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TECHNOLOGY AND INNOVATION TO REDUCE ENERGY & TRANSPORTATION COSTS

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ARGONNE'S PROUD HISTORY

Advancing basic science and transforming technology

Unveiling of commemorative plaque at Stagg Field, site of the first controlled nuclear chain reaction, in 1942 at the Manhattan Project's Metallurgical Laboratory at UChicago (Enrico Fermi, second from right)

Founded in 1946 to develop peaceful uses for nuclear energy, operated since then by the University of Chicago

A RICH LEGACY OF "FIRSTS" AND SUSTAINED IMPACT

NUCLEAR POWER since the '40s	**MATERIALS** since the '40s	**PHYSICS** since the '40s
NATIONAL SECURITY since the '40s	**CHEMISTRY** since the '40s	**COMPUTING** since the '50s
ACCELERATORS since the '60s	**MODELING** since the '60s	**TRANSPORTATION** since the '60s
SYSTEMS ANALYSIS since the '70s	**EARTH SCIENCE** since the '70s	**PROTEIN STRUCTURES** since the '90s

WORLD-LEADING RESEARCH AT SCALE

Argonne at a glance in FY24

$1.2B
budget

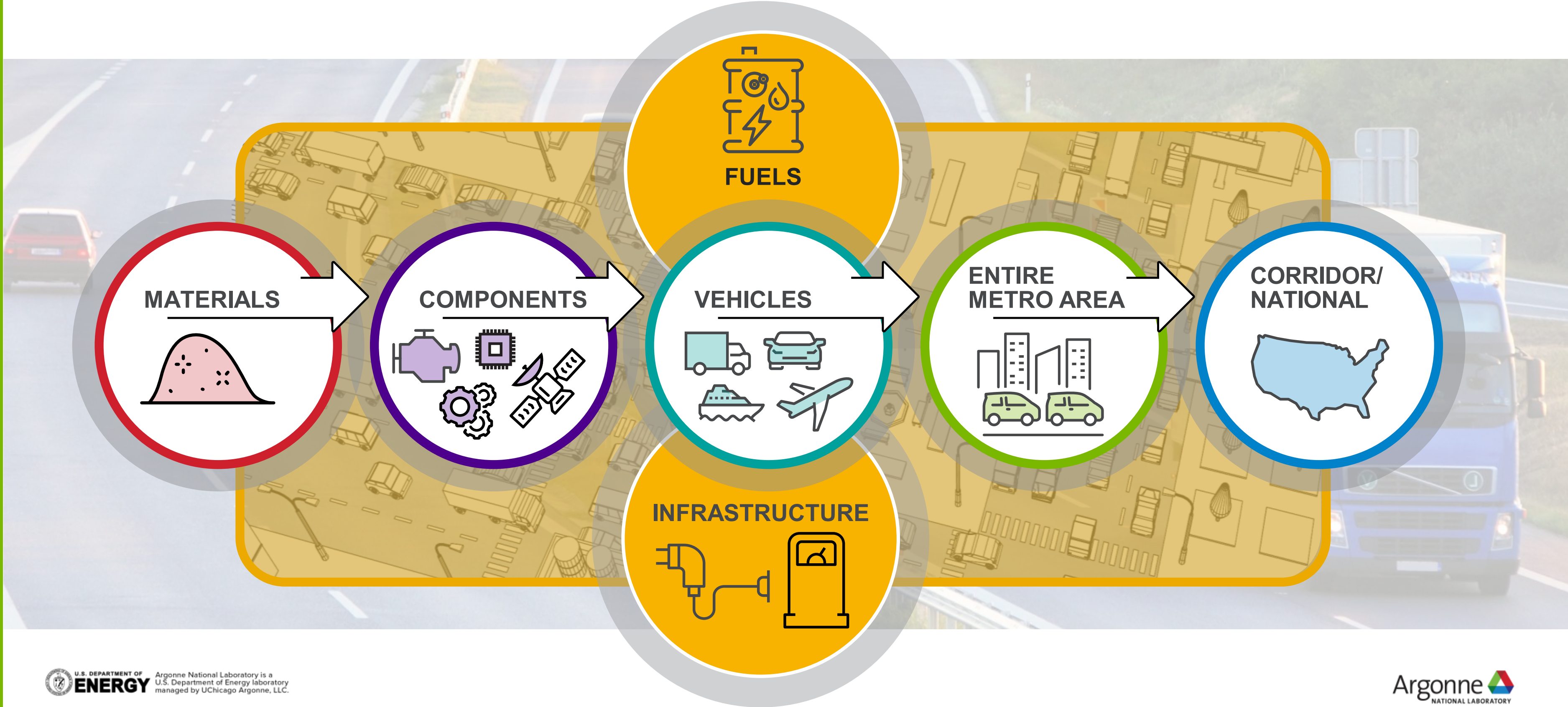
3770+
employees, with ~1900 S&T staff

3000+
research publications

1200+
college interns

60+
new patents

TRANSPORTATION RESEARCH AT EVERY SCALE



MARITIME ACTION PLAN

Multi-lab team formed to examine marine biofuel potential opportunities

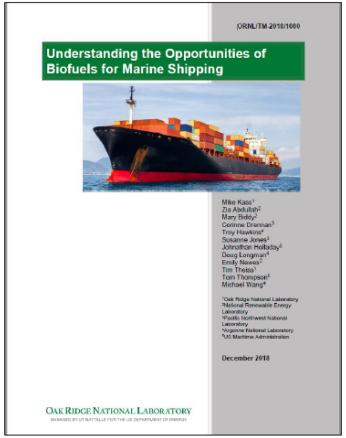
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Argonne
NATIONAL LABORATORY

OAK RIDGE
National Laboratory

Pacific Northwest
NATIONAL LABORATORY

- Initial motivation driven by potential of bio-intermediates to reduce sulfur emissions from 2-stroke marine engines
- Outcome: Publication describing the opportunities for biofuels for marine shipping was distributed to DOT Maritime Administration (MARAD) and industry
  – *This served as the basis for the current project*
- DOE Bioenergy Technologies Office (BETO) initiated a project to evaluate the viability of biofuels in the maritime sector
