WELCOME!

Vehicle Technologies Office
2021 Annual Merit Review Plenary
Monday, June 21, 2021 -- 1:00pm-3:00pm ET

1:00 - 1:05 PM	Welcoming Remarks	David Howell, Acting Director, Vehicle Technologies Office
1:05 - 1:10 PM	Message from the Secretary	Jennifer Granholm, Secretary of Energy
1:10 - 1:20 PM	Update from EERE Leadership	Kelly Speakes-Backman, Acting Assistant Secretary, Principal Deputy Assistant
1:20 - 1:35 PM	Priorities for the Sustainable Transportation Sector	Michael Berube, Deputy Assistant Secretary for Sustainable Transportation, EERE
1:35 - 1:50 PM	Vehicle Technologies Office Priorities: Goals, Key Targets, and Notable R&D Outcomes	David Howell, Acting Director
1:50 - 2:00 PM	Overview: Technology Integration	Mark Smith, Program Manager
2:00 - 2:10 PM	Overview: Batteries and Electrification R&D	Steven Boyd, Program Manager
2:10 - 2:20 PM	Overview: Energy Efficient Mobility Systems R&D	David Anderson, Program Manager
2:20 - 2:30 PM	Overview: Materials R&D	Sarah Kleinbaum, Program Manager
2:30 - 2:40 PM	Overview: Advanced Engine and Fuels R&D	Gurpreet Singh, Program Manager
2:40 - 3:00 PM	Awards	

[S-1 Joining live – 5 minutes]

Jennifer Granholm
Secretary of Energy
U.S. Department of Energy

[VIDEO FROM EE-1 – 10 minutes]

Kelly Speakes-Backman
Acting Assistant Secretary
Office of Energy Efficiency and Renewable Energy

[DAS-T – 15 minutes]

Michael Berube
Deputy Assistant Secretary for Sustainable Transportation
Office of Energy Efficiency and Renewable Energy

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

OVERVIEW | VEHICLE TECHNOLOGIES OFFICE

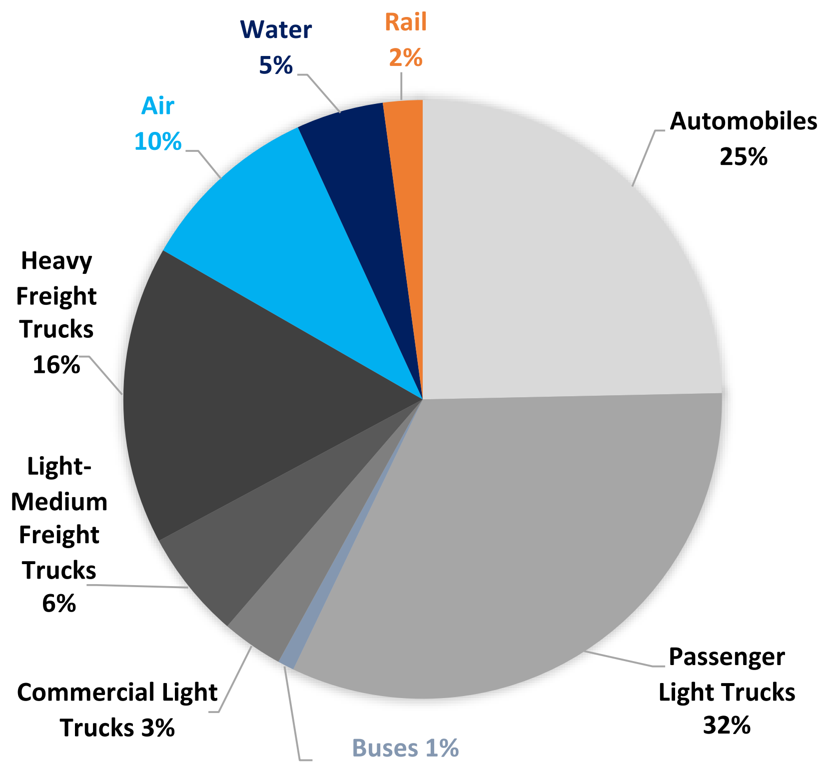
DAVID HOWELL
Acting Director, Vehicle Technologies Office

June 21, 2021

Vehicle Technologies Office (VTO)

Mission: Decarbonize transportation across all modes

2019 U.S. Transportation Energy Use (26.8 Quads)



Source: EIA AEO

- Net-zero by 2050 requires dramatic energy efficiency and emissions improvements in vehicle and the overall transportation system
- 100% clean electricity and dramatic technology cost reductions enable deep transportation decarbonization
- On-Road Vehicles (Light, Medium, Heavy) account for 83% of energy use, and can be electrified leveraging cheap and abundant clean electricity
- Long Haul freight movement and Air, Marine, Rail likely require Hydrogen and Biofuels

Vehicle Technologies Office (VTO)

ON-ROAD
Light-, Medium-, Heavy Duty Vehicles

Batteries & Electrification

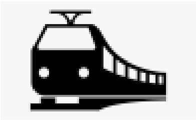
Materials Technology

Mobility Systems

Demonstration and Deployment

Clean Cities

Air, Marine, Rail



Some R&D for On/Off-Road MD/HD Vehicles

H2@Scale
U.S. Department of Energy

Vehicle Technologies – FY 2022 Budget Request

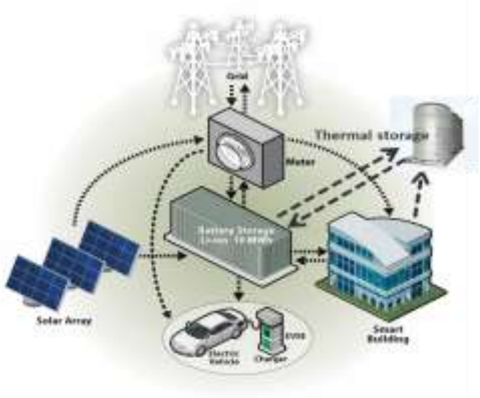
1) Advanced Battery R&D for EVs and batteries across clean energy applications including the Energy Storage Grand Challenge, aiming to reduce the cost of electric vehicle battery cells by more than half to $60/kWh.

2) Demonstrate and deploy technologies that enable transportation opportunities for all communities with emphasis on those currently underserved and accelerate EV adoption at the community level.

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Battery and Electrification Technologies	178,700	248,700	+70,000	+39%
Advanced Engines and Fuel Technologies	70,000	30,000	-40,000	-57%
Materials Technology	40,000	60,000	+20,000	+50%
Energy Efficient Mobility Systems	45,000	70,000	+25,000	+56%
Technology Integration	60,300	180,300	+120,000	+199%
Data, Modeling, and Analysis	6,000	6,000	0	-
Total	**400,000**	**595,000**	**+195,000**	**+49%**

Vehicle Technologies – FY 2022 Highlights and Major Changes

Accelerate Nationwide Adoption and Deployment of EVs and Infrastructure ($120M)



- ❑ Significantly expand EV community partner demonstration activities
- ❑ Demonstrate innovative charging/ infrastructure technology for various types of EV owners. Improve equitable access to the benefits of electrified transportation,
- ❑ Support Administration’s goal to deploy 500,000 charging stations across the Nation.
- ❑ Demonstrate innovations to enhance community resilience (especially underserved communities) to physical hazards using distributed solar, energy storage, EVs, and other DERs (joint EERE-OE effort).
- ❑ Support education and workforce training.

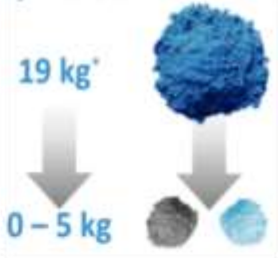
Vehicle Technologies – FY 2022 Highlights and Major Changes

Expanded Advance Battery R&D ($75M)

Solid State Batteries

- ❑ Accelerate and Scale-Up lithium Metal Battery R&D including Solid State Batteries

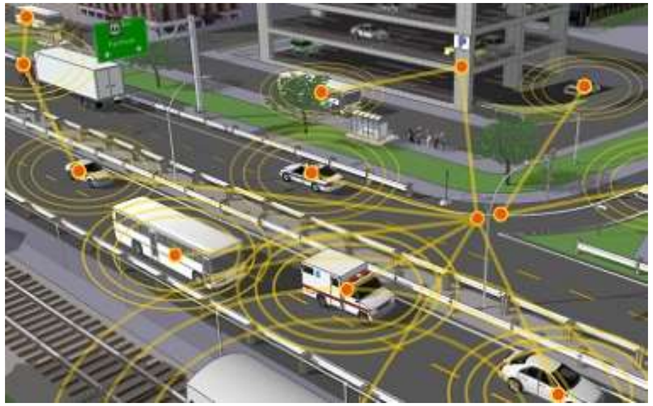
Low/No Cobalt Cathode



- ❑ Scale Up and Accelerate No Cobalt, No Nickel Cathode R&D

- ❑ Expand Lithium Battery Recycling R&D

Vehicle Technologies – FY 2022 Highlights and Major Changes



Clean Energy Mobility Solutions for Underserved Communities ($20M):

- Large-scale demonstration of connected and automated vehicle technologies applied to a specific transportation scenarios
- Demonstrate accessible, affordable, and efficient transportation options for underserved populations

Advanced Materials ($20M)

- New research on multi-functional materials to reduce the manufacturing cost and weight electric vehicles and reduce EV battery volume through increased vehicle efficiency
- New research effort on non-exhaust emissions (tire wear, brake wear, road wear, and stirred up dust) which contribute more particulate matter (PM2.5) particles than exhaust emissions.

Expand SuperTruck 3 ($30M)

- Expand the SuperTruck 3 effort to significantly acceleration to commercial truck electrification, connectivity and automation including medium duty, short haul heavy duty and long haul. Goal is to address freight movement from factory to the end user.

Public-Private Partnerships

Public-Private Partnerships provides a framework for both strategic and deep technical engagement among industry and government experts

USDRIVE

DRIVING RESEARCH AND INNOVATION FOR VEHICLE EFFICIENCY AND ENERGY SUSTAINABILITY

- **Automotive:** USCAR (Ford, GM, Stellantis)
- **Energy:** BP, Chevron, ExxonMobil, Phillips66, Shell
- **Government:** DOE
- **Utility:** AEP, DTE, Duke, EPRI, SCE

- **Auto:** Ford, GM, Stellantis
- **Gov't:** DOE

21st CENTURY TRUCK PARTNERSHIP

- **Industry:** Allison, Bosch, Cummins, Daimler / Detroit Diesel, Denso, Eaton, Ford, GM, Stellantis, Meritor, Navistar, Oshkosh, PACCAR, Volvo / Mack / Novabus
- **Government:** DOD, DOE, DOT, EPA

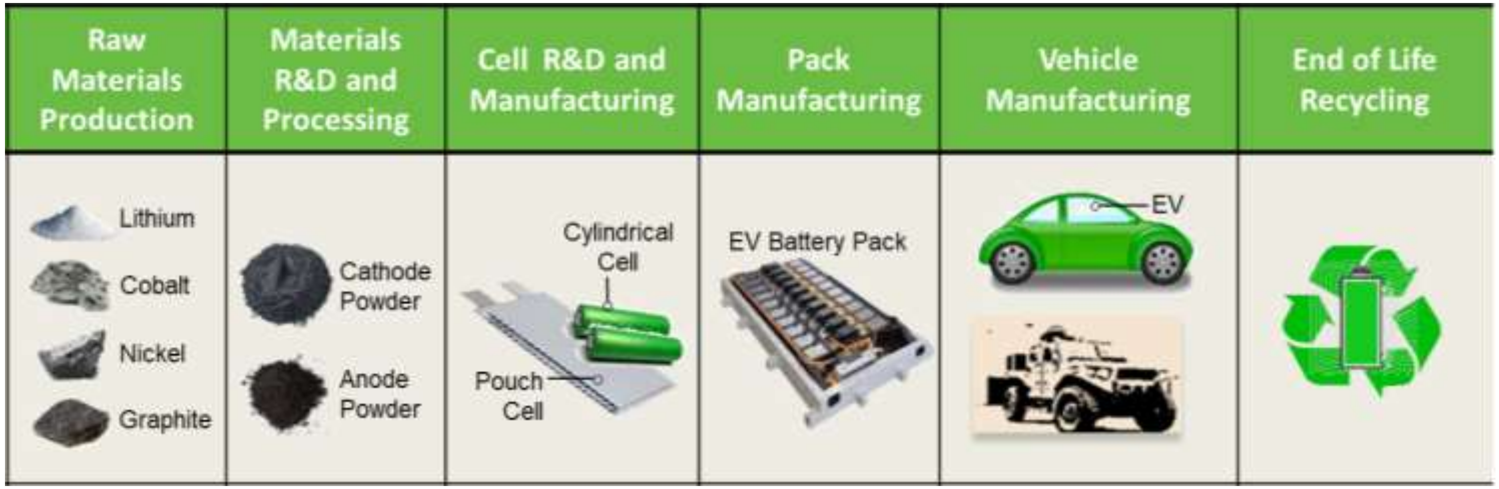
- Focuses DOE-funded R&D on high-risk barriers to technology commercialization, accelerates progress, and prevents duplication of effort.
- Includes development of technical targets and joint technical roadmaps.

