

# Grappling with Hard-to-Abate GHG in the US Freight Ecosystem

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**SMOKY**  
  
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Mobility Conference

NOVEMBER 14-17, 2022

# Agenda

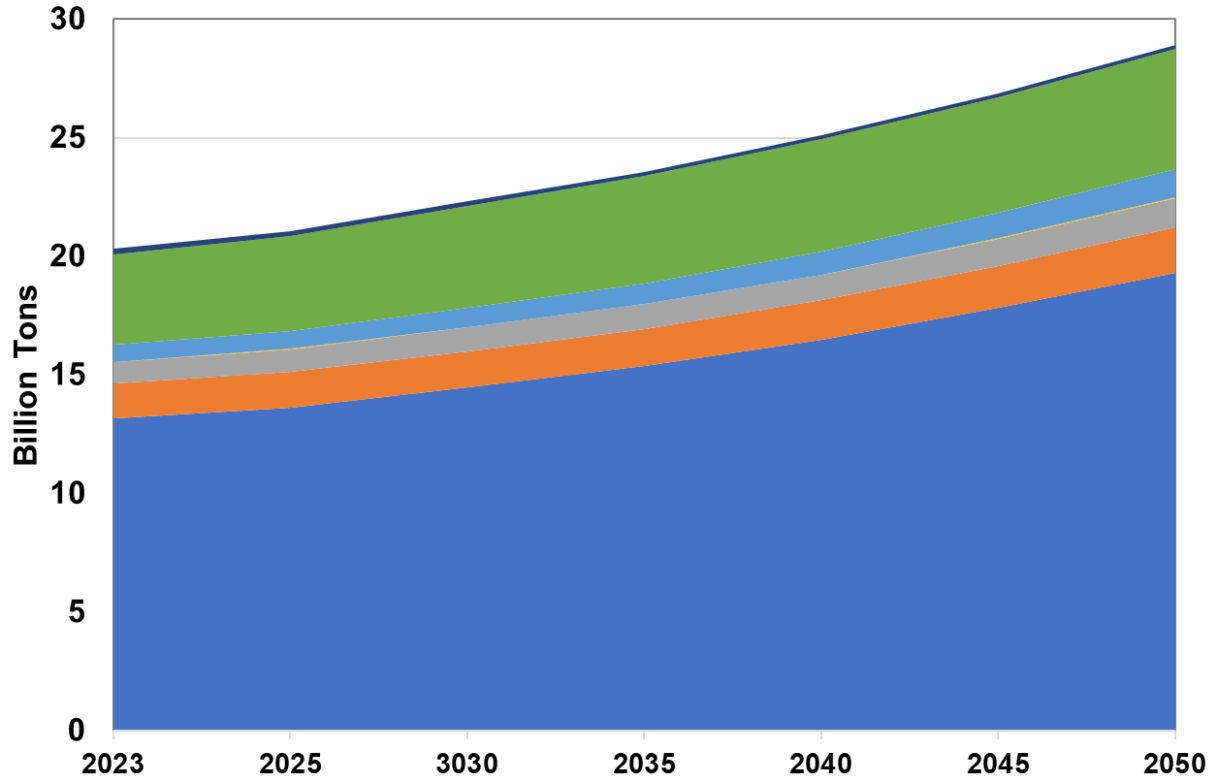
- What do we mean by hard-to-abate in the mobility sector?
- Contributing factors in the struggle to reduce GHG in US freight movement
- An Industry Perspective / Analysis
  - Can bioenergy save the day?
- Refining our Strategy and Execution
  - Bridging the gaps for sustainable technology adoption
- Call to Action
  - Going the distance!



