Today

- What’s New
- Office Vision and Strategy
- Goals and Successes
VTO Organizational Structure

Michael Berube
Director

David Howell
Deputy Director

Electrification R&D
- Program Manager
  - Technology Managers
    - Battery R&D
    - Electric Drive, Grid, and Charging R&D

Materials Technology R&D
- Program Manager
  - Technology Managers
    - Lightweight Materials
    - Propulsion Materials

Advanced Combustion Systems and Fuels R&D
- Program Manager
  - Technology Managers
    - Advanced Combustion Engines and Systems
    - Fuels and Lubricants

Energy Efficient Mobility Systems
- Program Manager
  - Technology Managers
    - Energy Efficient Mobility Systems

Deployment
- Program Manager
  - Deployment Managers
    - Clean Cities and Fueleconomy.gov
    - Energy Efficient Mobility Systems and Electrification
    - EPACT

Operations
- Operations Supervisor
  - Analysis
  - Budget
  - Communications and Education
  - Office Administration
Why Energy Efficient Mobility Systems (EEMS)?

Connectivity

How can disruption lead to new energy efficiency opportunities?

Automation

What are the most promising innovation levers?

Ride-sharing

What are the risks to energy use and how can we overcome them?

Car-sharing

New Powertrains

New Modes
Growing our Economy Requires Transportation, and Transportation Requires Energy

Annually, transport...

11 billion Tons Goods by Over 3 Trillion Miles

VTO providing low cost, secure, efficient, and clean energy technologies to transport people and goods across America
FY 18 Program Focus and Strategy

Early Stage Research that Advances...

Fuel Diversification
Domestic, Diverse, Alternative, Clean Fuels

Vehicle Efficiency
Energy Efficient Vehicle Technologies

Mobility Systems
Energy Efficient Transport Systems
<table>
<thead>
<tr>
<th>FY 18 Budget Structure</th>
<th>FY 17 Enacted ($K)</th>
<th>FY 18 Request ($K)</th>
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<tbody>
<tr>
<td>Battery and Electrification Technologies</td>
<td>$140,530</td>
<td>$36,300</td>
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<td>Energy Efficient Mobility Systems</td>
<td>$16,385</td>
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<tr>
<td>Advanced Engine and Fuel Technologies</td>
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<td>Materials Technologies</td>
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<td>Analysis</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$306,959</strong></td>
<td><strong>$82,000</strong></td>
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Ambitious Goals

+ 15% Fuel Economy from Fuels and Engine Cooptimization

Fuel Economy + 35%

55% Heavy-Duty Truck BTE

300 Mile Range

Weight - 25%

Costs: Battery = ICE

15 min Recharge Time
All New Fuel Injector Visualization

High Precision has been Achieved in Nozzle Geometry Visualization

World-class spatial resolution

Fuel Injector Nozzle Geometry
New Concept to Enable Lithium Metal Anodes

Novel Structure as Host for Storing Metallic Lithium

Could lead to

Range

Cost

Reduced Graphene Oxide (GO) with Nanoscale Interlayer Gaps as Stable Host for Li Metal

Cycling of Li–Reduced Graphene Oxide Electrodes

Analysis of Consumer Trips to Understand Charging Needs

Heat map of Columbus trip destination frequency derived from INRIX data set

Map of Electric Charging Stations from the Alternative Fuels Data Center
Ability to Derive Knock Computationally

Knock visualization in CFR

CAD = -30° ATDC
Atomic Level Observation Reducing Magnesium Corrosion

Fig. 1. Cross-section TOF-SIMS D map after 4 h in D₂O for A) Mg-0.46Zr. Both D and residual H segregated to Zr-rich coring regions. B) Corresponding Zr EPMA X-ray map (thermal scale) for Mg-0.46Zr, and C) Backscatter electron EPMA image of entire Mg-0.46 Zr sample cross-section.
New Math Based Models to Control Intersections

**Decentralized control**

**Lemmata:**
For each vehicle $i$, we define an optimal control problem $\mathcal{P}_i$ such that the solution $u_i^*$ depends only on the state of the vehicle $i$.

**Definition:**
For each vehicle $i \in \mathcal{V}$, we define the cost functional $J_i(u_i)$

$$J_i(u_i) = \frac{1}{2} \int_{t_0}^{t_1} q_i(u_i(s)) \ ds, \tag{6}$$

**Definition:**
For each vehicle $i \in \mathcal{V}$, we define the cost $J_i(u_i)$

$$u_i \in \begin{cases} \arg \min \{ J_i(u_i) \}, & \text{subject to:} \\ & \text{vehicle dynamics} \ (1) \ \text{and state-control bounds} \ (2) \end{cases}, \tag{7}$$

$$\min_{u_i} \left\{ \sum_{i=1}^{N} (G_i(u_i(0)) - G_i(u_i(T))) \right\}, \tag{8}$$

Subject to: $u_i \in \mathcal{U}$, $w \in \mathcal{W}$, no-end collisions $\Rightarrow (2)$, and lateral collisions $\Rightarrow (5)$.

**Intersection Control**

**Baseline case**

**Decentralized optimal control**

**Merging zone**
Vehicle Technologies in Use

EEMS Living Labs

www.fueleconomy.gov
the official U.S. government source for fuel economy information

Clean Cities
U.S. Department of Energy

23,424 alternative fuel stations in the United States

Biodiesel  Electricity  Ethanol  Hydrogen  Natural Gas  Propane
Keys for a Successful VTO

- Portfolio Approach
- Partnerships
- Ambitious Targets
- Great Team
Thank You