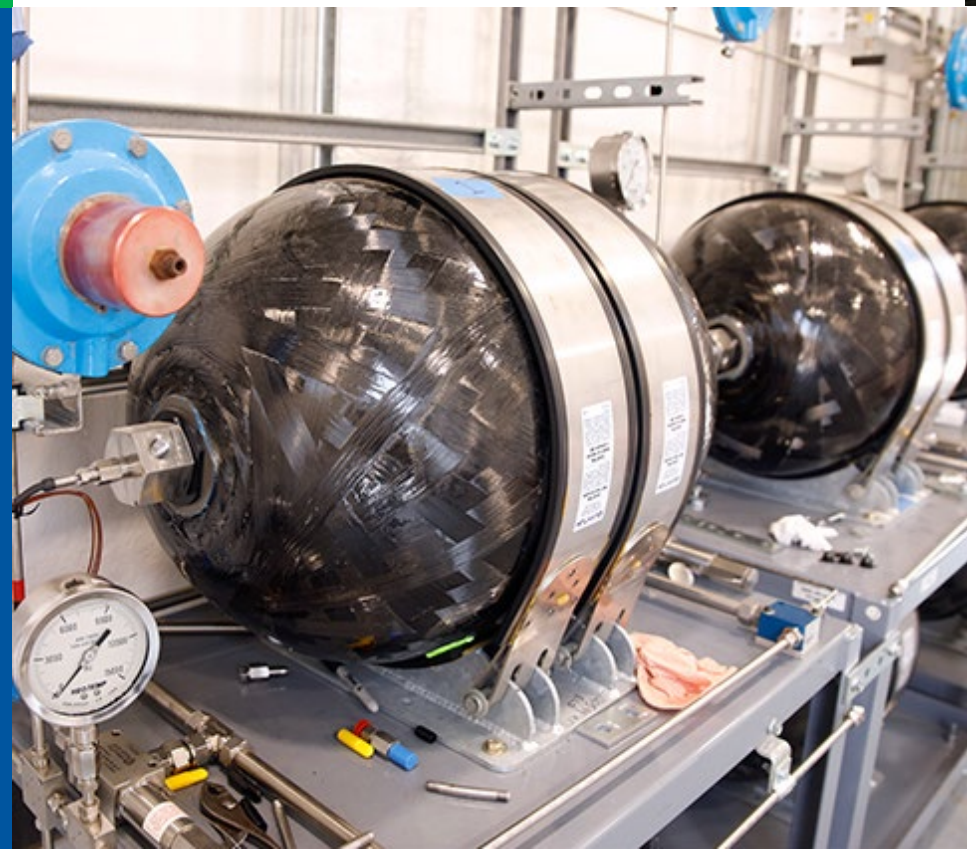
GTI ENERGY

solutions that transform



DOE Natural Gas Listening Sessions Review

Ted Barnes, GTI Energy, Sr. Director – Mobility

tbarnes@gti.energy

We develop, scale and deploy solutions in the transition to low-carbon, low-cost energy systems

GTI ENERGY

SOURCE MAKE MOVE STORE USE

500 Enterprise Employees

TOP WORK PLACES 2019 Chicago Tribune

TOP WORK PLACES 2020 Chicago Tribune

TOP WORK PLACES 2021 Chicago Tribune

TOP WORK PLACES 2022 Chicago Tribune

We work collaboratively to address critical energy challenges impacting gases, liquids, efficiency and infrastructure