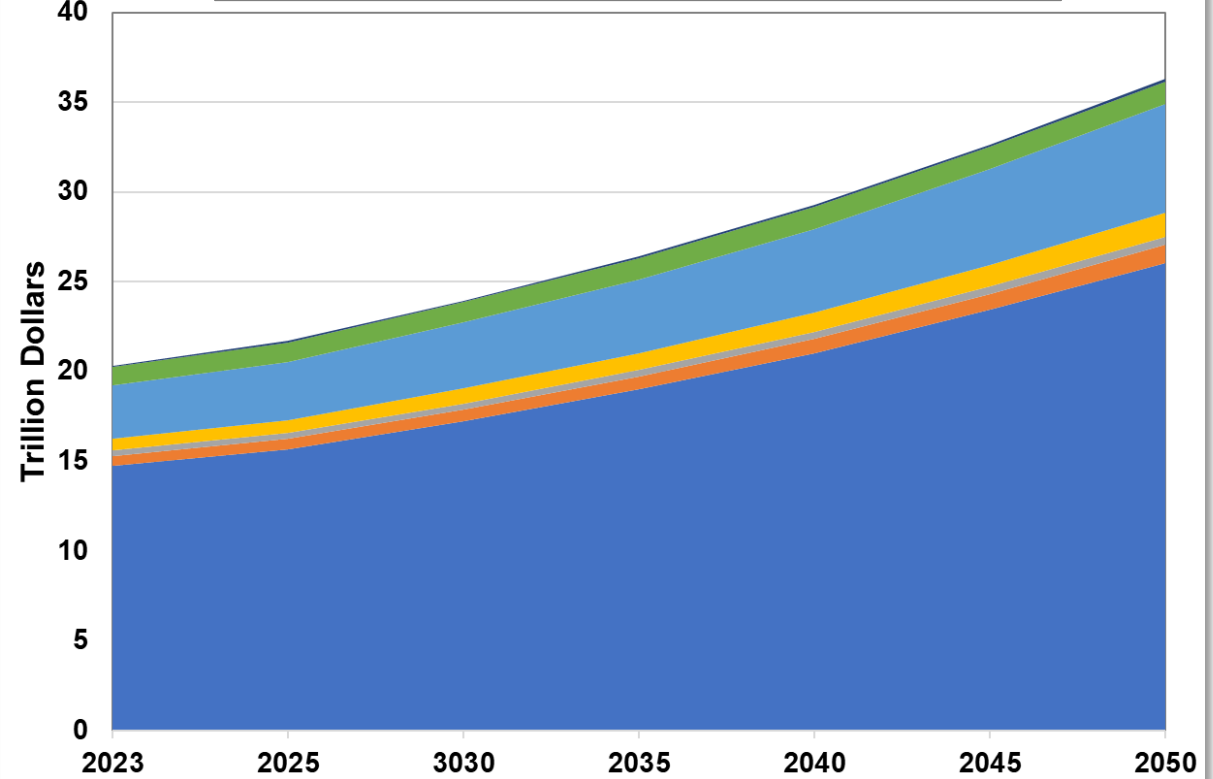
# Hard-to-abate GHG is focused on the future of *freight movement*