Increased engagement among Partnerships to discuss synergistic R&D pathways to de-carbonize On-Road vehicles across platforms.

Federal Consortium for Advanced Batteries (FCAB)

Establishes the framework for collaboration on lithium battery interests across the Federal Government

FCAB includes 17 Federal Agencies lead by DOE (EERE Chair), Dept of Commerce, Dept. of Defense, and Dept. of State



Lithium Battery Supply Chain

Domestic, Global, and Defense Markets

Technology Advancement

Technology Transition across End-Use Applications

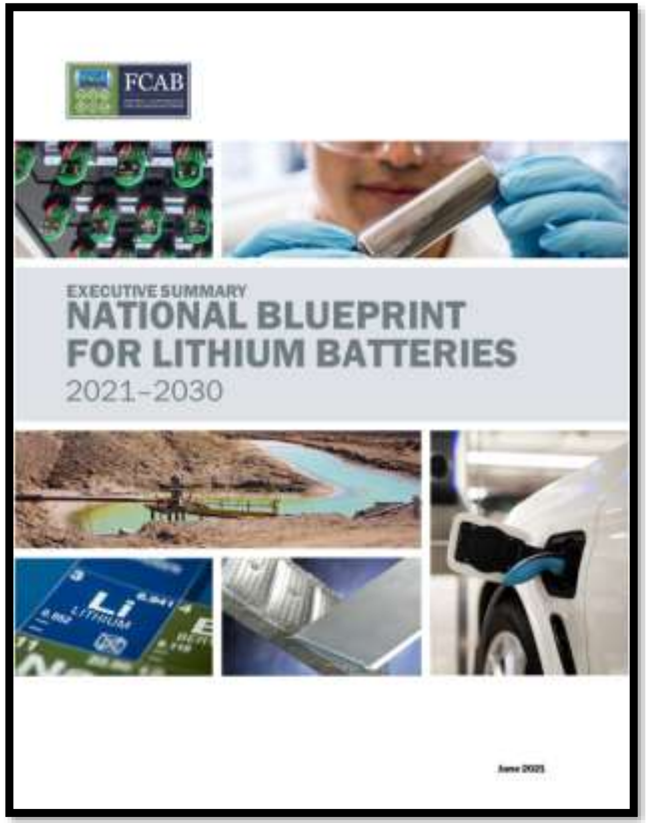
Intellectual Property and Knowledge Protection

Federal Policies and Authorities

National Blueprint for Lithium Batteries (2021-2030)

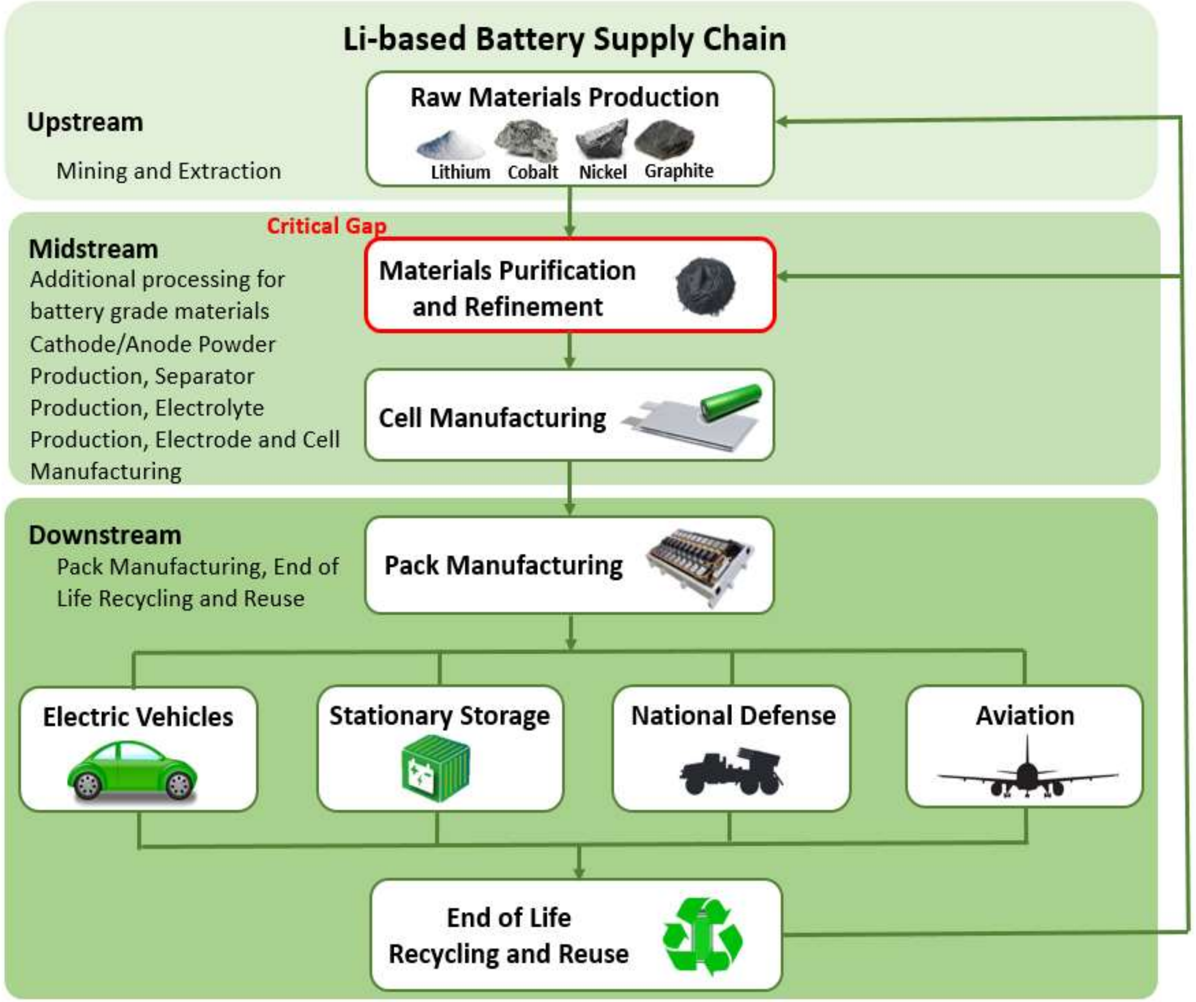
Released – 06/08/2021

Vision for the Lithium-Battery Supply Chain: *By 2030, the United States and its partners will establish a secure battery materials and technology supply chain that supports long-term U.S. economic competitiveness and equitable job creation, enables decarbonization, advances social justice, and meets national security requirements.*



GOALS TO ACHIEVE OUR VISION

1. Secure access to raw and refined materials and discover alternates for critical materials for commercial and defense applications
2. Support the growth of a U.S. materials-processing base able to meet domestic battery manufacturing demand
3. Stimulate the U.S. electrode, cell, and pack manufacturing sectors
4. Enable U.S. end-of-life reuse and critical-materials recycling at scale and a full competitive value chain in the U.S.
5. Maintain and advance U.S. battery technology leadership by strongly supporting scientific R&D, STEM education, and workforce development



Policy Recommendations

1. Stimulate demand for end products using domestically manufactured high-capacity batteries
2. Strengthen responsibly-sourced supplies for key advanced battery minerals
3. Promote sustainable domestic battery materials, cell, and pack production
4. Invest in the people and innovations that are central to maintain a competitive edge

Vehicle Technologies Office – FY 2020 - 2021 Accomplishments

Battery Cost Reduction

- Reduced the cost of EV lithium-ion battery packs to $143/kWh @ 100k packs per year.

Battery500 Research Consortium

- Demonstrated lab scale cell that achieved 350 Wh/kg & > 500 cycles)

Lithium-Ion Battery Recycling Prize

- Seven Phase II winners received a $357,000 cash prize and advance to Pilot Scale Demonstration and Validation"

Electric Drive Cost Reduction

- Reduced the cost of electric traction drive systems to $8/kW, a 33% reduction from 2015 baseline.

Vehicle Weight Reduction

- Demonstrated a carbon fiber composite underbody that achieved an 18% weight reduction (10.5 kg reduction) compared to the baseline steel underbody.

Engine Efficiency Improvement

- Demonstrated a fuel economy of 43.0 MPG (20% improvement over 2016 baseline) with a Low-Temperature Gasoline Combustion (LTGC) engine.

Energy Efficient Mobility Systems

- Established baseline Mobility Energy Productivity (MEP) metric for 5 different cities/regions.

Who we are – Vehicle Technologies Office

Acting Director
David Howell

BATTERIES AND ELECTRIFICATION R&D
Program Manager
Steven Boyd

BATTERY R&D
Technology Managers
- Mallory Clites
- Haiyan Croft
- Brian Cunningham
- Tien Duong
- Peter Faguy
- Samm Gillard
- Simon Thompson

ELECTRIFICATION R&D
Technology Managers
- Susan Rogers
- Lee Slezak

MATERIALS TECHNOLOGY R&D
Program Manager
Sarah Kleinbaum

Technology Managers
- Jerry Gibbs
- Felix Wu

ADVANCED COMBUSTION ENGINES AND FUELS R&D
Program Manager
Gurpreet Singh

Technology Managers
- Ken Howden
- Siddiq Khan
- Kevin Stork
- Mike Weismiller

ENERGY EFFICIENT MOBILITY SYSTEMS
Program Manager
David Anderson

Technology Managers
- Erin Boyd
- Heather Croteau
- Prasad Gupte

TECHNOLOGY INTEGRATION
Program Manager
Mark Smith

Technology Managers
- Michael Laughlin
- Margaret Smith

OPERATIONS
Acting Supervisor
Mark Smith

Analysis
Jake Ward

Budget
Jeremiah Freeman

Communications and Education
Connie Bezanson

Office Administration
Bernadette Jackson

Who We Are – Program Manager and Operations Team

Mark Smith
Tech Integration

Steven Boyd
Battery/Electrification

Sarah Kleinbaum
Materials

Gurpreet Singh
Engines/Fuels

David Anderson
Mobility Systems

Connie Bezanson

Jeremiah Freeman

Bernadette Jackson

Jake Ward

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

OVERVIEW | TECHNOLOGY INTEGRATION

MARK SMITH
Program Manager, Vehicle Technologies Office

June 21, 2021

Who We Are

Mark Smith

Dennis Smith

Mike Laughlin

Margaret Smith

Technology Integration Program

Provide objective/unbiased data and real-world lessons learned that inform future research needs and support local decision-making