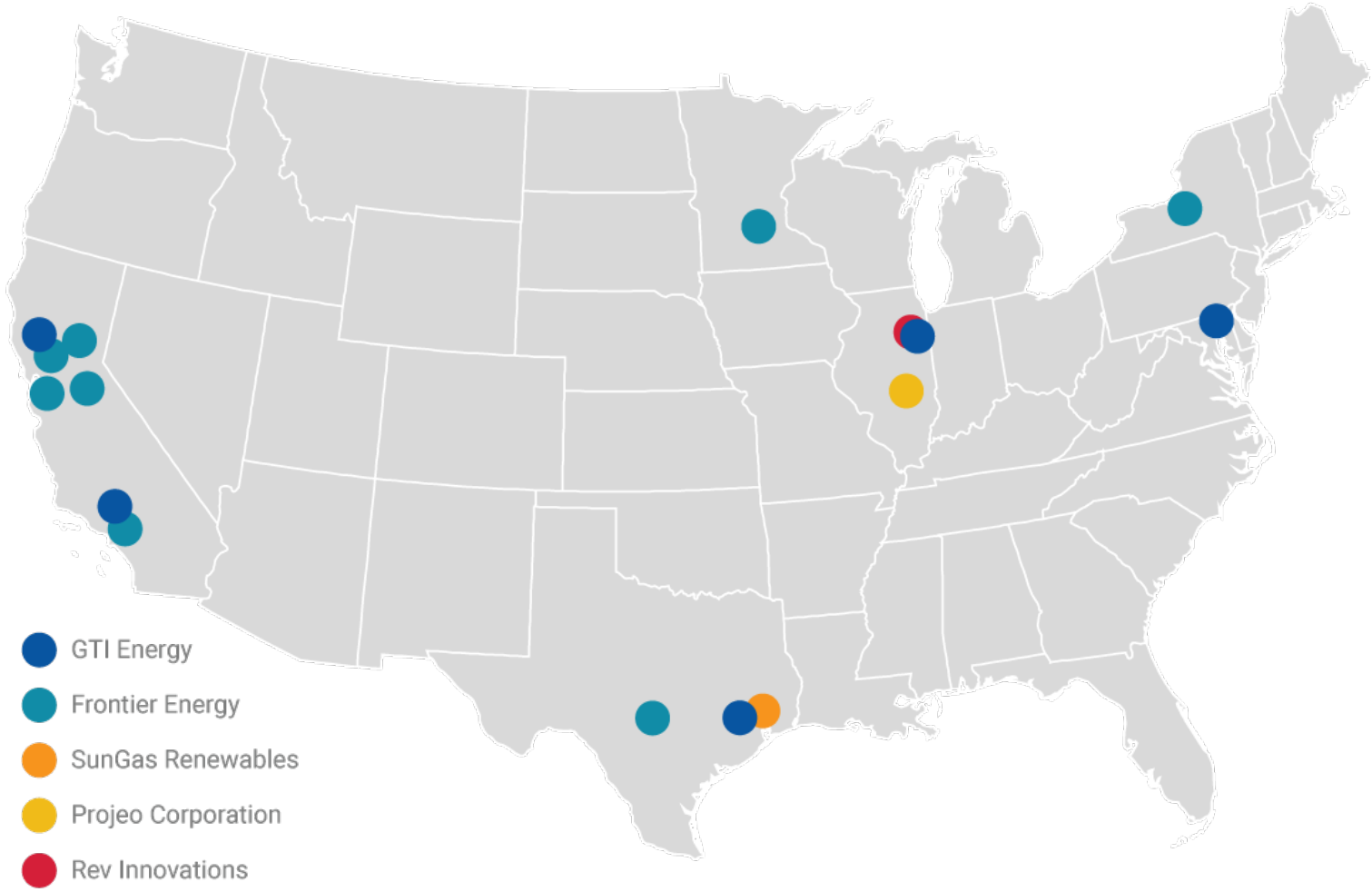
OTD Operations Technology Development

UTD Utilization Technology Development

ETP Emerging Technology Program

LCRI LOW-CARBON RESOURCES INITIATIVE

Our office locations



GTI Energy – Main Campus

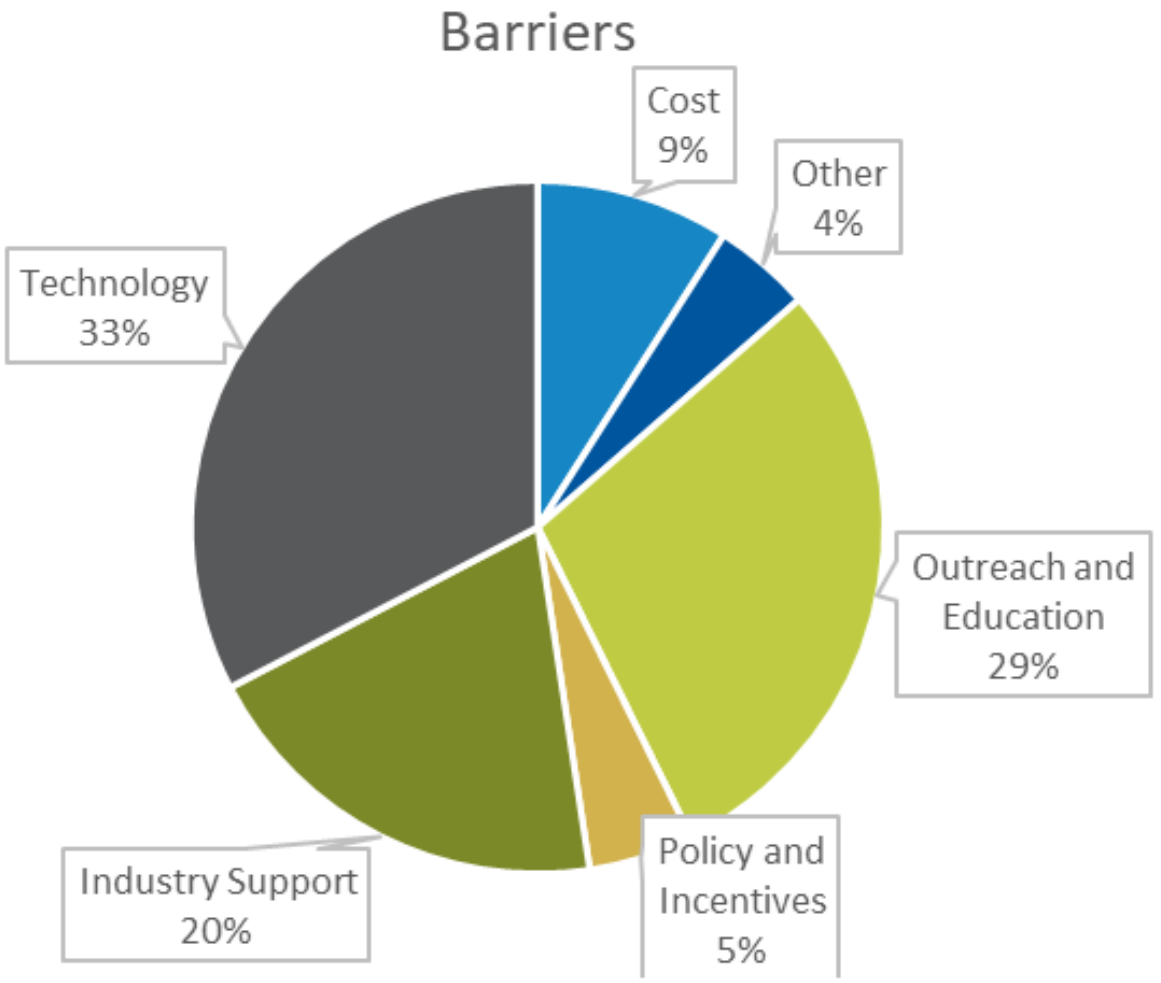
CNG Listening Sessions - Methodology

"…organize and facilitate fuel and/or technology-specific listening sessions with fleets and other stakeholders to identify technology gaps and critical research needs to improve vehicle/infrastructure performance and usability."

- Clean Cities Directors held ~60 listening sessions with stakeholders
  - –Conducted over 5 years (2018-2022)
- Over 1,000 comments received and analyzed by GTI Energy
- Identified ~50 distinct barriers to adoption