- Lab Roles:
  – **ORNL**: project lead & engine/emissions expertise
  – **NREL**: Catalytic fast pyrolysis (CFP) oil production & technoeconomic analysis
  – **PNNL**: Hydrothermal liquefaction oil production & technoeconomic analysis
  – **ANL**: life-cycle, scale-up analysis & engine expertise



ORNL/TM-2018/1080

Understanding the Opportunities of Biofuels for Marine Shipping

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December 2018

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

OAK RIDGE
National Laboratory

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ACTION PLAN LEADERSHIP

The following individuals were responsible for the overall leadership and visions behind the action plan:

- DOE: Michael Berube, Morgan Ellis
- EPA: Alejandra Nunez, Karl Simon
- DOT: Anne Shikany, Daniel Yuska
- HUD: Alexis Pelosi

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- DOT: Alyson Azzara, Galen Hon, Tyler Clevenger, Marcelo Norsworthy
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The following core team members were responsible for key elements of the writing drafting and editing content and addressing comments made by peer reviewers:

- DOE: Robert Natelson, Anthony Sorbera (Contractor)

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- DOT: Rohemir Ramirez Ballagas
- EPA: Reza Farzaneh, Chris Ramig, Paul Machiele, Aaron Levy, Dallas Burkholder, Michael Samulski
- HUD: Michael Freedberg, Madeleine Parker

AN ACTION PLAN FOR MARITIME ENERGY AND EMISSIONS INNOVATION

December 2024

https://www.energy.gov/sites/default/files/2024-12/doe-eere-modal-reports_maritime-energy-emissions-innovation-action-plan.pdf

MARITIME CAPABILITIES OVERVIEW

Biofuel

▶ Biofuel Viability for the Ocean-Going Marine Sector

- Replacements for heavy fuel oils for large ocean-going vessels
- Techno-economic, life cycle and technical feasibility of biofuels.
- Onboard testing effectiveness of treatment methods