Clean Cities Coalitions

Information and Tools

Technical Assistance

Training, Outreach, Partnerships

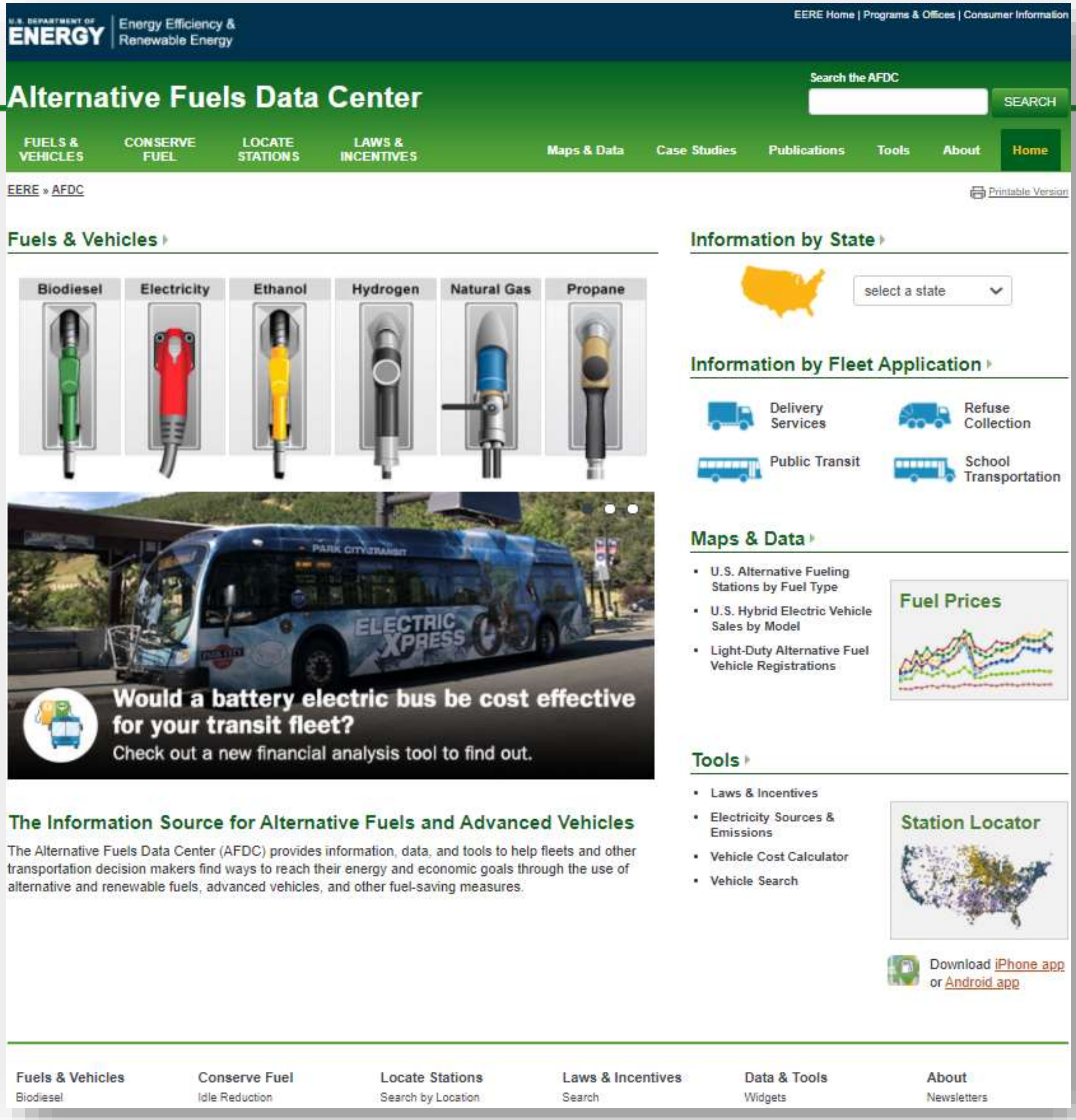
Financial Assistance

Regulatory Activities / State and Alt Fuel Provider Fleets

Advanced Vehicle Technology Competitions

Alternative Fuels Data Center (AFDC)

afdc.energy.gov



Fuel Economy

FuelEconomy.gov

Training, Outreach & Partnerships

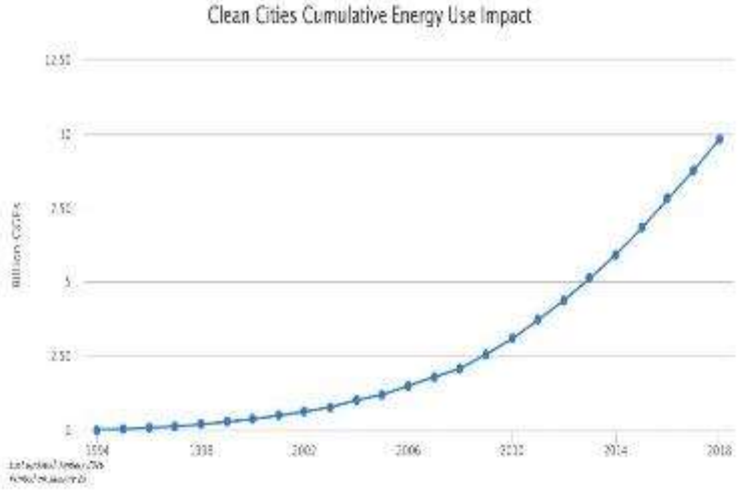
- Propane Education & Research Council
- NGVAmerica
- National Biodiesel Board
- Renewable Fuels Association
- California Fuel Cell Partnership
- NTEA

Clean Cities University Workforce Development (Intern) Program

More than 75 Clean Cities coalitions with thousands of stakeholders, representing ~80% of U.S. population

Clean City Coalition Results

- Since 1993, the cumulative energy impact of Clean Cities coalition activities has surpassed 9.8 billion GGEs through alternative fuel use, fuel economy improvements, idle-reduction measures, and other strategies
- In 2019, nearly 1 million of the AFVs in operation were a result of Clean Cities coalition efforts.



VTO Technology Integration Competitive Project Funding

VTO has funded over **600 Technology Integration** projects and distributed nearly **$500 million** since 1993

Living Labs for Energy Efficient Transportation

AFV Adoption Through Partnerships

AFV Safety Training

Rural New Mobility Solutions

EV Community Partner Projects

AFV Data Collection and Analysis

For more info, attend our track sessions

June 22: Vehicle Analysis (VAN)– 10:00am – 4:30pm

June 23: Technology Integration (TI) – 10:00am – 6:20pm

June 24: Technology Integration (TI) – 10:00am – 2:10pm

June 24: EcoCar Mobility Challenge (TI) – 3:45pm – 4:30pm

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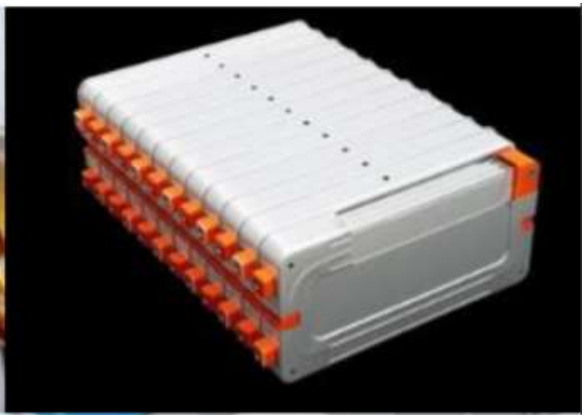
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

OVERVIEW | BATTERIES AND ELECTRIFICATION R&D

STEVEN BOYD
Program Manager, Vehicle Technologies Office

June 21, 2021






Who We Are

Steven Boyd

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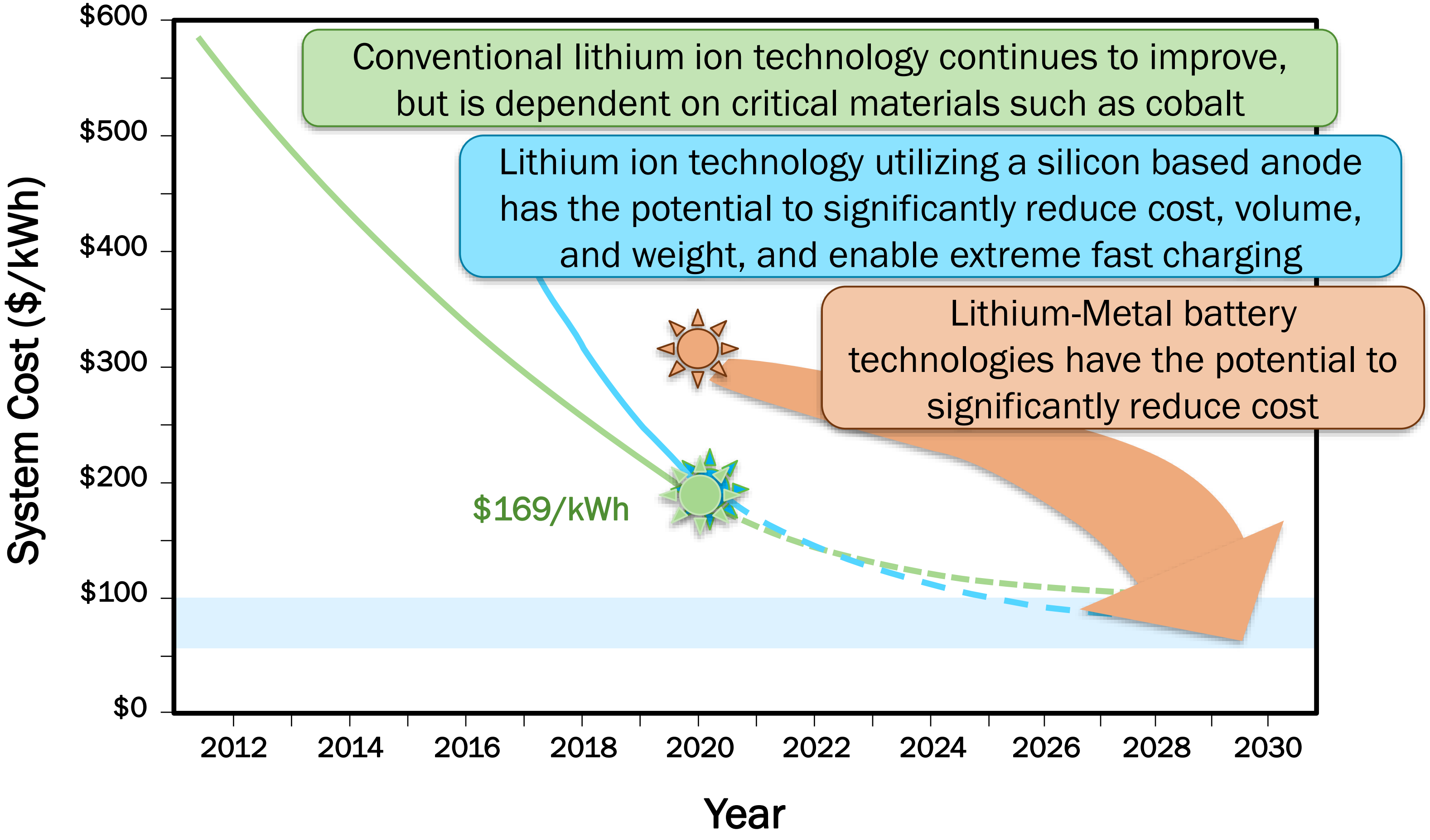
Susan Rogers

Lee Slezak

Simon Thompson

What We Do

- ***Battery R&D: Core Technology for Clean Energy***
  - *Materials,* processing, cells, and recycling
- ***Electric Drive Systems: Key Enabler for EVs***
  - *Motors,* power electronics, and integrated traction drive
- ***Electrification: Impacts and Benefits of EV/Grid Integration***
  - *Smart* charging, Cyber-Physical Security, High Power DC Fast Charging

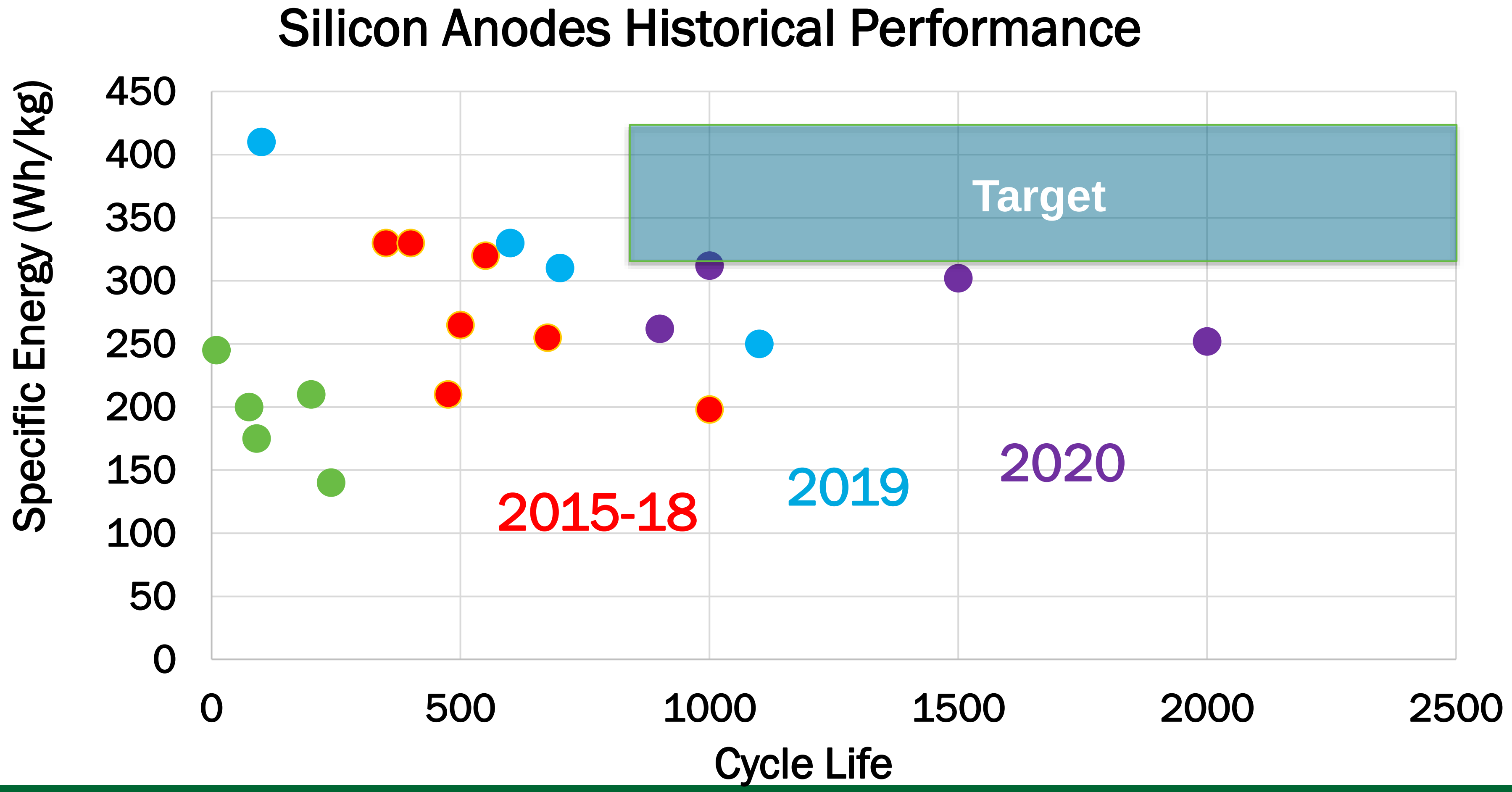


VTO R&D lowered the cost of EV battery packs to $169/kWh useable ($143/kWh rated) in 2020, a more than 80% reduction since 2008 based on useable pack energy.