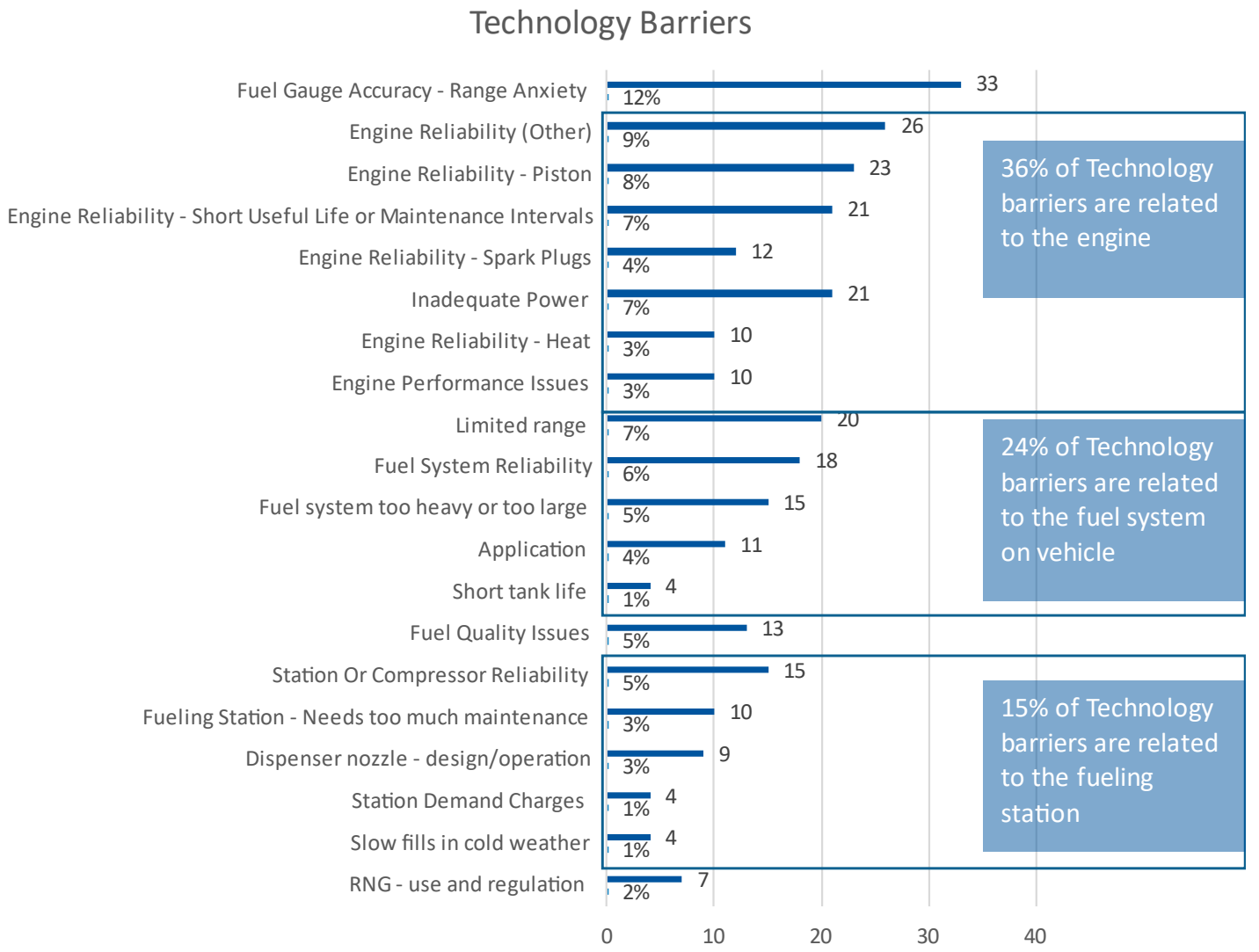
Key Barriers

- **Technology**
- **Outreach and Education**
- Industry Support
- Cost
- Policy and Incentives
- Other



Technology Barriers – Complaints/Key Topics

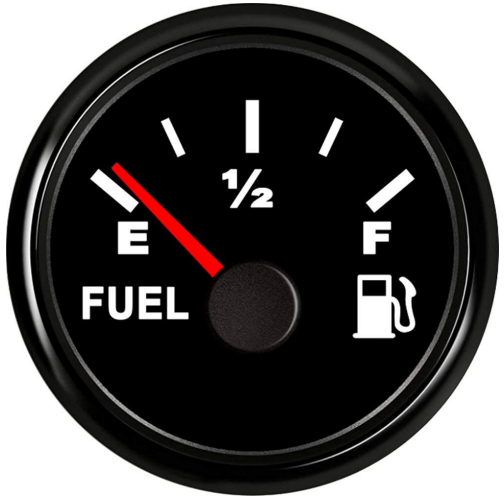
- **Range anxiety** was the single most mentioned topic
- **Engine problems** - largest group
  - Pistons, overheating, low power, etc.
- **Fuel storage system**
  - Leaks, failures, not enough fuel capacity
- **Fuel station issues**
  - Uptime, maintenance, cold weather fills



Technology Barriers – Deeper dive

Range Anxiety

- **Issues**
  - Temperature compensation (i.e. relationship between pressure and temperature) confusing
    - "Full" changes based on temperature
  - Fuel gauges (pressure only) unreliable due to gas thermodynamics
  - Oversized (or additional) tanks add cost and weight
- **Potential Solutions**
  - Smart fuel gauge / full fill technologies
  - Tanks sized for the job
  - Operator training



Technology Barriers – Deeper dive

Engine Problems

- **Issues**
  - Lingering complaints from early engine models (i.e. piston failures, valvetrain issues)
  - Maintenance intervals / life shorter than diesel
  - Inadequate power / overheating
- **Potential Solutions**
  - Some improvements need OEM actions
  - Follow OEM O&M guidelines - train the technicians and operators
  - Engines must be spec'd for the job (CNG engine is not a diesel drop-in)