■ Truck ■ Rail ■ Water ■ Air ■ Multiple Modes ■ Pipeline ■ Other

Tons of Freight Shipments : 2023 - 2050



Value of Freight Shipments : 2023 - 2050

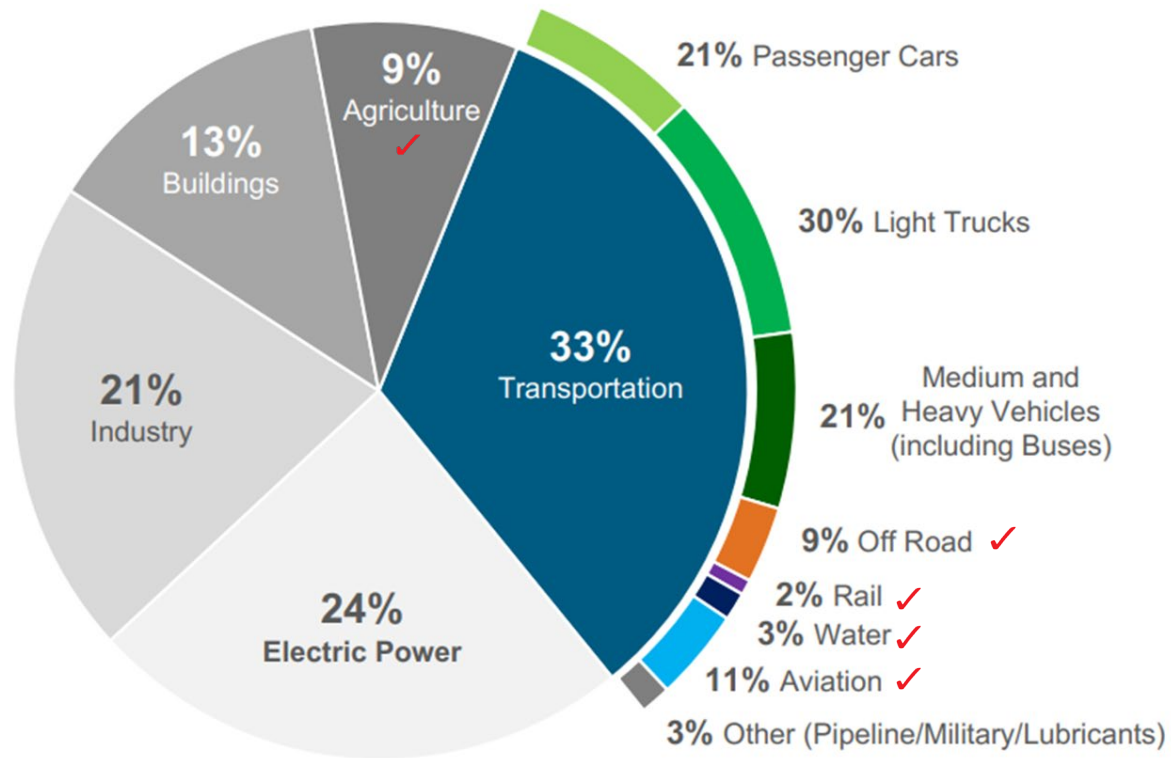


Source: U.S. Department of Transportation Freight Analysis Framework, Version 5.4, developed by Oak Ridge National Laboratory, 2022.

- Global freight demand expected to triple between 2015 and 2050 (International Transport Forum, 2019)
- Freight-related carbon dioxide emissions are projected to more than double, even accounting for already announced mitigation strategies (International Transport Forum, 2019)

# What are hard-to-abate transportation segments?

## 2019 U.S. GHG Emissions



Aviation and water include emissions from international bunker fuels.  
Fractions may not add up to 100% due to rounding.

Source: U.S. Department of Energy

- Segments typically identify as hard to abate:
  - Off-Road
  - Rail
  - Marine (Water)
  - Aviation
  - Agriculture
- **Caution** – these application segments are not monolithic as “hard or easy” to abate (e.g., heavy haul on-road trucks)
- Application segments have tremendous variation in machinery and use cases
- Bioenergy will play an enormous role in GHG reduction

# GHG abatement from freight movement remains a hardy perennial due to a mix of technology, business, and policy challenges

- Higher *upfront costs* for sustainable solutions even when the total cost of ownership is lower.
- Scalability, range, and weight remain technical barriers
- Displacing incumbent fossil fuels requires enormous investments in research and development to create *economies of scale* and *product energy efficiency*
- Delayed adoption of sustainable solutions attributed to *long asset replacement cycles*
- Development, production and adoption of sustainable solutions further delayed by uncertainty around the supply and demand for *alternative fuels* and *alternative fuel propulsion systems*