Silicon Anode Battery Progress

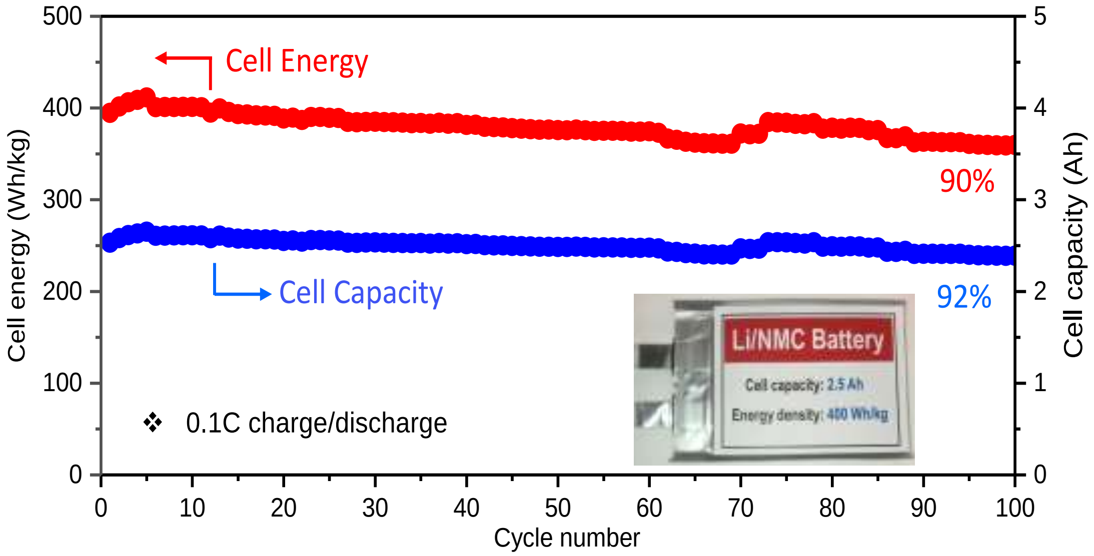
Multiple industry and laboratory projects have developed cells containing silicon-based anodes achieving >300 Wh/kg (or equivalent electrode loading) with >1,000 cycle life with less than 20% capacity fade

- Targets
  - 1000+ mAh/g
  - 10 yrs, 1000 cycles
- Challenges
  - Large first cycle irreversible loss
  - Low cycle and calendar life / high capacity fade



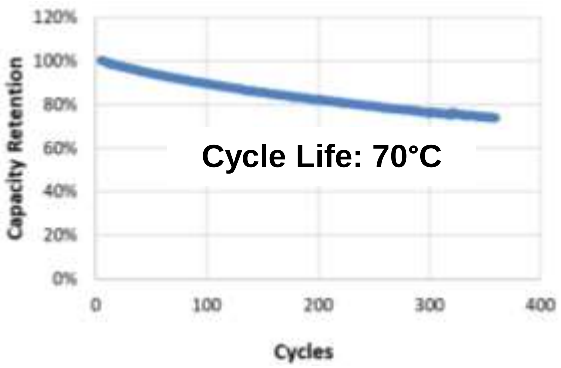
Lithium Metal and Solid State Battery Progress

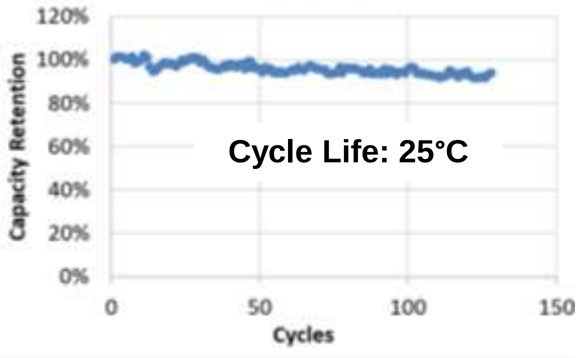
Cycling stability of a prototype 400 Wh/kg lithium metal battery containing $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$ cathode



- Achieve ≥ 100 cycles and ≥ 400 Wh/kg (< 20% capacity degradation over cycle life) in 2.5 Ah lithium metal pouch cell when cycled at moderate charge/discharge rate.
- After 100 cycles, the cell capacity and energy retentions are 92% and 90%, respectively.

Solid Power All Solid State Battery Pouch Cell (NMC622 cathode 3.0 mAh/cm^2, 2.8-4.2V, C/5-C/5)





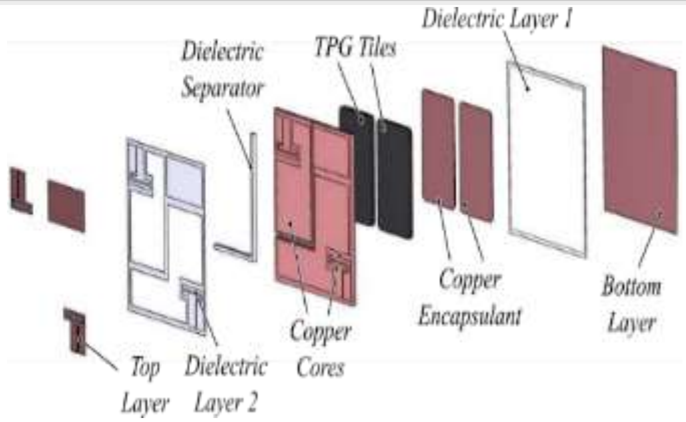
Continuous Roll-to-Roll Cell Production

2-Ah Production-Line Cell

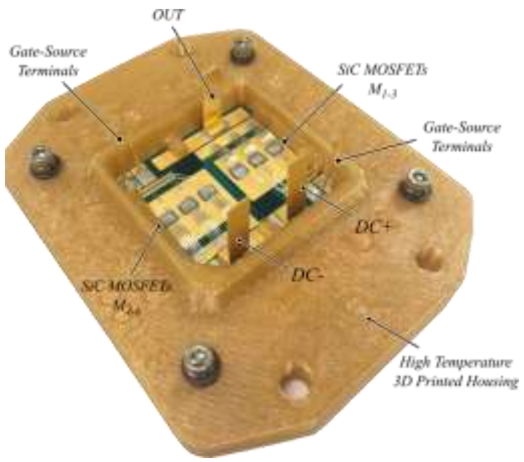
Novel Substrates for Integrated Power Modules

Electric Drive Technologies: researchers developed a high-performance substrate to provide high performance thermal management for wide-bandgap (WBG) power modules.

- 17% reduction in device-to-case thermal resistance for SiC MOSFET
- 10% increase in device current density regardless of thermal management
- Minimal impact on conduction and switching performance of SiC MOSFETs.



Structure of the graphite embedded insulated metal substrate



Half-Bridge Power Module based on IMSwTPG

Assembled module for thermal characterization

Benefits of Direct Connect Medium Voltage DC Charger

NC STATE UNIVERSITY | ABB | NEW YORK STATE OF OPPORTUNITY. NY Power Authority

Power:	720 kW	40% more power	1,000 kW
Volume:	12,910 L	2x volume reduction	6,000 L
Mass:	13,000 lb.	3x mass reduction	4,000 lb.
Efficiency:	92%	4x loss reduction	98%
Concrete pad:	177 sq. ft.	2.5x footprint reduction	75 sq. ft.

For more info, attend our track sessions BAT and ELT

June 22

BAT:
- eXtreme Fast Charge Cell (XCEL)
- Recycling R&D (ReCell)
- Behind the Meter Storage (BTMS)

ELT:
- High Power Density Electric Drive R&D Consortium
- Rare-Earth-Free Traction Drive Systems

June 23

BAT:
- Battery Materials and Component Processing
- Overviews for:
  - Silicon and Intermetallic Anodes
  - Liquid Electrolytes
  - Battery Materials Research

ELT:
- Vehicle-Grid Integration
- Charging Infrastructure
- Heavy Duty EV Trucks

June 24

BAT:
- Soild State Batteries and Electrolytes
- Lithium-Sulfur Batteries

ELT:
- Cybersecurity
- Megawatt DC Fast Chargers
- Wireless Charging

U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

OVERVIEW | ENERGY EFFICIENT MOBILITY SYSTEMS R&D

DAVID ANDERSON
Program Manager, Vehicle Technologies Office

June 21, 2021

Who We Are

David Anderson

Erin Boyd

Heather Croteau

Prasad Gupte*

Danielle Chou**

**Currently on detail to S4*

***AAAS Science & Technology Policy Fellow*

What We Do

- New connected & automated vehicle technologies will shape the future of mobility

Source: Ford Motor Company

What We Do

- New connected & automated vehicle technologies will shape the future of mobility
- Mobility service providers will continue to disrupt markets

Source: GETTY IMAGES (MLENNY)

Source: AirportImprovement.com

Source: David Goldman/AP

What We Do

- New connected & automated vehicle technologies will shape the future of mobility
- Mobility service providers will continue to disrupt markets
- New modes for personal transport will have cascading impacts

Source: melissamn/Shutterstock


Source: Pinterest


Source: Alain Jocard/Getty


Source: Spin

What We Do

- New connected & automated vehicle technologies will shape the future of mobility
- Mobility service providers will continue to disrupt markets
- New modes for personal transport will have cascading impacts
- Trends in e-commerce will change how goods are moved