Technology Barriers – Deeper dive

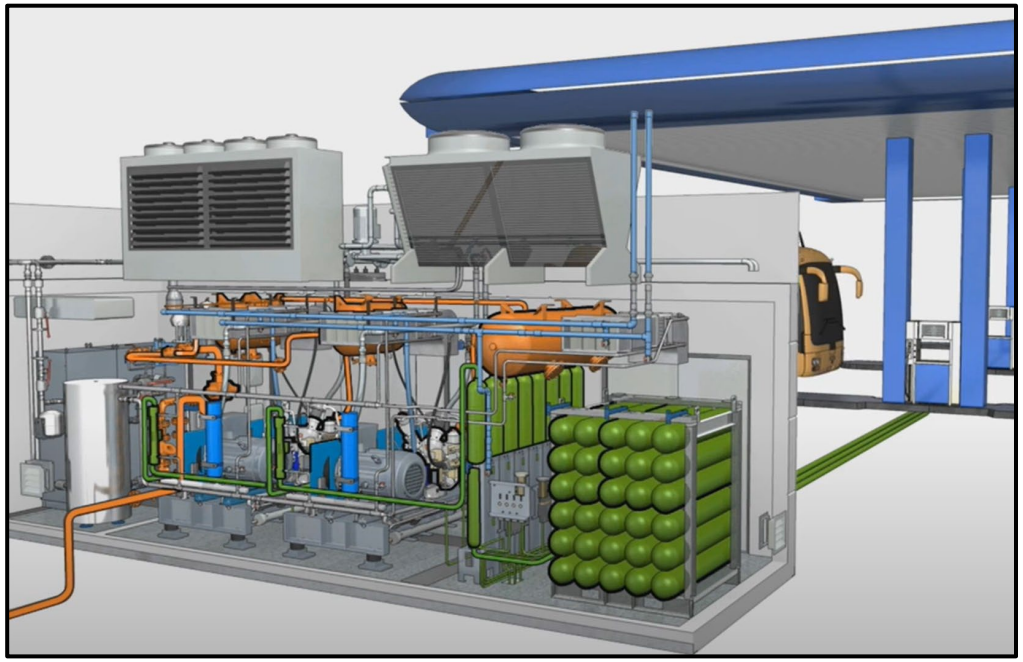
CNG Fuel System

- **Issues**
  - Fuel storage too small for the job (limited range)
  - Component failures, leaks
  - Weight / cargo penalty
- **Potential Solutions**
  - Thorough application review
  - Component improvements (i.e. filters, regulators, receptacles)
  - Some applications just won't work
    - 100,000 lb GVWR with 12L engine
    - 600-mile range on school buses

