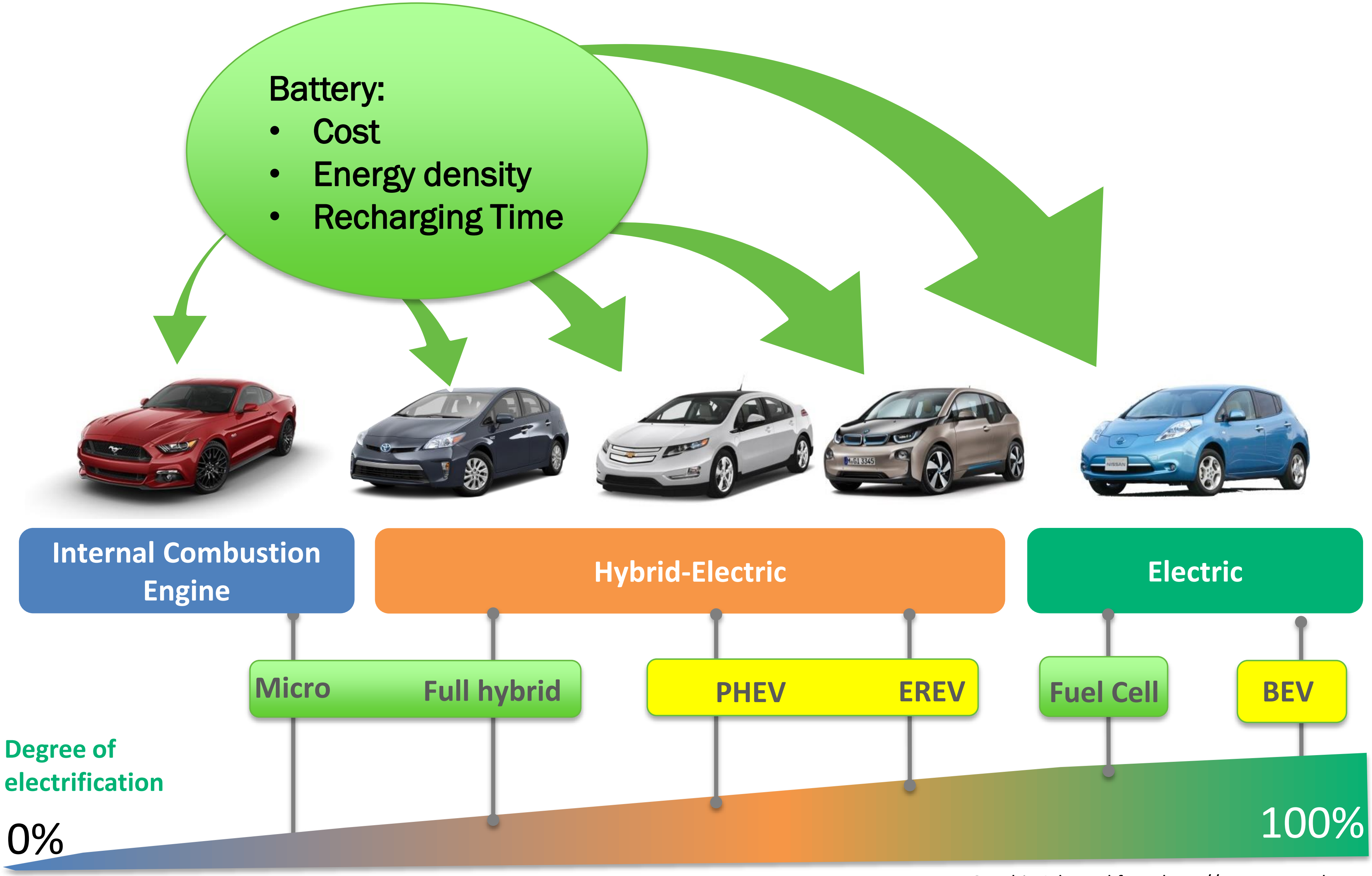
Energy Efficient Mobility Systems

Partnerships Outreach, Deployment, & Analysis

VTO develops advanced transportation technologies that:

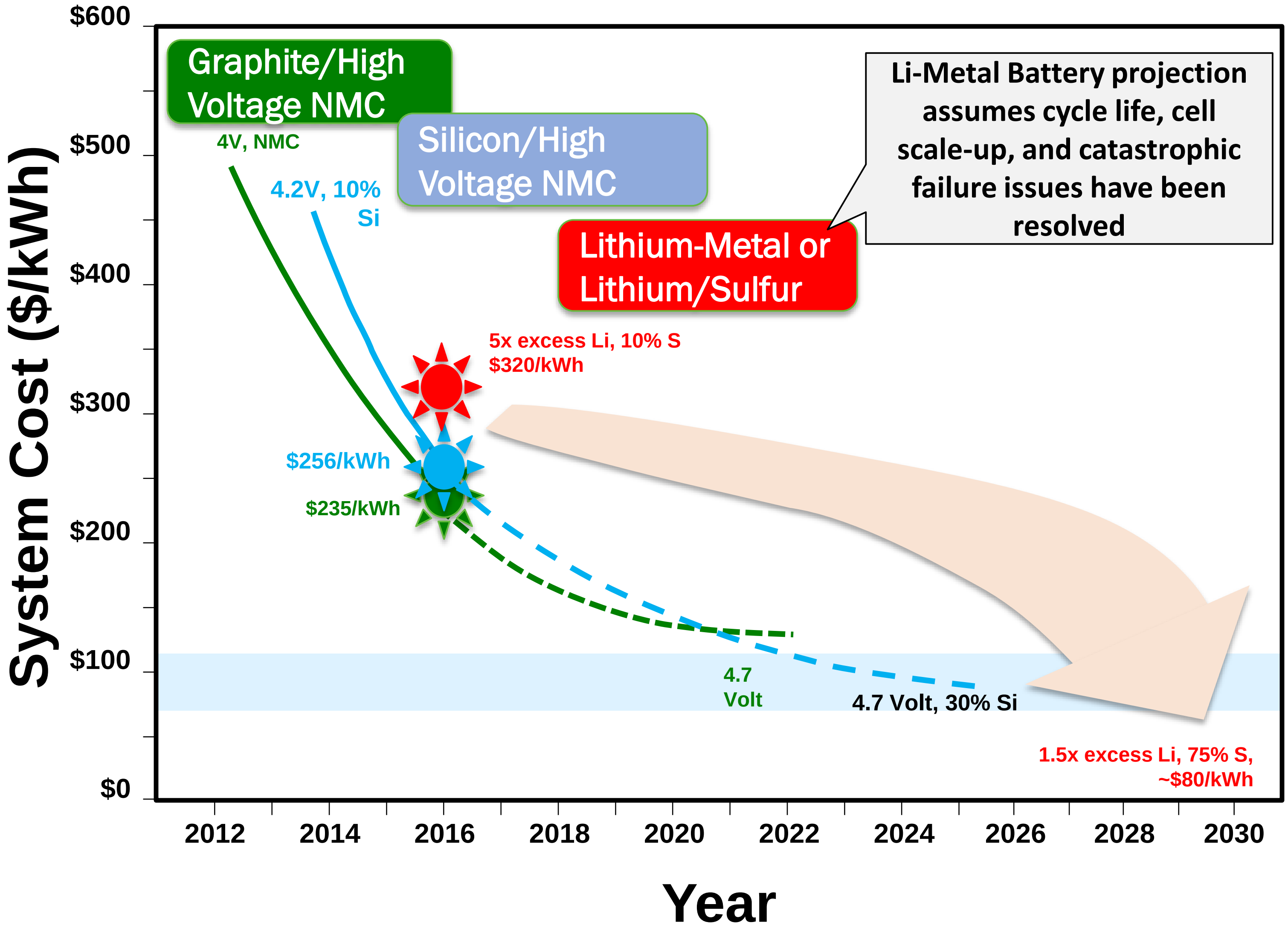
- ✓ Improve energy ***efficiency***
- ✓ Increase domestic energy ***security***
- ✓ Reduce operating ***cost*** for consumers & business
- ✓ Improve global ***competitiveness*** of US economy