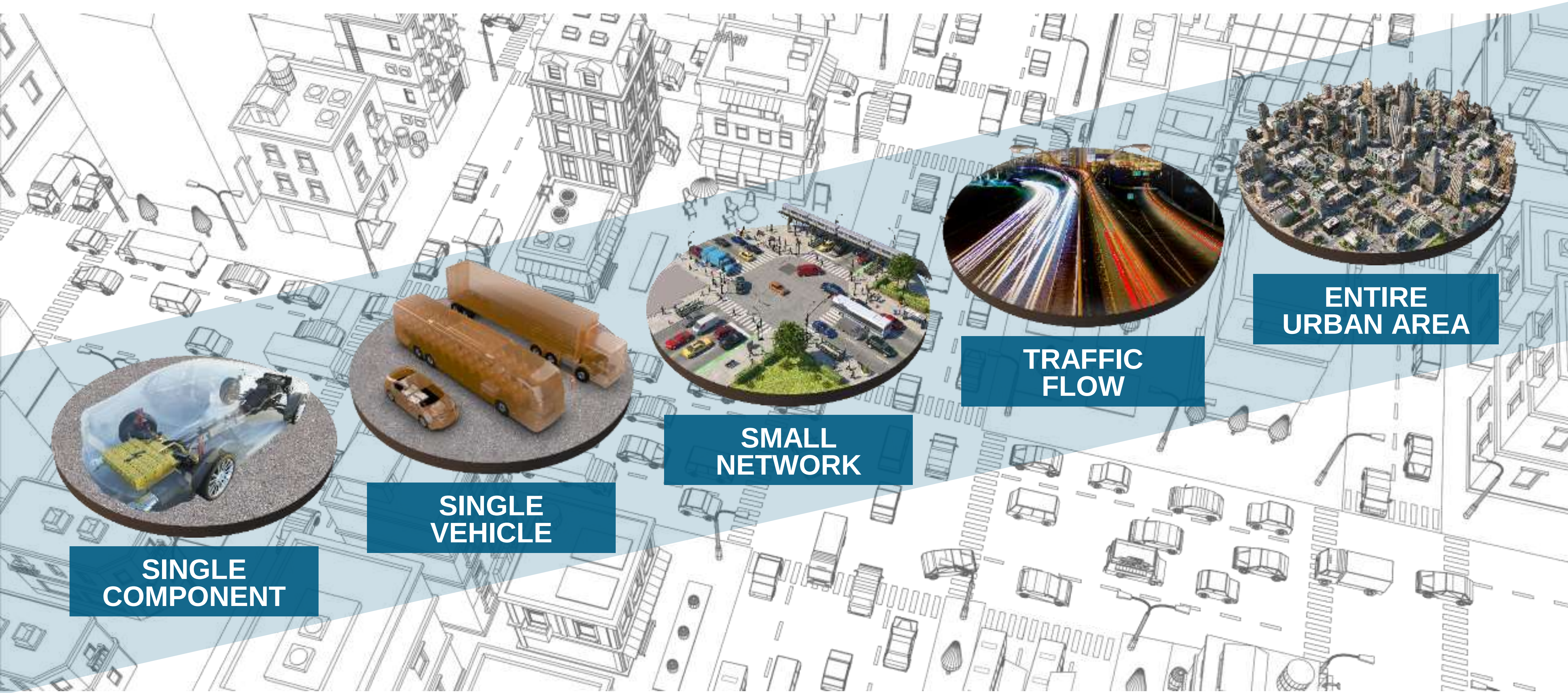
Source: InBin

Source: Shutterstock

Source: iStock

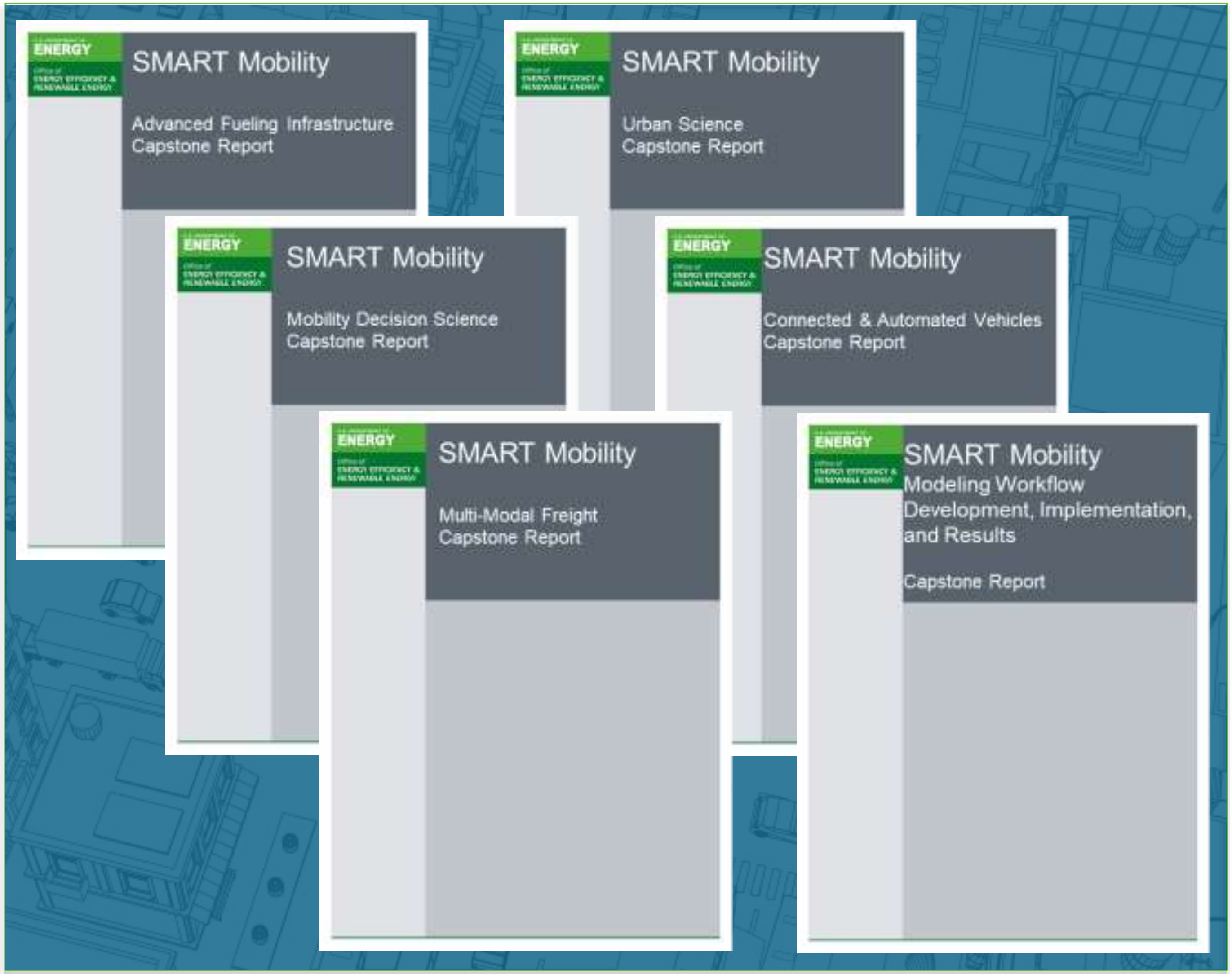
Source: Kevork Djansezian/Getty Images

What We Do


SINGLE COMPONENT
SINGLE VEHICLE
SMALL NETWORK
TRAFFIC FLOW
ENTIRE URBAN AREA

SMART Mobility Lab Consortium

- Completed SMART Mobility "Phase 1"
- Published 6 Capstone Reports:
  - Advanced Fueling Infrastructure
  - Mobility Decision Science
  - Multi-Modal Freight
  - Urban Science
  - Connected & Automated Vehicles
  - Modeling Workflow
- Webinar Series Recordings & Transcripts Available



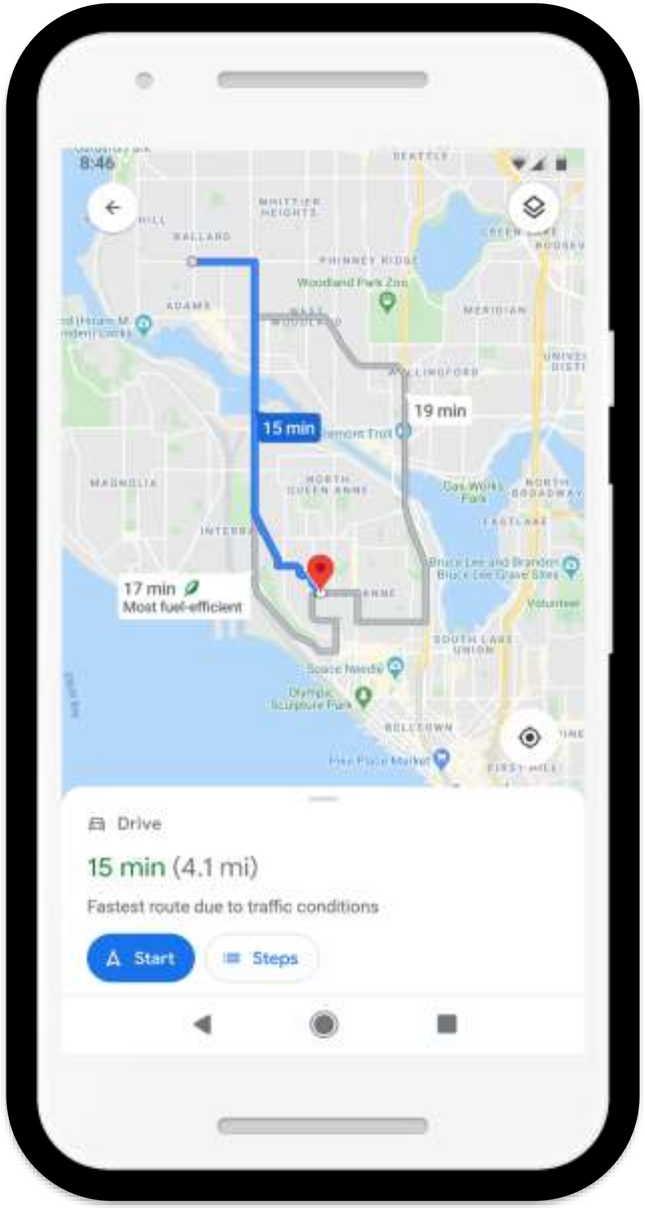
www.energy.gov/eere/vehicles/downloads/eems-smart-mobility-capstone-reports-and-webinar-series

Real-World Application of EEMS Research

- Google Maps will incorporate NREL eco-routing tools
  - RouteE: Route Energy Prediction Model
  - FASTSim: Future Automotive Systems Technology Simulator

- Approximately 1/3 of vehicle trips could use a more fuel-efficient route
  - 10%-15% savings possible for these trips

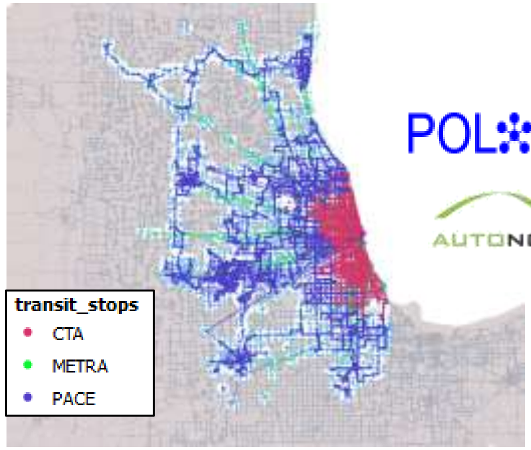
- Google Maps will default to lowest carbon footprint route

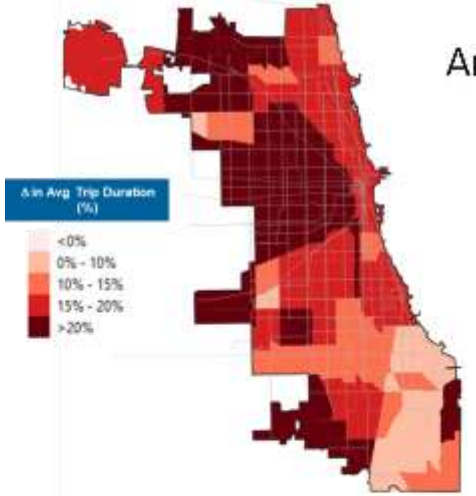


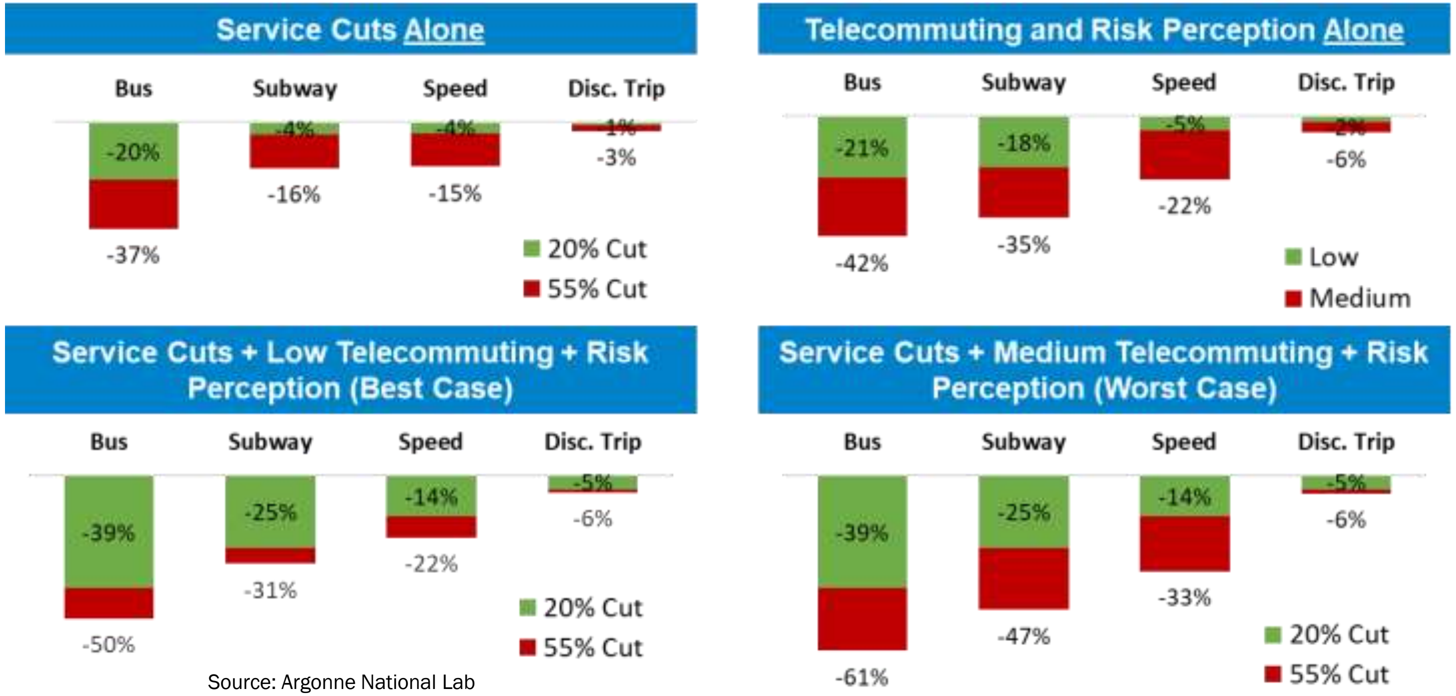
Source: Google

Real-World Application of EEMS Research

- ANL applied capabilities developed through SMART Mobility to assist in transit planning post-COVID
- Analyzed scenarios to review equity of various policy or operational changes
  - Service cuts
  - Telecommuting
  - Risk perception
- Increased congestion and low ridership result in up to $7.2B economic loss
- Hear more in EEMS088