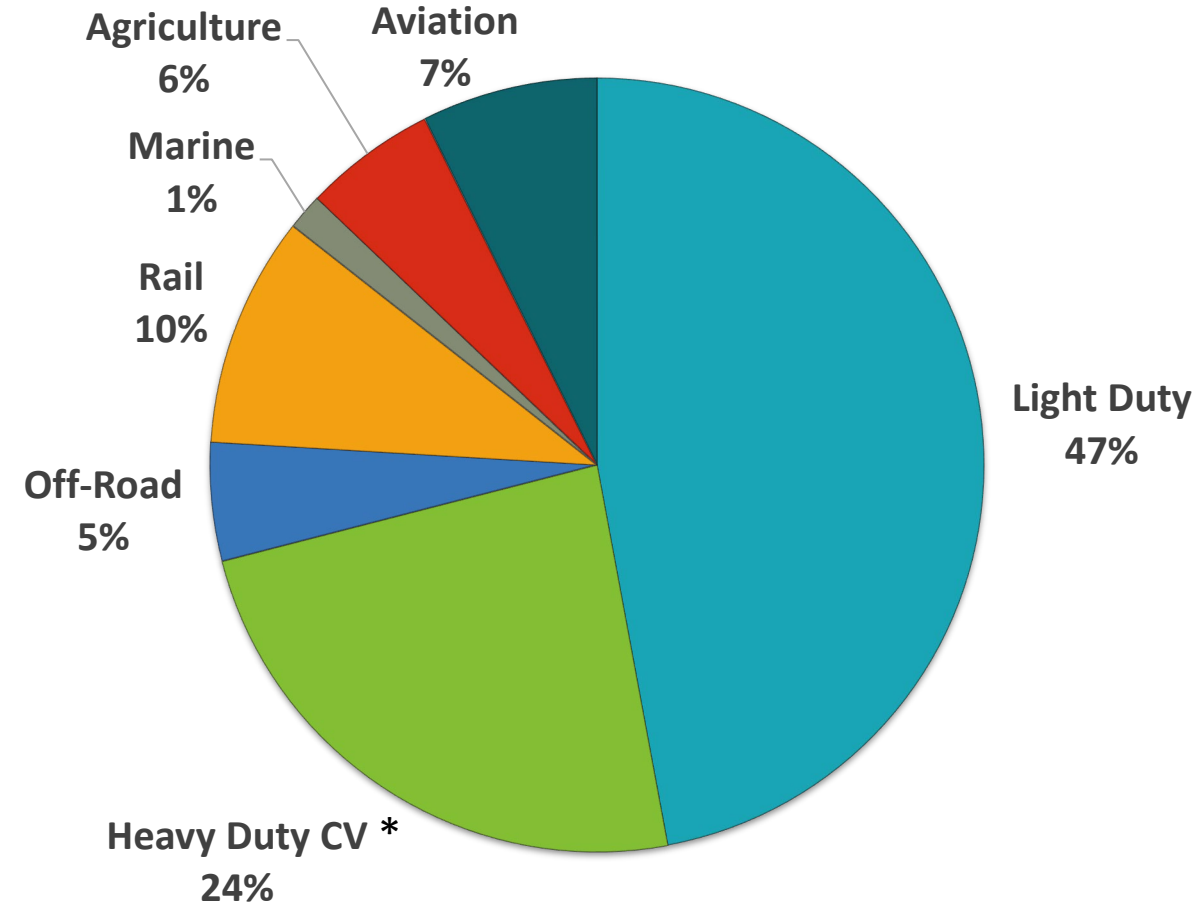
# Capturing a view from industry

- Why? *Help identify and close gaps between industry and government agencies to drive critical research, demonstration and deployment for hard to abate transportation*
- Conducting analysis based on input from industry business and technical leaders in the hard-to-abate transportation sectors to answer key questions?
  - 21 individuals in the energy production sector (US and EU)
  - 80+ end users in off-road, rail, marine, agriculture, aviation and on-road heavy duty truck
  - OEMs across all segments
- Important elements
  - Technology readiness (infrastructure, processing, propulsion, etc.)
  - Business models covering breadth of freight movement / business innovation / modal shifts / import-export of fuels
  - Assessment against battery electric and hydrogen propulsion systems
  - Evolution in regulatory framework for FE, GHG, and criteria emissions
  - Option to submit information at various degrees of anonymity
- Limited exploration of policy scenarios

## Key Perspective from Industry Analysis

# 2035 Renewable / Bio Transportation Liquid Fuels Consumed

	Quantity B GGE
Total Renewable/Bio Liquid Fuels Consumed	21.8
Min Consumed	14.6
Max Consumed	24.2
Consumed by Transportation	15.5 (71% of total)