Combustion

2-Stroke EMD 1-710 (11.6L) Engine

▶ Increase Fuel and Engine Efficiency

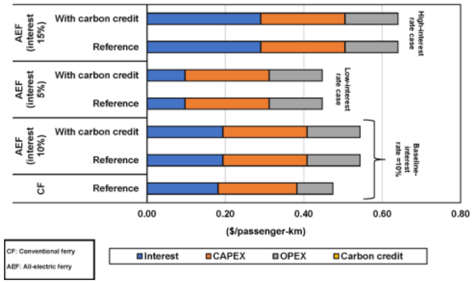
- Engine test facility (dual-fuel)
- Investigate the spray characteristics of the Very Low Sulfur Fuel Oil and Biofuels
- Conduct fuel spray characterization tests on fuel blend candidates of VLSFO/Biofuel
- Engine CFD from fuel spray to criteria pollutants

Vessel Design

▶ Improve Energy Consumption / Reduce Vessel Cost

- Advanced powertrains (conv, HEVs, PHEVs, BEVs…)
- Advanced component technologies
- Total cost of ownership
- Numerous vessel applications (e.g., ferry, tug boat, container ships, bulk carrier…)

Vessel Usage



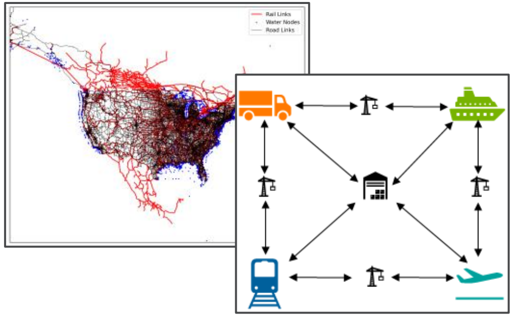
Vessel electrification

▶ Improve Energy Consumption / Reduce Operating Cost

- Total cost of ownership (TCO)
- Impact at system level (e.g., port infrastructure)
- Energy safety / risks

MARITIME CAPABILITIES OVERVIEW

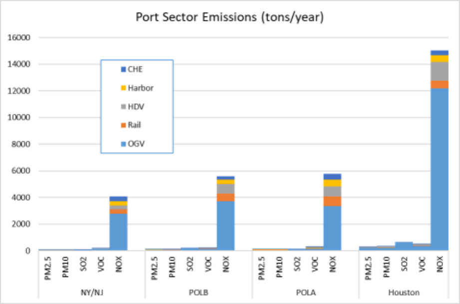
Port Operations & Intermodal Network



▶ System Level Analysis

- Port operations (e.g., vehicles…)
- Intermodel connections (waterway-highway/railway; highway-railway)
- Ports and commodity flows
- Mode shifts across marine/road/rail

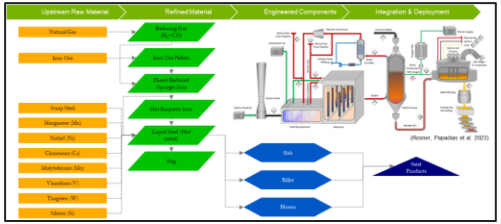
Port Emissions and Health Impact



▶ Marine Footprint calculator

- Data based on EPA Ports Emissions Inventory guidance and GREET
- Ocean going vessels/Harbor craft/Recreational
- Port inventory data analysis at equipment level (off-road, rail, harbor, HDV…)

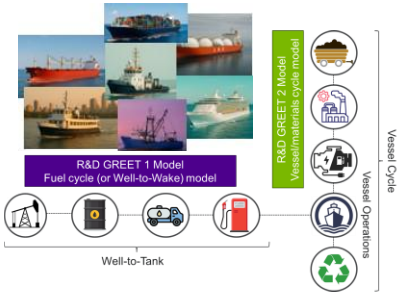
Supply Chain and Shipbuilding



▶ Supply chain & Workforce

- End-to-end supply chain
- Quantify capacity to scale production of assets
- Employment by occupations

Life Cycle Analysis



▶ Life Cycle Energy and Environmental Impacts

- 39+ fuel and 8 electricity pathways
- Expanding to 70 vessels types
- 5 operating modes for 36 routes

COLLABORATION THROUGH CLEAN CITIES AND COMMUNITIES

A DOE Partnership to Foster Transportation Energy Choices Nationwide