Technology Barriers – Deeper dive

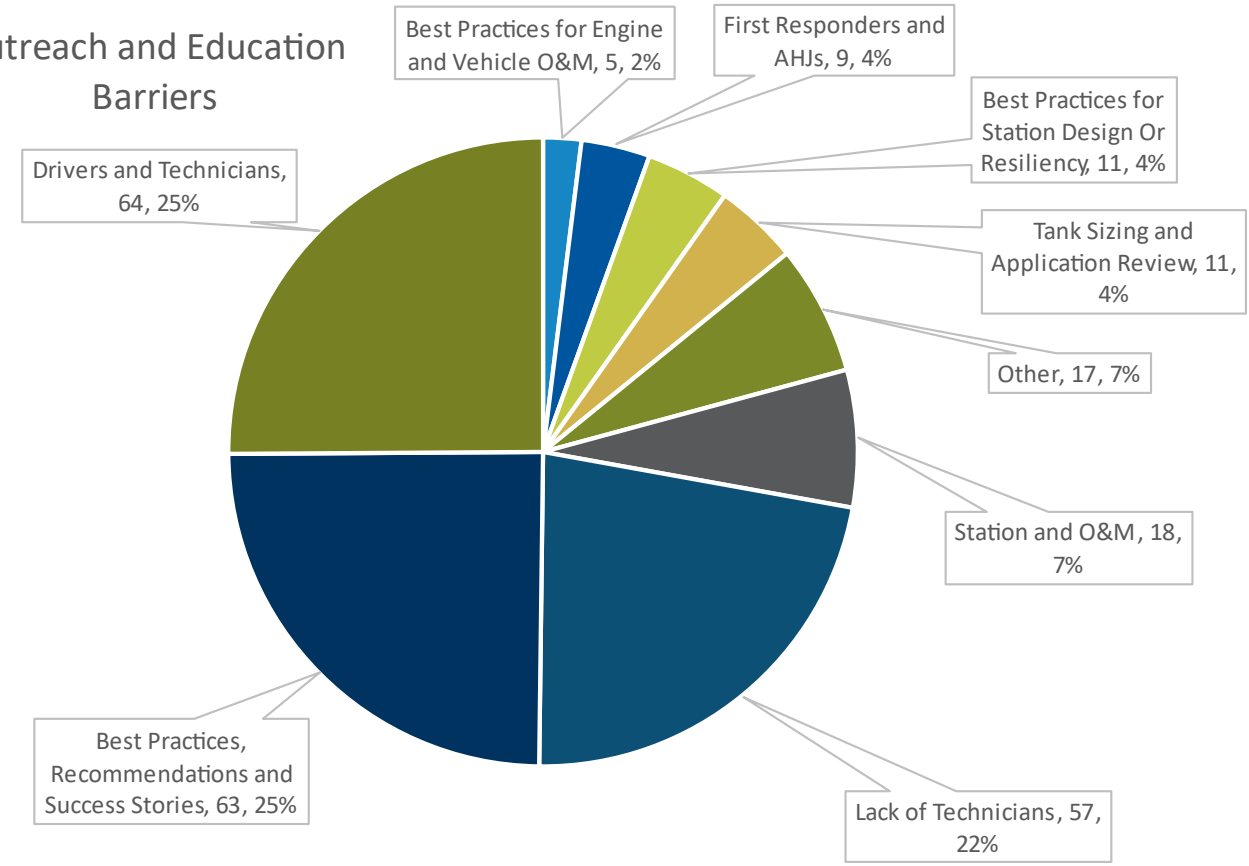
CNG Fueling Stations

- **Issues**
  - Low station reliability; frequent, complex and costly maintenance
  - Poor user experience with dispenser/nozzle
  - Inconsistent fills (i.e. slow, low pressure, etc.)
  - High electricity demand charges
  - Fuel quality issues (impurities in natural gas)
- **Potential Solutions**
  - Technology development (i.e. compressors, filters, dispensers, fueling algorithms, etc.)
  - Exchange of best practices and success stories