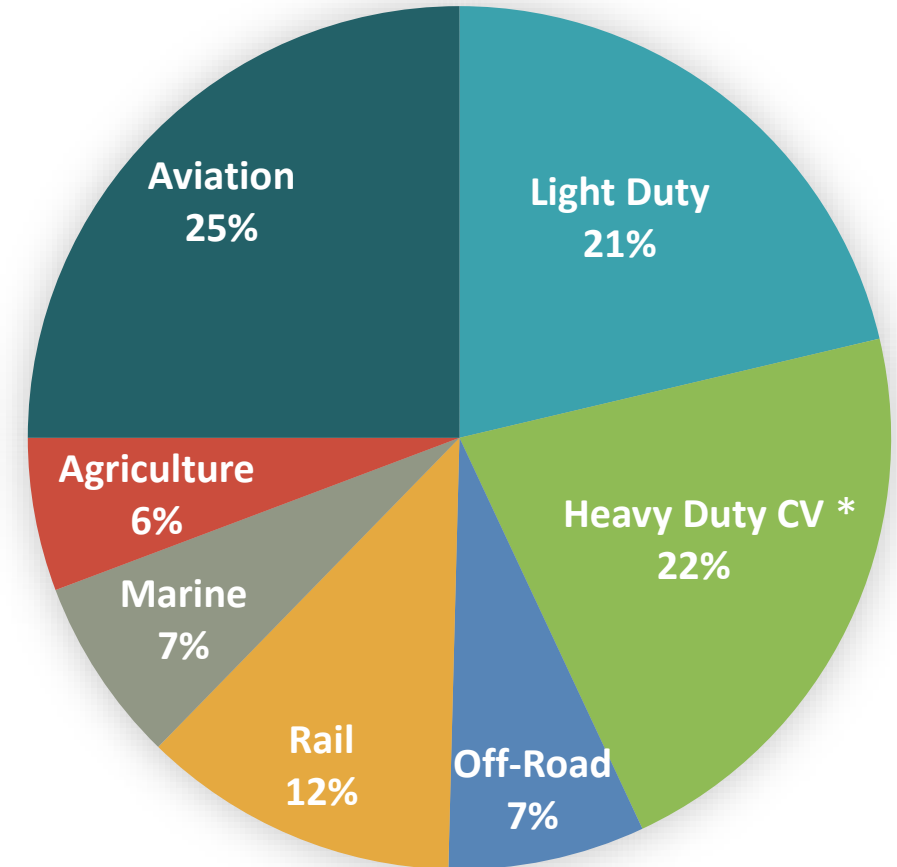
# Insights for 2035 Assessment

- Strong growth in renewable diesel with increased imports from Asia and modest growth in biodiesel and ethanol
- On-road GHG, LCFS, and RFS regulations will drive demand. The amount of sustainable diesel (renewable and bio) will not meet the hard-to-abate HD CV market segments (3.7 B GGE vs a need for 8-11 B GGE)
- Agriculture sees increase consumption in locally available biodiesel and ethanol
- No clear demand signal from off-road markets coupled with uncertainty in GHG regulations hamper consumption of lower carbon fuels
- International aviation and marine markets are sending stronger demand signals, but international lower carbon fuel demand will limit availability
- Long asset replacement cycles dampen the consumption of biofuels in marine
- Top 2 concerns for every market is reliability and asset utilization – can lower carbon fuels be harnessed without sacrificing these product attributes?