Vision for Electrification



Graphic Adapted from http://www.eucar.be

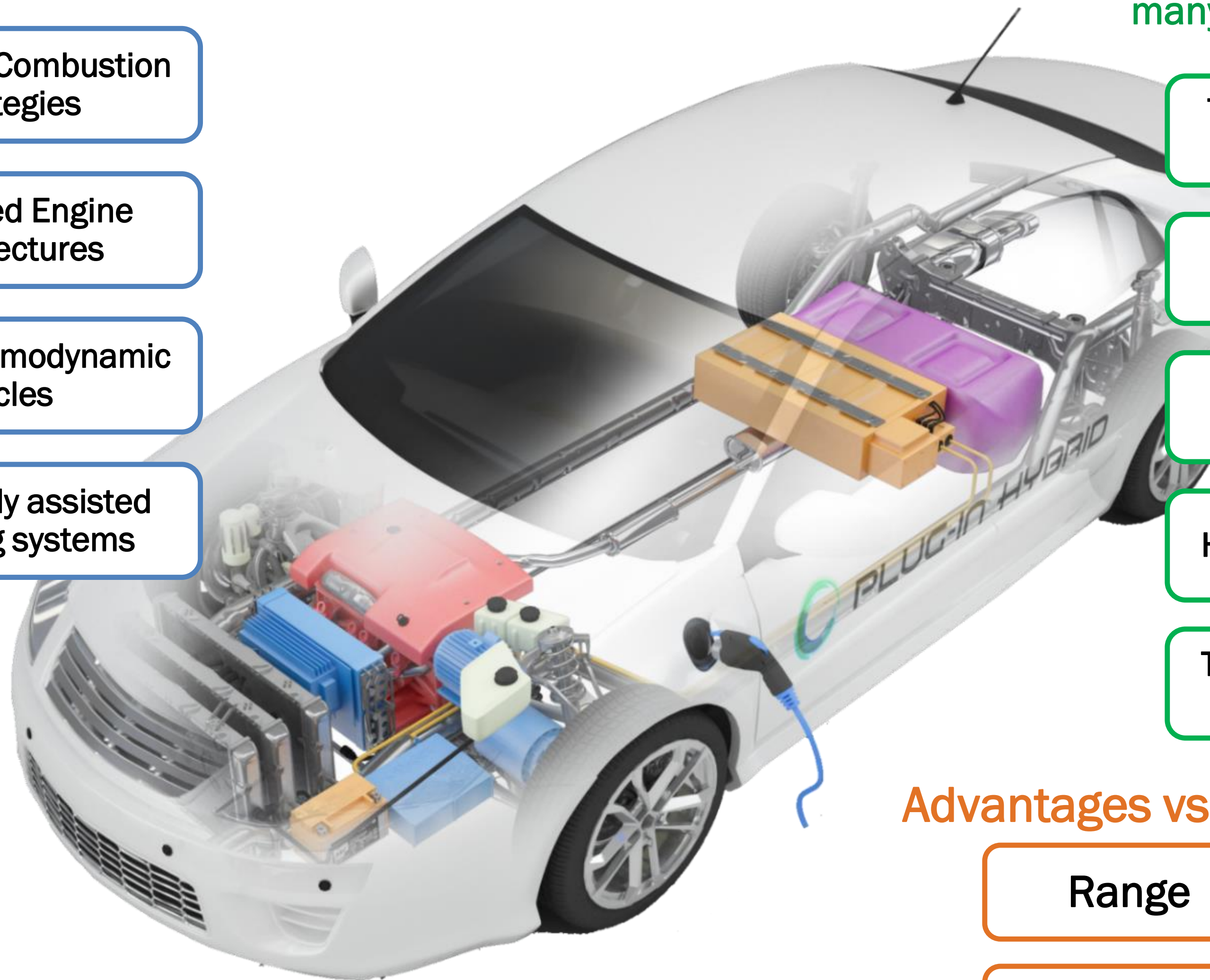
Cost Trajectories for Lithium Based EV Batteries



Hybridization has Advantages for Advanced Engines

Enabling Opportunities

- Advanced Combustion Strategies
- Advanced Engine Architectures
- Novel Thermodynamic Cycles
- Electrically assisted boosting systems