Source: Argonne National Lab

Real-World Application of EEMS Research

AI HPC BIG DATA

- ORNL licensed revolutionary AI system to General Motors (1st commercial license)
- GM will assess MENNDL's potential to accelerate advanced driver assistance technology
- Creates better neural networks for sensing, perception, and control
- Hear more in EEMS062

menndl
Multinode Evolutionary Neural Networks for Deep Learning

Source: Oak Ridge National Lab

gm

OAK RIDGE National Laboratory

For more info, attend the EEMS sessions:

June 22

<u>10:00am – 7:20pm</u>

- Core Simulation & Evaluation Tools
- AI/HPC/Big Data
- Connected & Automated Technology R&D

June 23

<u>10:00am – 7:20pm</u>

- SMART Mobility
  - Integrated Modeling Platform
  - CAV Controls & Testing
  - Micromobility, Drones, Curb Management
- Track-based Validation of SMART Models

June 24

<u>11:00am – 5:15pm</u>

- Connected & Automated Technology R&D (New Projects)
  - Public Transit
  - System Efficiency
  - Vehicle/Infrastructure Connectivity

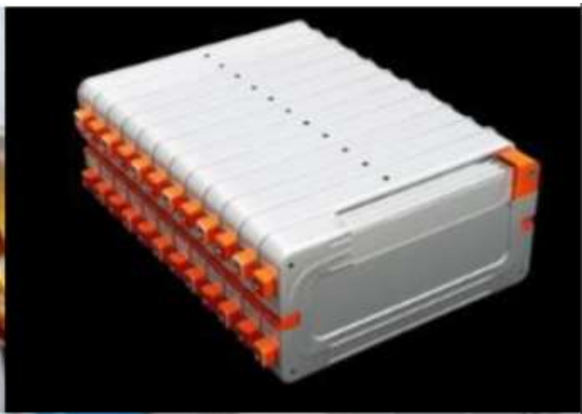
U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

OVERVIEW | MATERIALS R&D

SARAH KLEINBAUM
Program Manager, Vehicle Technologies Office

June 21, 2021





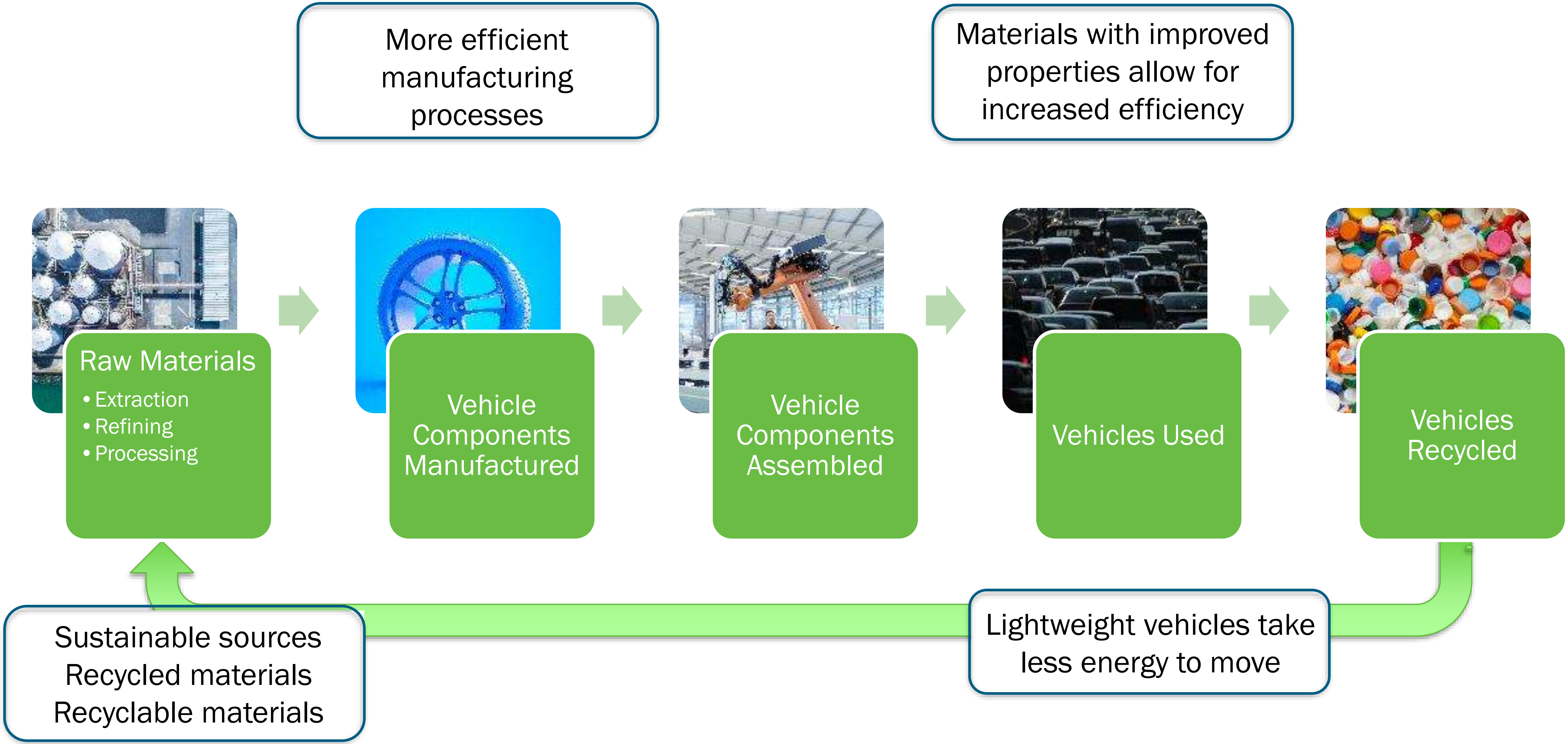

Who We Are

Sarah Kleinbaum,
Program Manager

Jerry Gibbs,
Powertrain Materials

Felix Wu,
Polymer Composites

Materials Impact on Automotive Emissions



What We Do

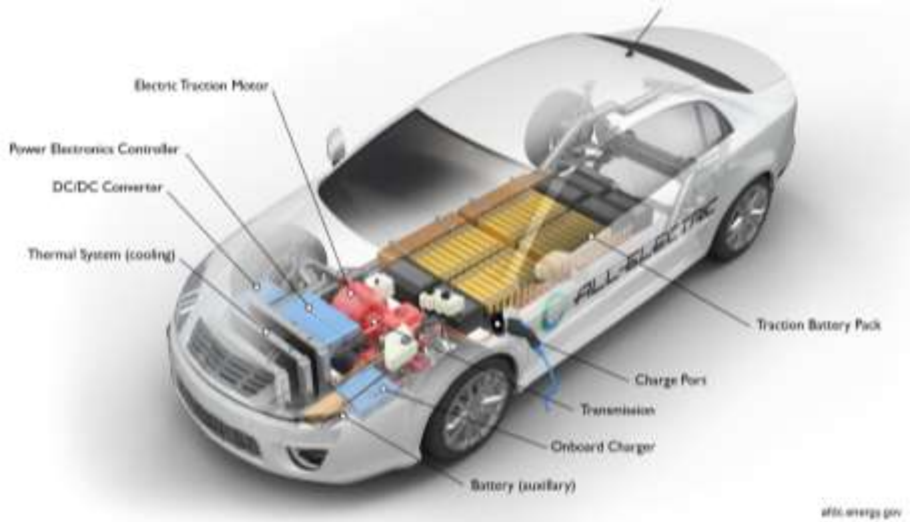
Decarbonize the Transportation Sector through Material and Process Development

Lightweight Materials enable an improvement in fuel economy through vehicle mass reduction.

Research areas include:
- Lightweight Metals (Al, AHSS, Mg)
- Polymer Composites
- Multi-Material Joining

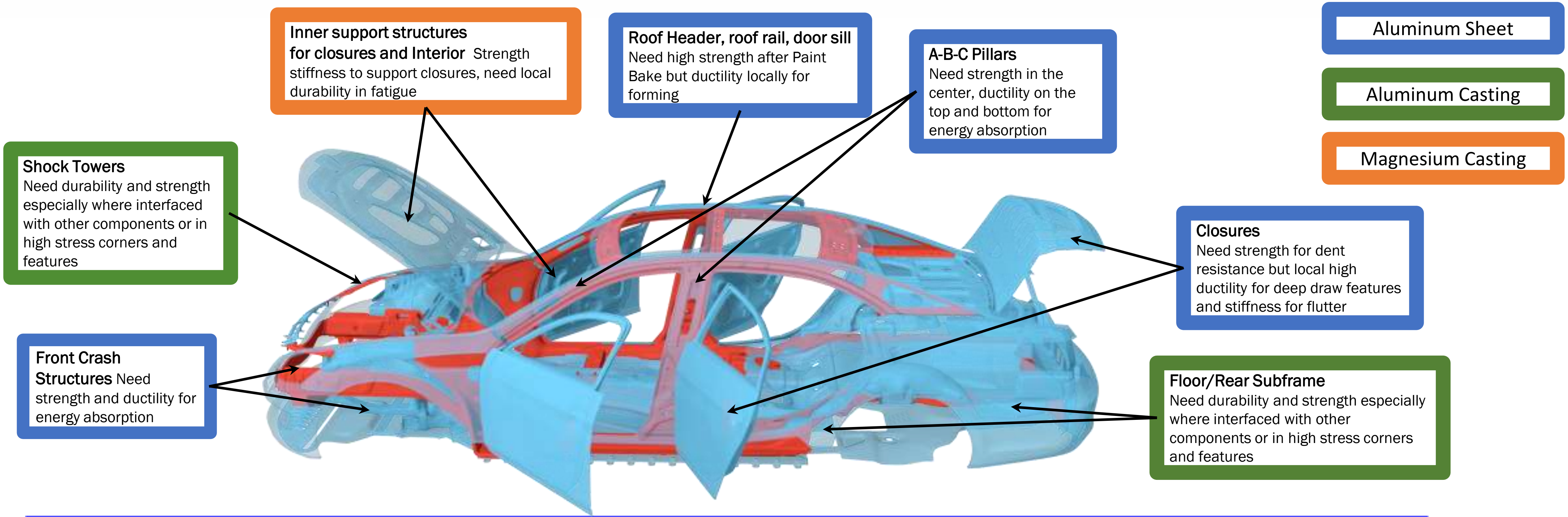
Propulsion Materials enable an improvement in fuel economy through increased powertrain efficiency.

Research areas include:
- High Temperature Strength
- Increased Electrical Conductivity



Program Goals: 25% glider weight reduction at less than $5 / lb-saved and 25% improvement in high temperature component strength by 2025.

The Lightweight Metal Core Program is putting the right material properties in the right place to enable increased usage of aluminum and magnesium



Thrust 1. Selective Processing of Aluminum Sheet

Thrust 2. Selective Processing of Aluminum Castings

Thrust 3. Selective Processing of Magnesium Castings

Crosscut Thrust. Characterization, Modeling and Life Cycle Analysis

Dissimilar Material Joining – Core Program

<u>Objective:</u> Enable the use of the right material in the right place by developing joining methods suitable for high volume manufacturing that can join AHSS, Al, CFRC, and Mg components.