## Key Perspective from Industry Analysis

# 2045 Renewable / Bio Transportation Liquid Fuels Consumed

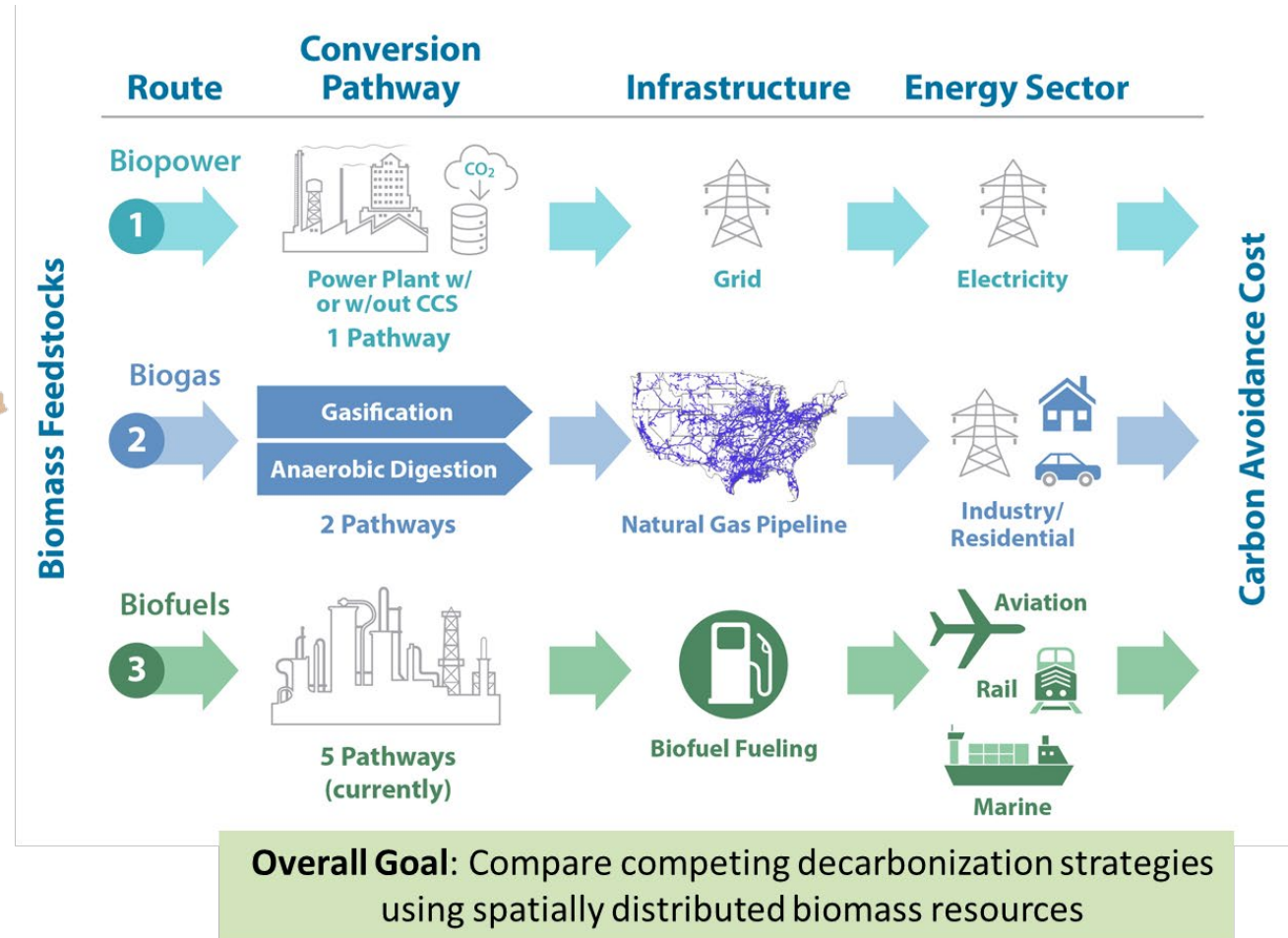
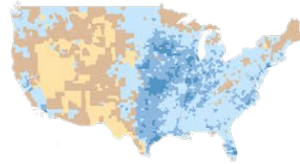
	Quantity B GGE
Total Renewable/Bio Liquid Fuels Consumed	38.4 (~62% of DoE 2050 BTB)
Min Consumed	26.3
Max Consumed	44.7
Consumed by Transportation	26.1 (68% of total)