Ability to better manage many current challenges

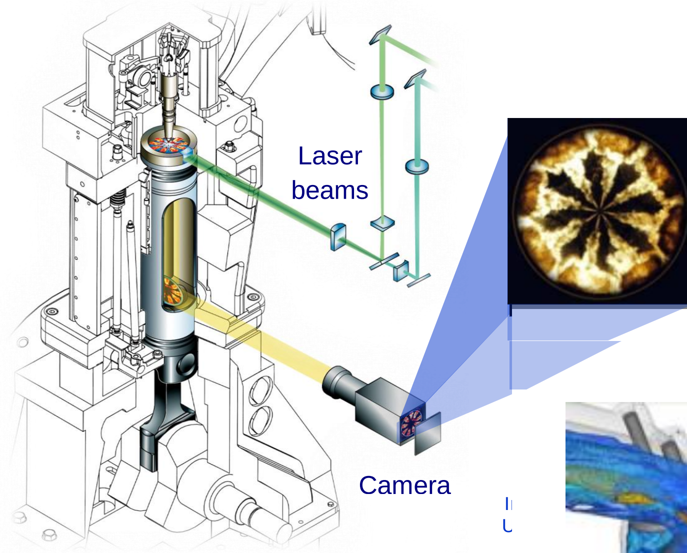
- Transient Emissions Control
- Cranking emissions and startability
- Catalyst light-off
- Higher power density
- Transient waste heat recovery

Advantages vs. BEVs

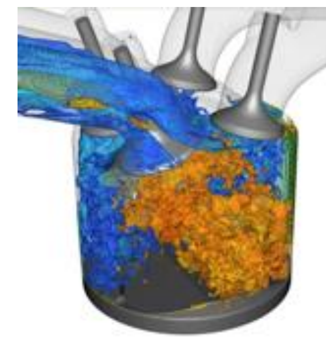
- Range
- Cost

Combustion R&D towards next-generation engines

- Explore advanced combustion strategies to achieve higher engine efficiencies with near-zero emission of NO_x and PM.
- Develop greater understanding of engine combustion and in-cylinder emissions formation processes.
- Develop science-based, truly predictive simulation tools for industry to design advanced engine.