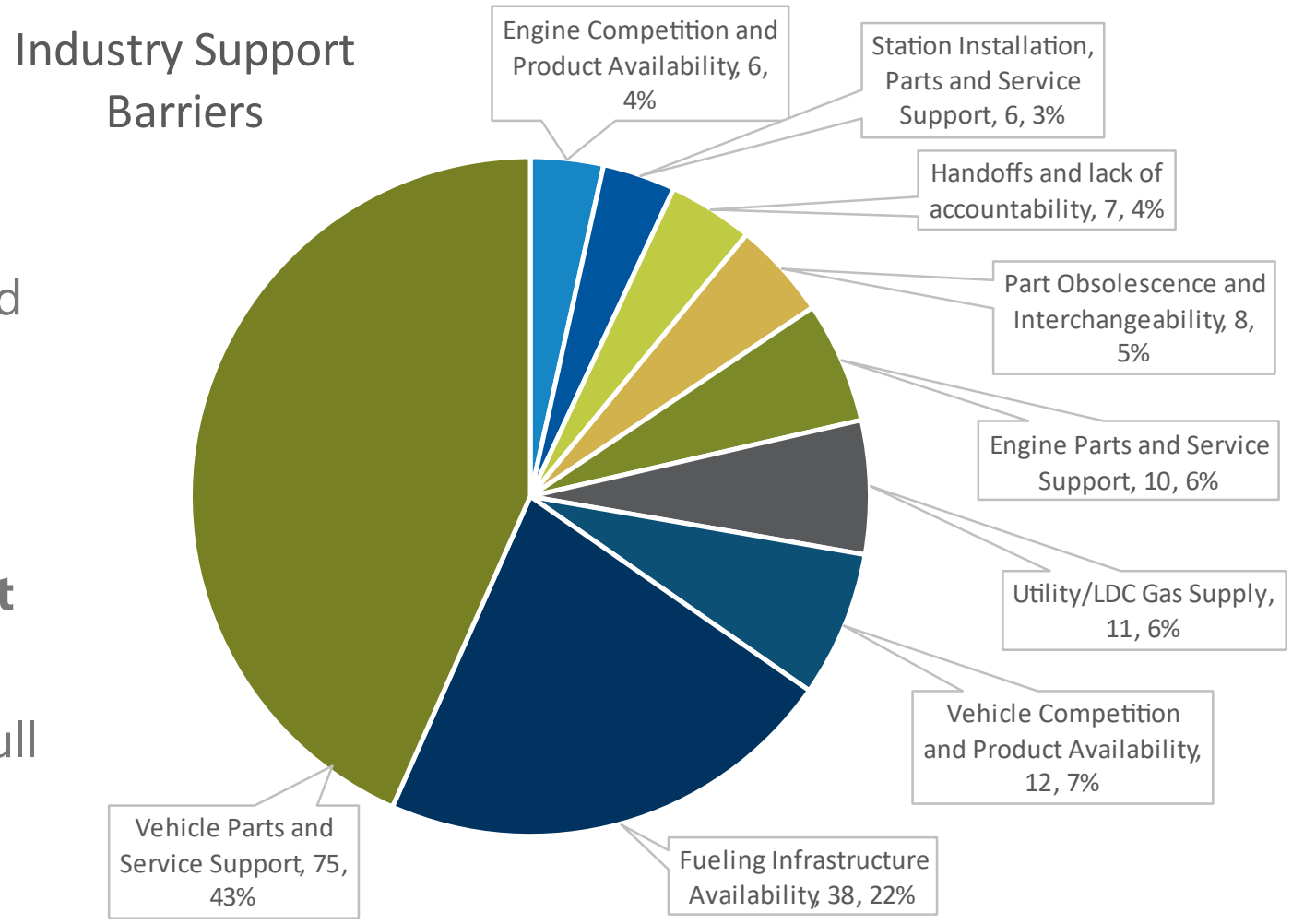
Outreach and Education

- Ensure the fleet managers get the **right truck for the job**
- Drivers and technicians **blindsided by the technology differences**
- Ensure drivers and technicians know what to expect
- Share success stories and best practices!
  - **Don't let the bad news be the only news**
- **Shortage of qualified technicians** (fleets and dealerships)
- Educate the **first responders/inspectors**
  - Unfamiliar with the technology



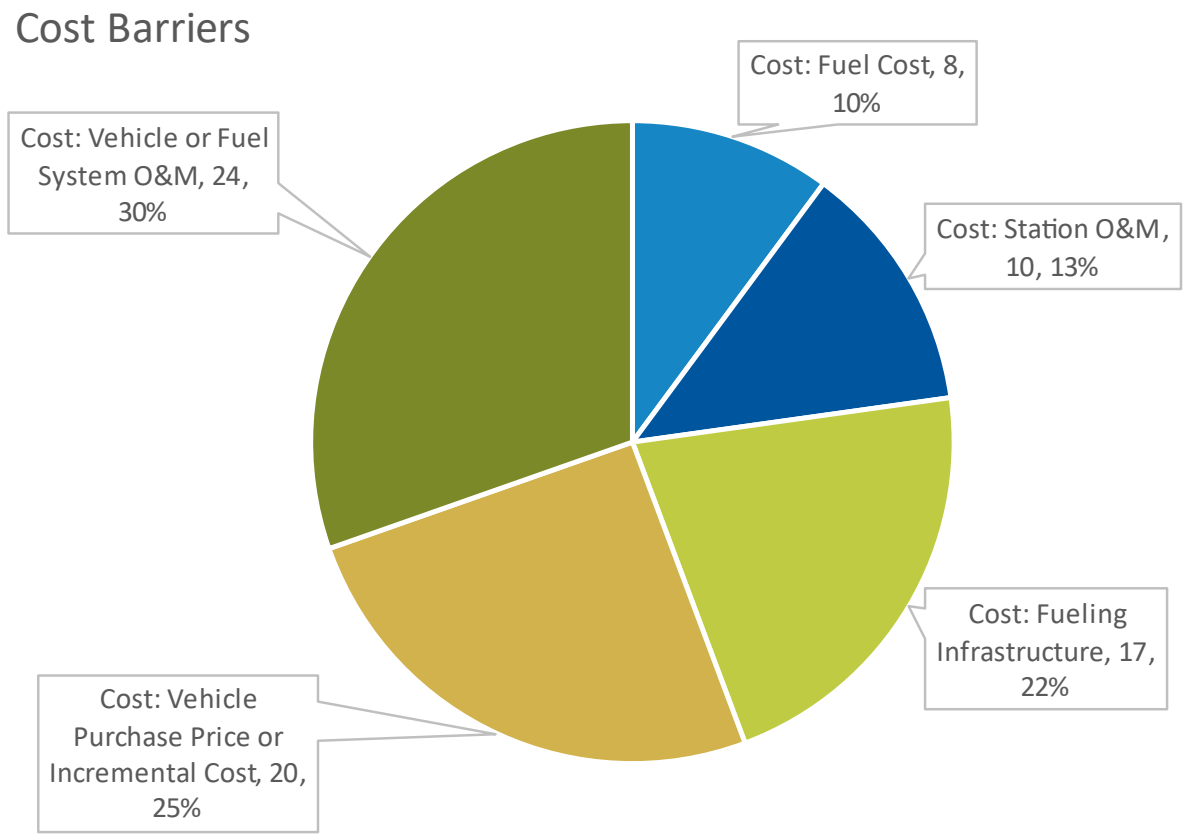
Industry Support Barriers

- Dealers don't have the **parts in stock**
- **Not enough stations**, fleets nervous about fueling and range
- **Shortage of qualified technicians** (fleets and dealerships)
- Not enough options from vehicle and engine manufacturers
- People want to hear **success stories and best practices**
- No single point of contact for ownership of full system (i.e. finger pointing)