\* 7-10 B GGE fuel demand for HD CV hard to abate

# DoE lab network taking action to address hard-to-abate *non-road* sectors

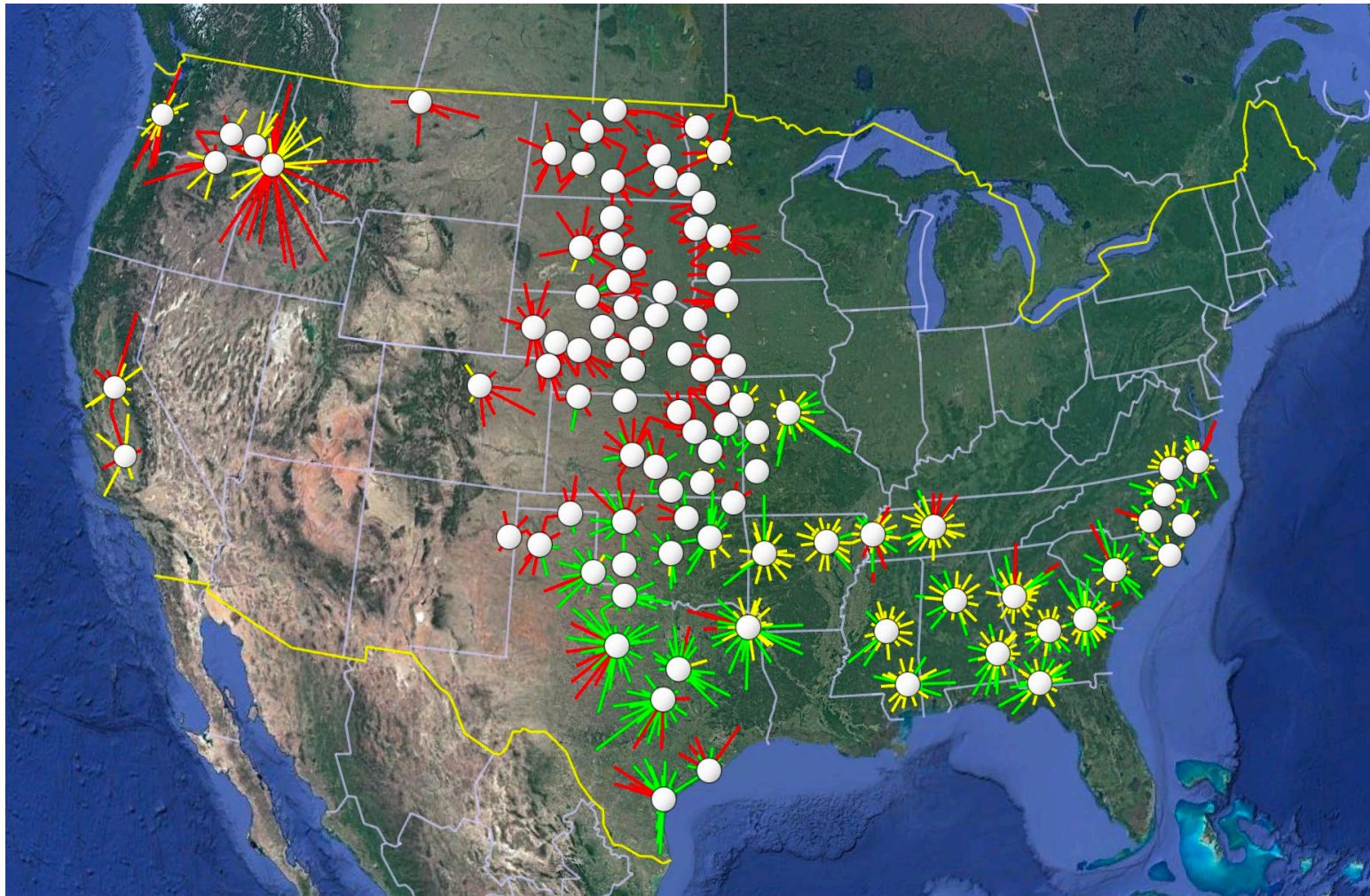
- Identify the *optimal vehicle and fuel decarbonization pathways*
- Developing and exercising a flexible, integrated data and analysis framework to rapidly screen scenarios
- Active engagement with stakeholders is essential for success (industry, national labs, academia, and federal agencies)



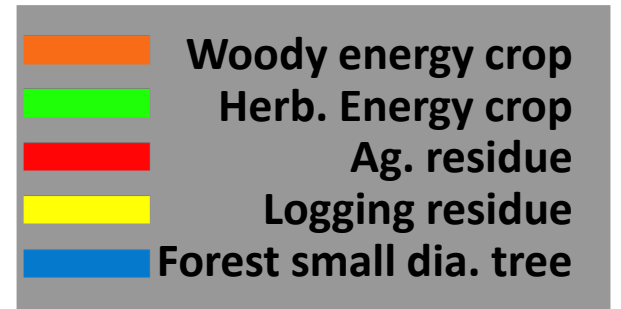
Courtesy: Tim Theiss, Oak Ridge National Lab (Best Uses of Biomass for Energy-Sector Decarbonization)