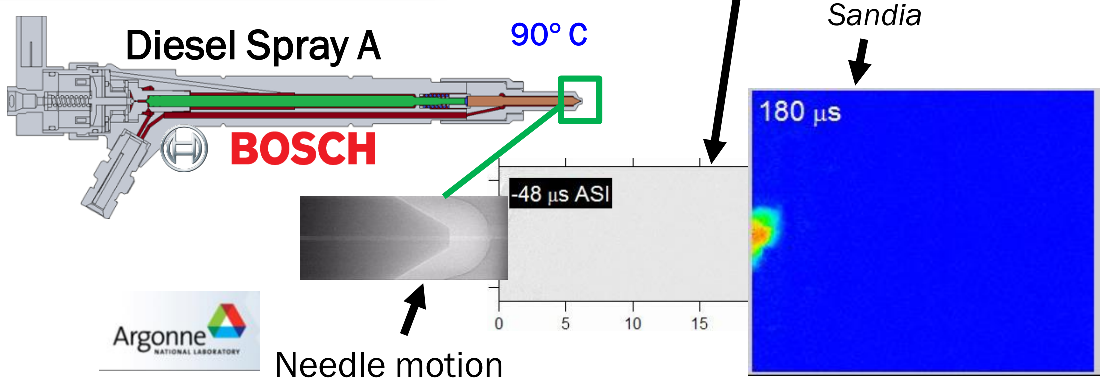
Sandia National Laboratories



Engine Simulation

Liquid–phase structure
Sandia

Fuel concentration
Sandia



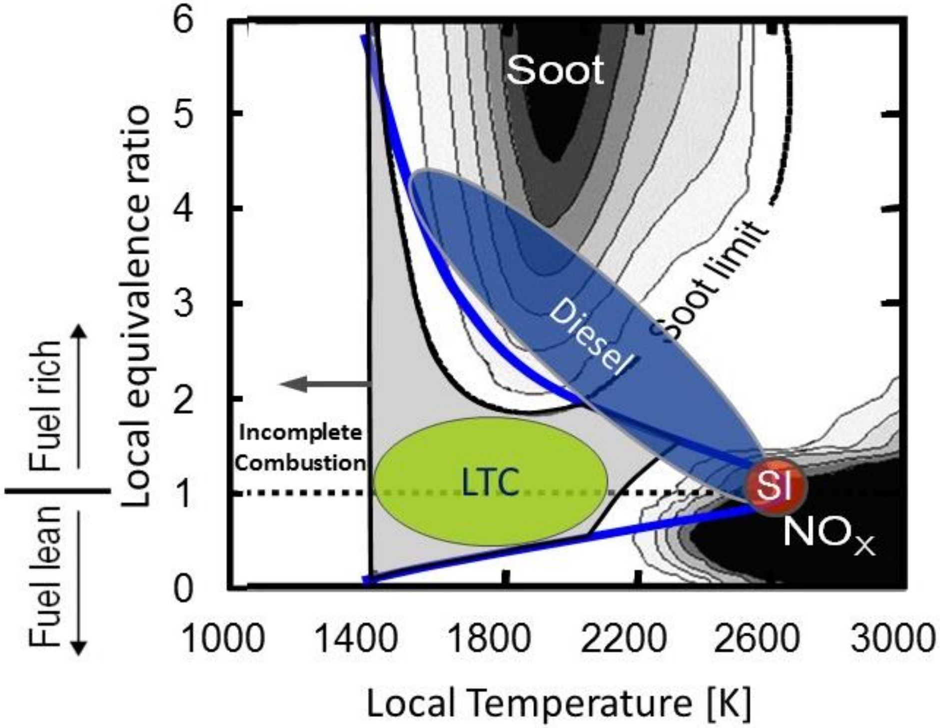
Argonne

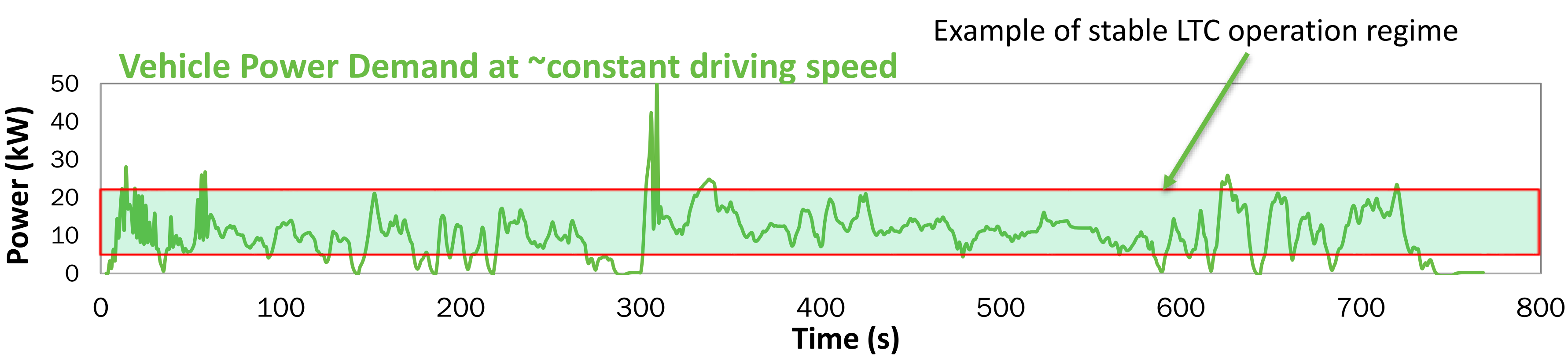
Needle motion
Argonne

900 K, 60 bar

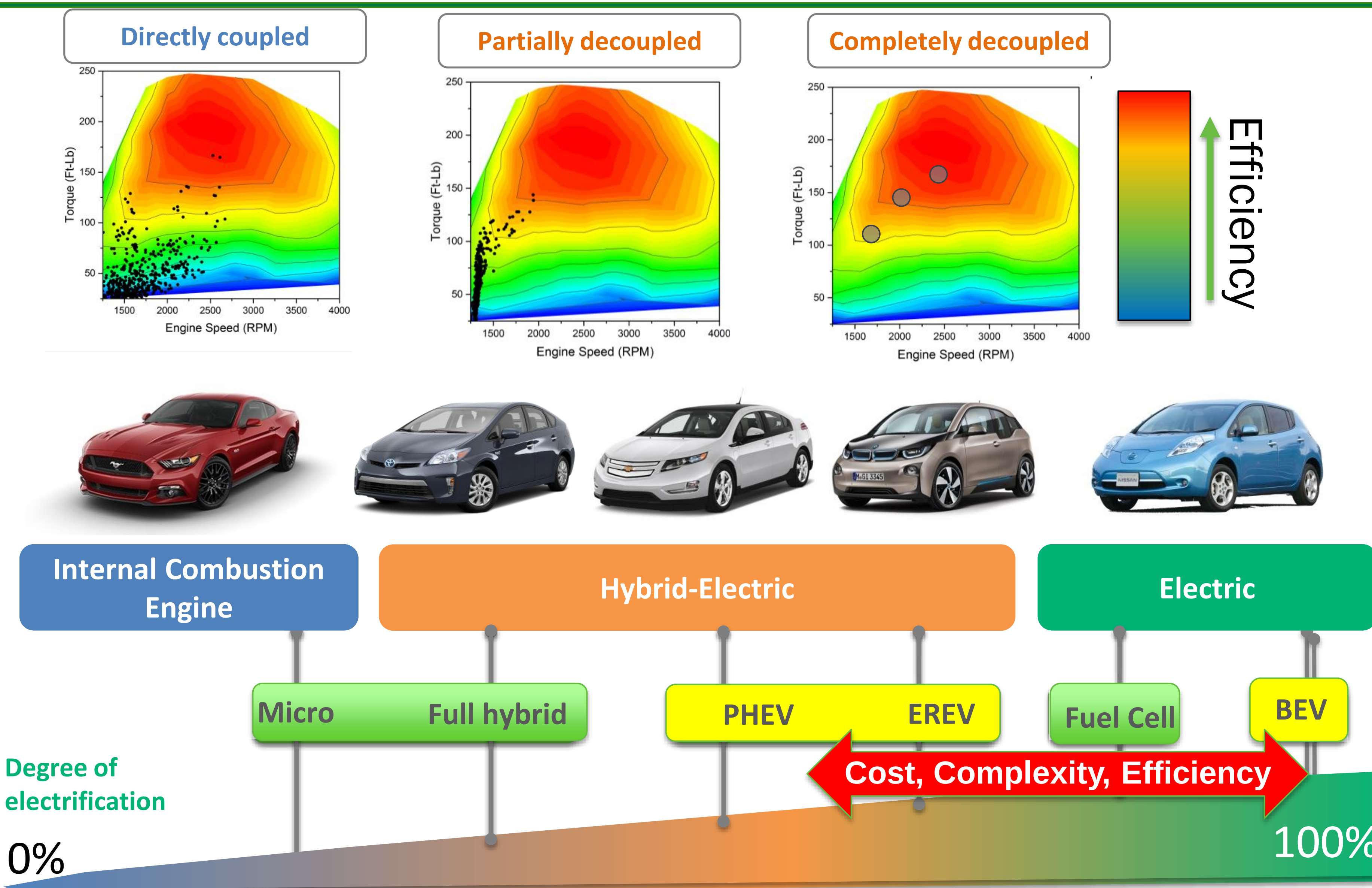
Low-Temperature Combustion (LTC)

- Achieve high efficiency with ultra-low emissions
- Many modes are inherently unstable outside of a narrow operating range
- Even when driving at a constant speed, vehicle power demand can vary considerably
- Hybrid configurations have potential to enable LTC operation by smoothing power demand from the engine





How we use engines is changing



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Hybrid engine efficiency goals and progress

Advanced Combustion-Emission Control Tech Team
(pre-competitive, BTE at speed/load points)

Technology Pathway	Fuel	2010 Baselines: Peak Efficiency (BTE %)	2010 Baselines: Efficiency at 2 bar BMEP and 2000 rpm (BTE %)	2010 Baselines: Efficiency at 20% of the Peak Load at 2000 rpm (BTE %)	2020 Stretch Goals: Peak Efficiency (BTE %)	2020 Stretch Goals: Efficiency at 2 bar BMEP and 2000 rpm (BTE %)	2020 Stretch Goals: Efficiency at 20% of the Peak Load at 2000 rpm (BTE %)	2025 Stretch Goals: Peak Efficiency (BTE %)	2025 Stretch Goals: Efficiency at 2 bar BMEP and 2000 rpm (BTE %)	2025 Stretch Goals: Efficiency at 20% of the Peak Load at 2000 rpm (BTE %)
Hybrid Application	Gasoline	38	25	24	46	30	29	46	31	30