- **Thrust A – Expanding Applicability of Joining Methods**
  - Ultrasonic Joining (ORNL)
  - High Rate Riveting (PNNL)
- **Thrust B – Advancing Joining Method toward Industry Readiness**
  - Friction-Self Pierce Riveting (ORNL)
  - Friction Stir Lap Welding (PNNL)
- **Thrust C – Surface Modifications for Adhesion and Corrosion**
- **Thrust D – Artificial Intelligence for In Process Quality Control of Joints**

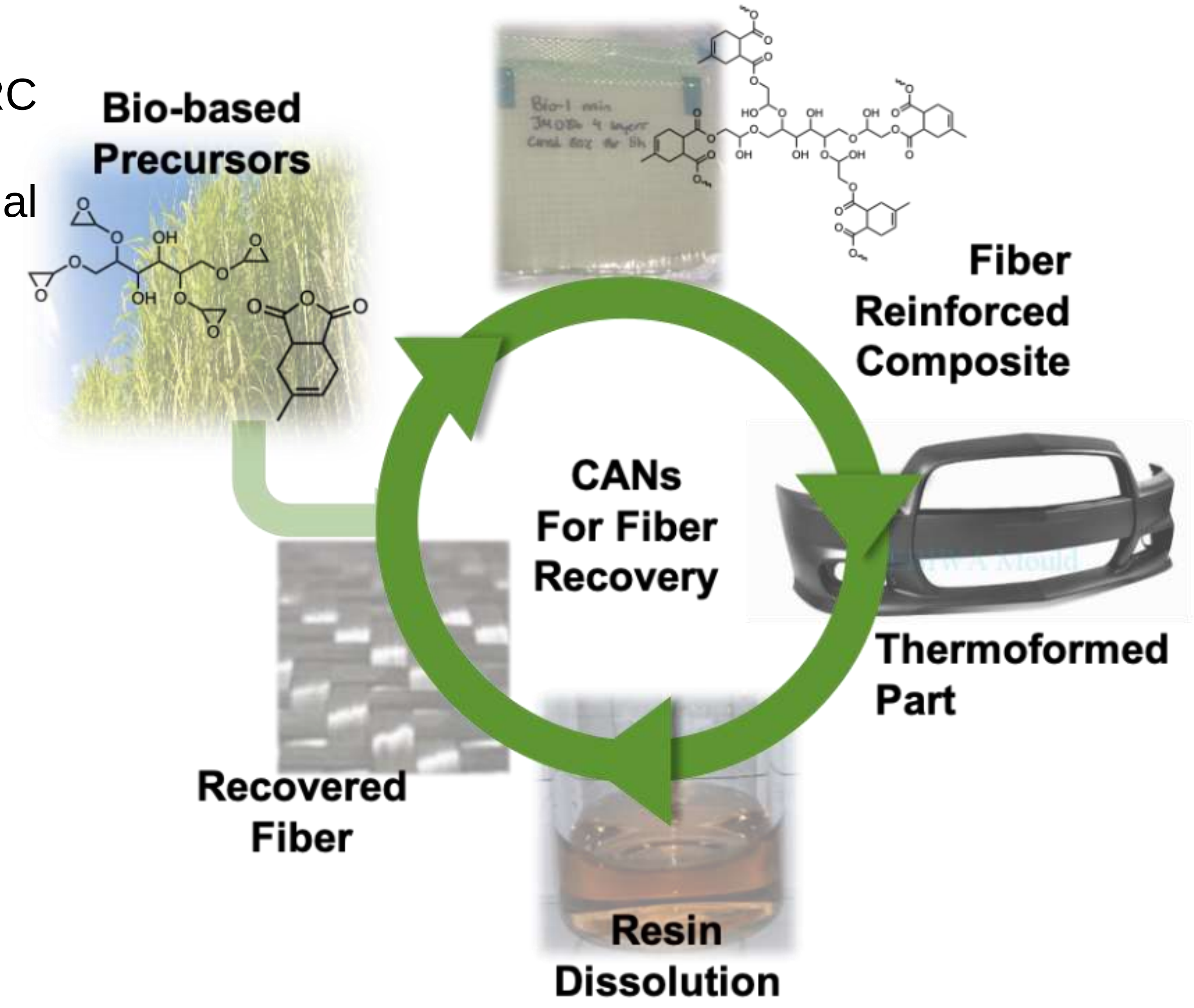
Chemically Recyclable Polymer Composites

Objective

This work aims to produce recyclable by design CFRC that leverage a bio-derivable epoxy-anhydride covalently adaptable network (CAN) for better material and environmental performance

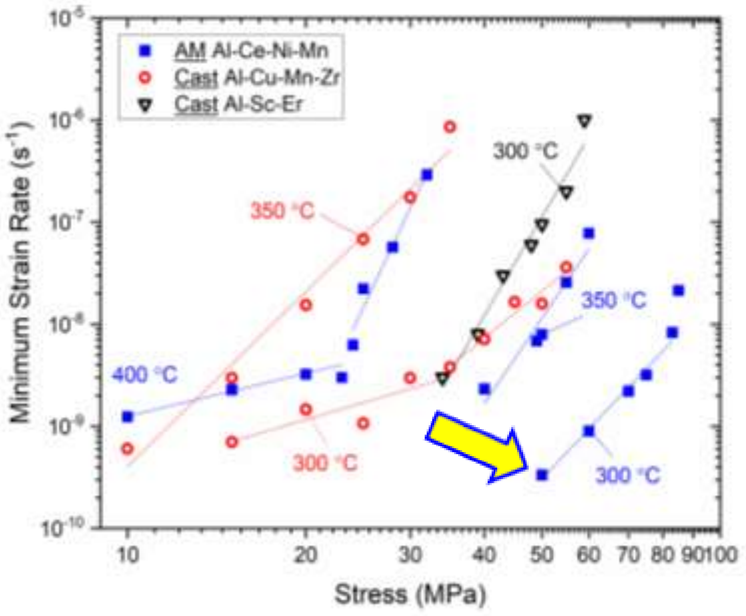
Impact

- Carbon fiber reinforced composites (CFRCs) can light-weight vehicle parts up to 60-70%, but the cost of carbon fiber (CF) remains very high and CFRCs can undergo mechanical failure due to brittleness
- By developing resins that can undergo exchange reactions, CFs can be recycled and thermomechanical properties can be modulated
- By leveraging biobased starting blocks, this work has the potential to decarbonize the processes associated with vehicle part manufacture, especially in the second+ life of materials

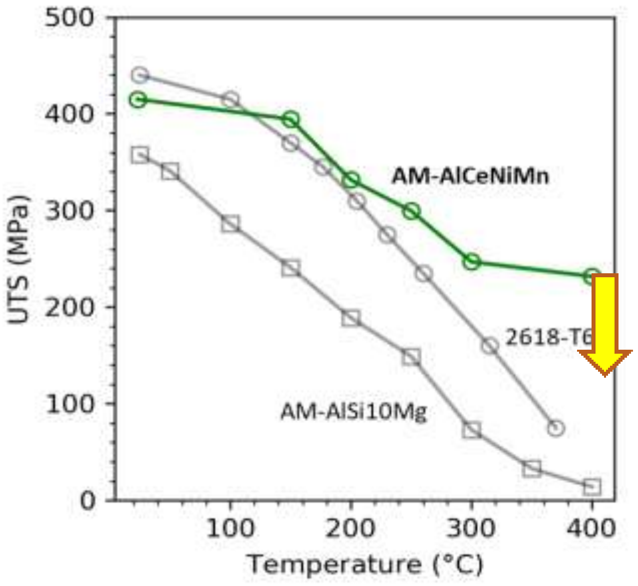


The Powertrain Materials Core Program is developing new alloys with remarkable properties

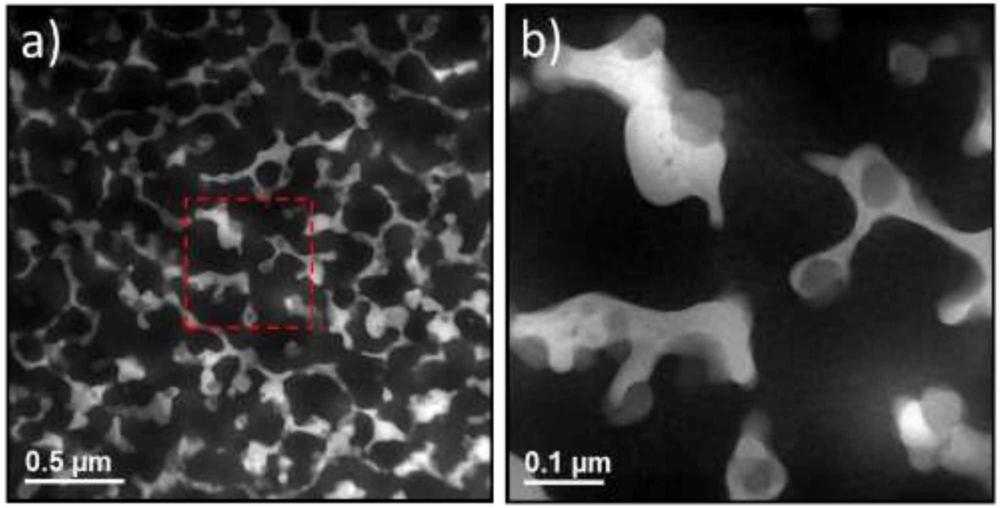
- Properties are enabled by the rapid solidification rates in metal additive manufacturing, which result in formation of a nano-scale distribution of thermally stable intermetallic phases
- **New understanding in alloy development will now be applied to thermal, electrical, magnetic & mechanical properties targeted for future, lighter EV powertrains**



AM AlCeNiMn creep rates (300-400°C) compared to high-performance Al castings



Significant improvement in tensile strength over existing AM & wrought alloys to 400°C



Remarkable AM properties are driven by a nano-scale dispersion of non-equilibrium but stable intermetallic particles (shown through HAADF STEM microscopy)

For more info, attend our track sessions

June 22

- MAT I: MMJ, Automotive Metals, and Propulsion Materials
  - 10 am – 6:50 pm
- MAT II: Carbon Fiber and Composites
  10 am – 6:50 pm

June 23

- MAT I: MMJ, Automotive Metals, and Propulsion Materials
  - 10 am – 6:50 pm
- MAT II: Carbon Fiber and Composites
  10 am – 5:15 pm

June 24

- MAT I: MMJ, Automotive Metals, and Propulsion Materials
  - 10 am – 5:15 pm

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OVERVIEW | ADVANCED ENGINE AND FUELS R&D