With or without carbon sequestration at the conversion facility

# When Soil Organic Carbon (SOC) is considered, a shift in feedstock used and plant locations occurs

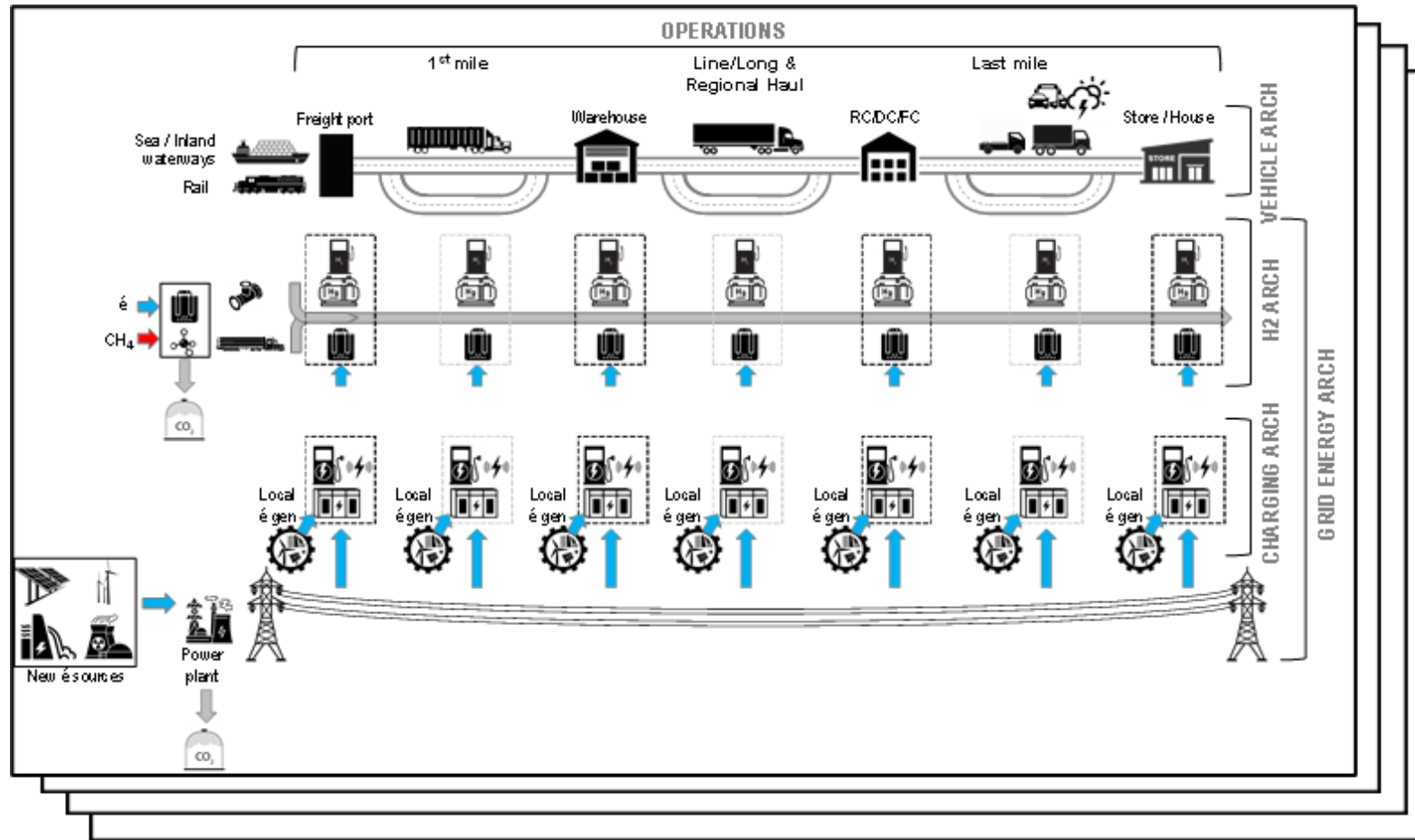


Courtesy: Tim Theiss, Oak Ridge National Lab  
(Best Uses of Biomass for Energy-Sector  
Decarbonization)



Length of star line is distance transported from centroid of county level biomass.  
Color denotes feedstock type transported

# Addition of Non-road applications to the freight movement ecosystem to address hard-to-abate GHG transpiration sectors



Regional specific to accurately represent real world scenarios including freight movement, energy infrastructure, operational characteristics, and local constraints

Courtesy: Vivek Sujan, Oak Ridge National Lab

# Call to Action

- Global freight demand expected to triple between 2015 and 2050\*
- Freight-related carbon dioxide emissions are projected to more than double, even accounting for already announced mitigation strategies\*
- DoE can facilitate outreach across offices and numerous stakeholders within the US freight ecosystem and will be critical in providing technology and economic analysis of decarbonization pathways
- Awareness of DoE project opportunities and data sharing can help the hard-to-abate sectors reduce GHG more quickly and collectively
- DoE's role is critical for researching and demonstrating customized solutions that match fuel types to propulsion systems and operational strategies to site-specific requirements and resources.
- Industry engagement is the linchpin to see impactful results

\* Source: International Transport Forum, 2019