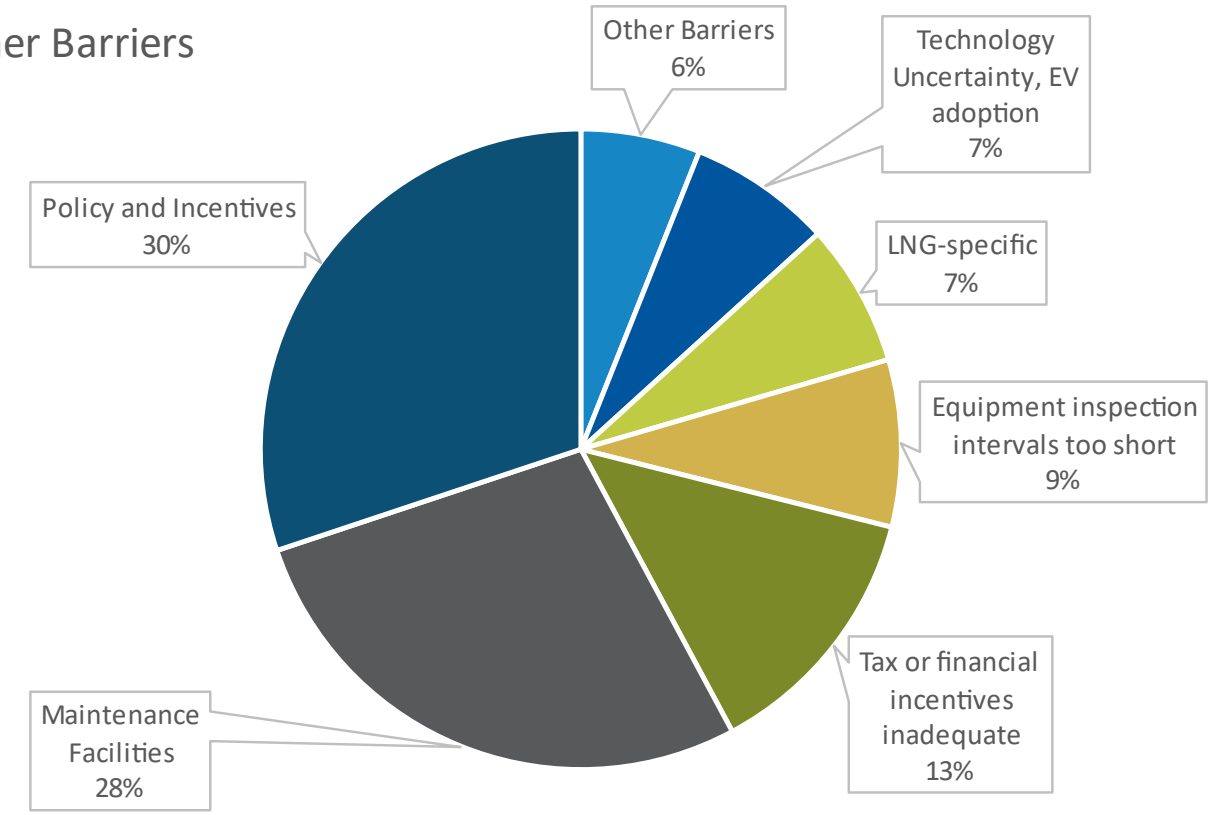
Cost

- Higher **cost of operation and maintenance of vehicle** (parts and labor)
- **Vehicles are expensive** (compared to diesel)
- **Cost of CNG station is prohibitive**, must rely on public infrastructure
- Higher cost of **operation and maintenance of CNG station** (preventative and repairs)
- Cost spread between CNG and diesel/gasoline not enough to justify investment
  - Unstable diesel/gasoline price



Other

- Inadequate incentives and policy support (i.e. weight exemptions, “Buy America” for federal incentives, ZEV’s are getting more incentives and attention)
- Limited availability of certified maintenance facilities are a barrier
- Tax credits are not permanent, diesel is a safer investment
- Tank inspections are too frequent
  - Recent change to US DOT regulation should help (https://ngvamerica.org/2022/03/09/ngvamerica-reissues-cng-fuel-system-inspection-guidance-document-to-include-new-federal-standard/)



Summary

- Many comments – wide variety of topics covered
- Technology and Outreach/Education are largest topics
  - Areas that DOE and Clean Cities have great experience and impact
- Industry/Commercial Support is needed – more stable environment needed
- Costs are too high
  - High gasoline/diesel prices lead to better Return on Investment

GTI ENERGY

solutions that transform

GTI Energy develops innovative solutions that transform lives, economies, and the environment