GURPREET SINGH
Program Manager, Vehicle Technologies Office

June 21, 2021

Who We Are

Gurpreet Singh

Program Manager

Ken Howden

SuperTruck, ATP

Siddiq Khan

Emission Control

Kevin Stork

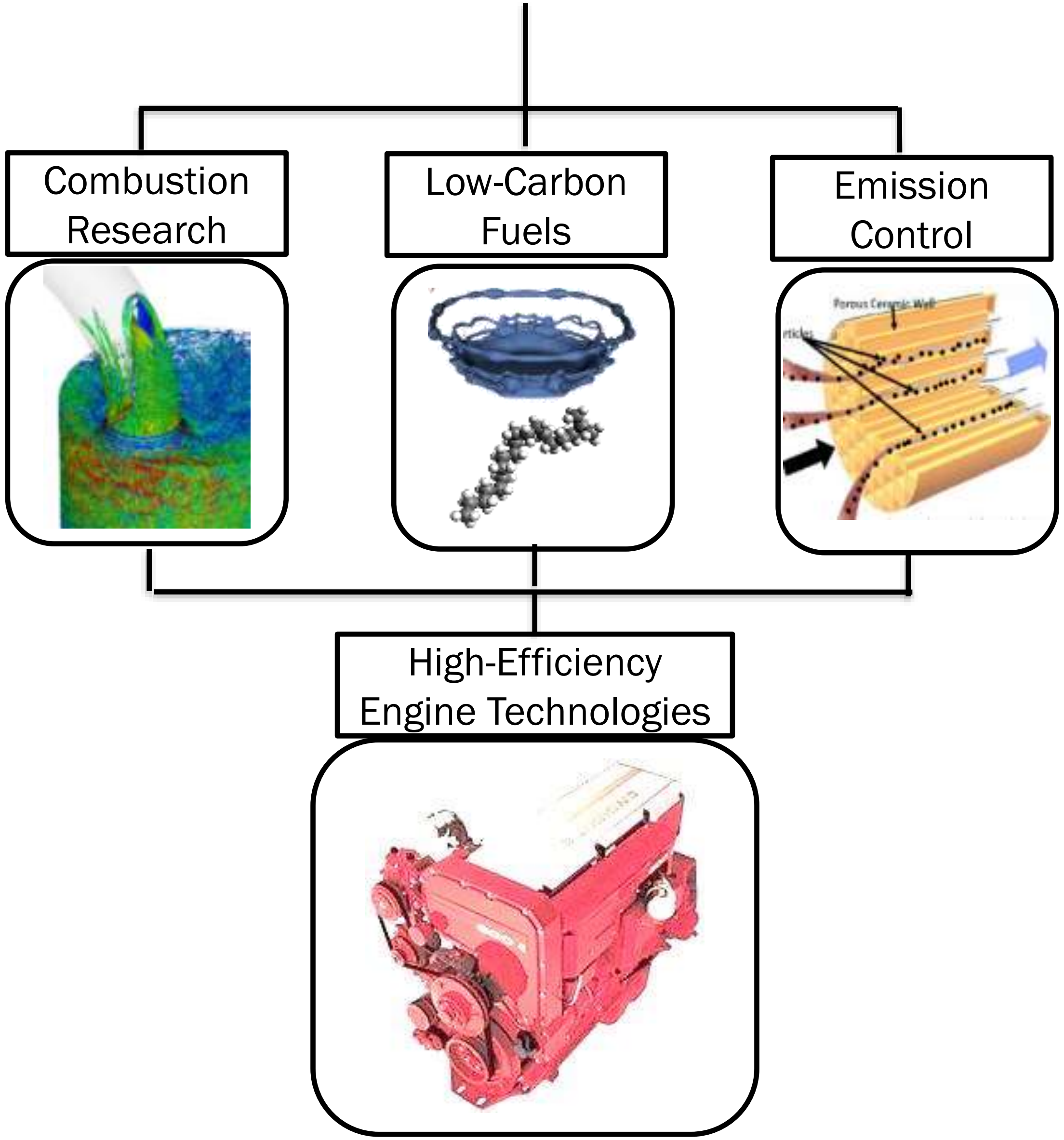
Fuel Technologies

Michael Weismiller

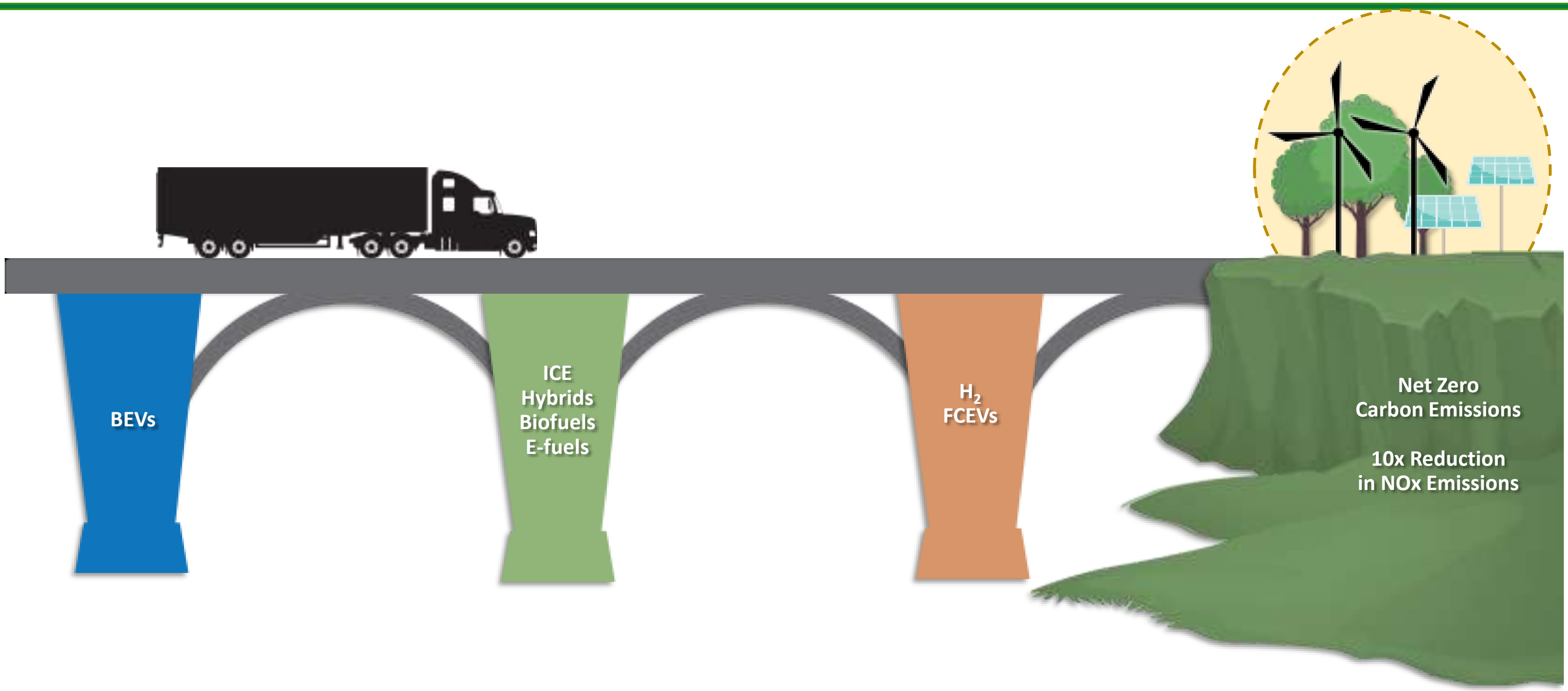
Combustion, Off-Road Vehicles

Advanced Engine and Fuels R&D

- Efficient engines for medium- and heavy-duty on-road trucks, off-road vehicles, rail, marine and aviation
- Renewable fuels, such as advanced biofuels, hydrogen, and e-fuels, to reduce GHGs, and
- Emission control technologies to reduce criteria emissions to near-zero levels.



Future Directions for MD/HD Transportation

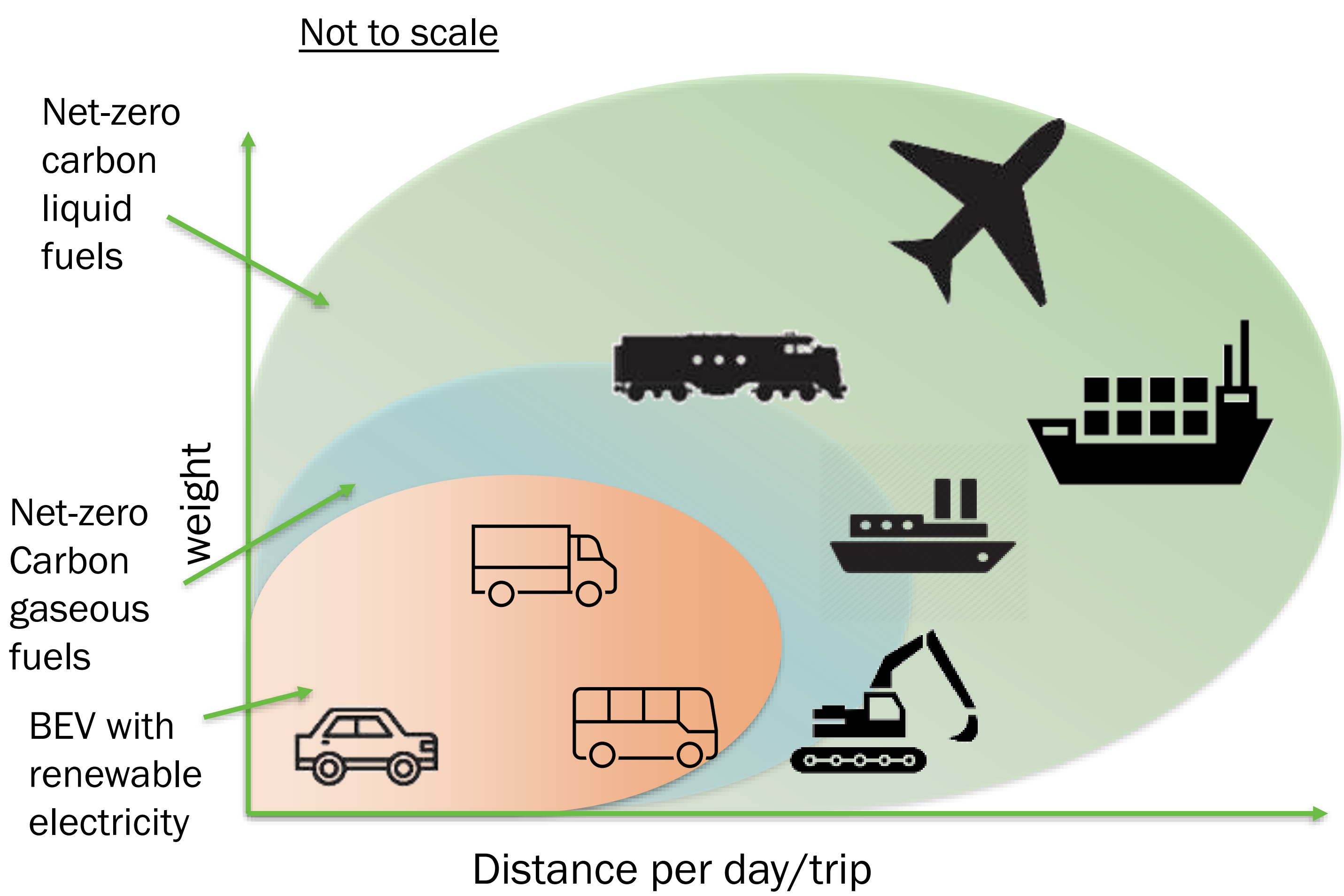


"The bridge to zero emissions will include a mix of powertrain technologies that use low carbon and renewable fueled ICE hybrids, fuel cell hybrids, and battery electric powertrains"
- Wayne Eckerle, Cummins VP of Research and Technology, CRC Workshop, Oct. 2020

- Improve engine efficiency and reduce GHG and criteria emissions using low-carbon and renewable fuels
- Develop simulation tools using HPC and experimental data to expedite market penetration of advanced gasoline and diesel engines
- Develop hybrid-optimized engines for appropriate applications

Increase Focus on Sectors with the Most Barriers to Electrification

- **Aviation and large marine likely to require liquid fuels**
- **Liquid or gaseous fuels could play a role in inland marine, long-haul locomotive, and off-road vehicles**
- **Unique challenges that are distinct from on-road**
  - Experiments are expensive and difficult → need for predictive simulations of combustion and emission control technologies
  - Ability to virtually screen net-zero carbon fuels
  - Variety of applications and duty-cycles adds complexity
- **Expand off-road projects with industry**



Other dimensions: duty-cycle, availability of charging, durability requirements

High Efficiency, Low Mass Engines: Light- and Medium-Duty Trucks

- **Ford** is developing an engine that will achieve 23% fuel economy improvement and 15% weight reduction relative to a 2016MY 3.5L V6 EcoBoost F150 baseline.
- **Impact:** Technologies investigated in this project will reduce CO_2 emissions of the highest production volume powertrains found in light-duty vehicles.

- **General Motors** is developing a medium-duty truck engine capable of ≥10% fuel economy improvement and ≥15% engine weight reduction relative to a 2015 L96 VORTEC 6.0L V8 engine.
- **Impact:** Technologies developed and demonstrate in this project will help bridge the technology gap between light- and medium-duty engines.

SuperTruck 2

Objective: Demonstrate 55% engine brake thermal efficiency (BTE), and greater than 100% improvement in freight efficiency (ton-mpg)

- **Cummins-Peterbilt team recently demonstrated 55% engine BTE and will demonstrate freight efficiency target in 2022**
- **Daimler, Navistar, Volvo and PACCAR teams will demonstrate engine BTE and vehicle freight efficiency targets in 2021-2022**

Volvo SuperTruck 2 Concept

For more info, attend our track sessions – ACE & FT

June 22

- 10:00-6:30pm: Partnership for Advanced Combustion Engines (PACE)

June 23

- 10:00-6.30pm: Emission Control

June 24

- 10:00-12:30pm: Off-road Vehicles
- 1:40-3:10pm: Light- and Medium-Duty Engines
- 3:45-6:35pm SuperTruck 2

June 24

- 10:00 -4:15pm: Co-Optima
- 4:15-5:00pm: Propane Engines

2021 Vehicle Technologies Office Annual Merit Review Awards

Distinguished Achievement Awards

Distinguished Achievement Award

JUN KIKUCHI

Ford Motor Company

For outstanding leadership of the US DRIVE EETT and insightful expertise and contributions to research efforts, plans, and future priorities

Distinguished Achievement Award

BURAK OZPINECI

Oak Ridge National Laboratory

For many years of outstanding expertise and leadership to the VTO Electric Drive Technologies research, planning, and collaboration

Distinguished Achievement Award

PROFESSOR XIAODONG (CHRIS) LI

University of Virginia

In recognition of extraordinary expertise in leading alternative precursor R&D via ICME framework to achieve low cost carbon fiber

Team Awards

Team Award

Co-Optima Project Team

In recognition of significant contributions to the development of the science base for fuel and engine technologies

Team Award

Cummins, Inc.

For pioneering research and development in heavy-duty diesel engine technology, demonstrating a breakthrough efficiency of 55 percent

Lifetime Distinguished Achievement Awards

Lifetime Distinguished Achievement Award

RONALD GRAVES

Oak Ridge National Laboratory

In recognition of conceiving and building the automotive research program that is today the National Transportation Research Center at Oak Ridge National Laboratory.

Lifetime Distinguished Achievement Award

In recognition of your significant contributions to the field of chemical kinetics

WILLIAM PITZ

Lawrence Livermore National Laboratory

Lifetime Distinguished Achievement Award

ANN SCHLENKER

Argonne National Laboratory

For tireless leadership, vision, and devotion to advancing efficient vehicle technologies and DOE's sustainable transportation mission

Lifetime Distinguished Achievement Award

DENNIS A. SMITH
U.S. Department of Energy

LINDA BLUESTEIN
U.S. Department of Energy

In appreciation and recognition of valuable contributions to the Vehicle Technologies Office as Director and Co-Director of the Clean Cities program