- Peak efficiency is most applicable for hybrid application
- 2025 Target includes emissions compliance for SULEV 30 and 1 mg/mile particulates

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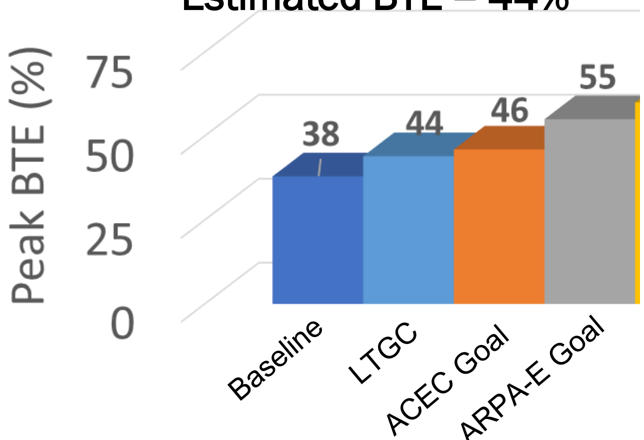
Low Temperature Gasoline Combustion (LTGC) Research Engine
Estimated BTE = 44%



"The maximum BTE expected for slider-crank engines is about 60%, assuming that cost is not a constraint."[1]

[1]Experts' consensus. *Report on the Transportation Combustion Engine Efficiency Colloquium Held at USCAR*, March 3–4, 2010, ORNL/TM-2010/265

Heavy-Duty Engine Efficiency Goals

DOE/VTO SuperTruck Initiative

- Exceeded the SuperTruck initiative 50% diesel engine efficiency goal;
- Developed pathways to 55% efficiency; and
- Exceeded the SuperTruck initiative 50% tractor-trailer freight efficiency goal.

Navistar, Volvo, Cummins/Peterbilt, and Daimler SuperTruck demonstration vehicles

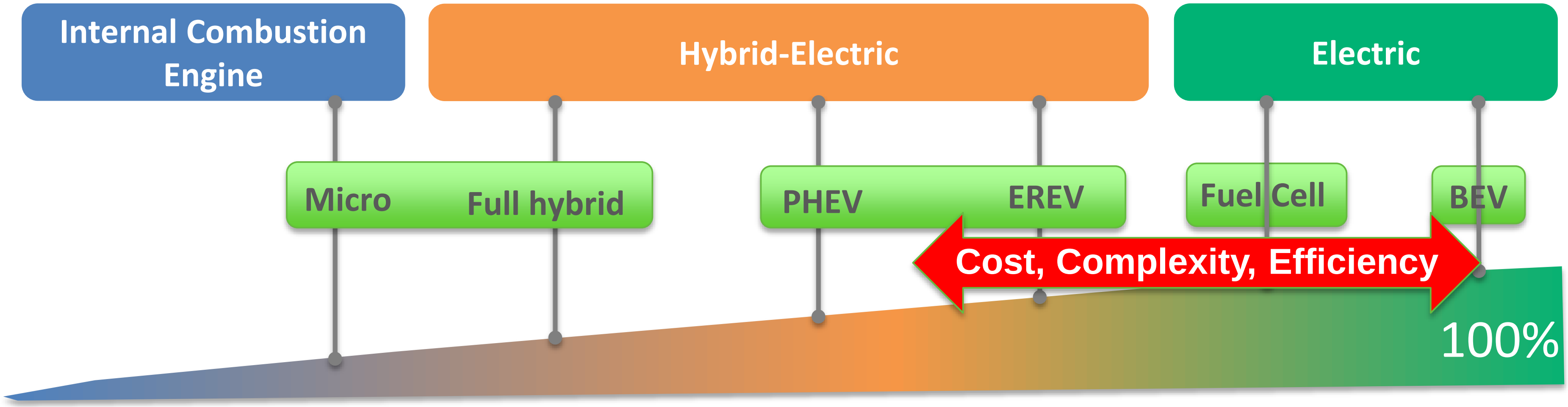
Challenges for Future Engines

Technical Challenges

- Improve Efficiency
- Reduce emissions
- Improve transient response, and noise, vibration, and harshness (NVH)
- Reduce overall engine system cost
- Reduce volume and weight

Market Challenges

- Fuel Economy ↑
- Emissions (more stringent regulations) ↓
- Cost to Consumer ↓



Thank You

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