No Membership Fees: Thanks to Sponsors
Three Pillars of NACFE Work

1. Scale Current Techs
2. Improve Information Flow
3. Guide Emerging Techs

Confidence Reports  
Annual Fleet Fuel Study  
Run On Less Demonstrations  
Thought Leadership  
Electrification Guidance Reports  
Trade Shows  
Collaboration Reports  
Workshops

NACFE.org  
RunOnLess.com
2019 Annual Fleet Fuel Study

All Technologies

https://nacfe.org/annual-fleet-fuel-studies/

April 2021
Best of the Best

2017
Long Haul
7 Fleets
10.1 MPG

2019
Regional Haul
10 Fleets
8.3 MPG

2021
All BEVs
13 Fleets
New metrics!

April 2021
• Interviewed 30+ potential pairs
• Required trucks to be in-service by June 1\textsuperscript{st}
• Mix
  • Multiple classes and duty cycles
  • Multiple truck OEMs
  • Locations around NA
• Selection Criteria
  • Uptime, design maturity
  • Scale potential
  • Mix
  • Fleet / OEM commitment
Timeline for Run on Less – Electric

**Announcement**
- Participants’ fleet, truck and location detailed
- Bootcamp registration
- Website launched

**Pre-Run**
- 10 Trainings every other Tuesday
- April 20 to August 24
- Summarize learnings
- Visit all participants in June & July
- Continued promotion
- Profiles on runonless.com August 16

**Post-Run**
- Starts September 3 at ACT Expo
- Metrics and daily stories
- TMC Cleveland, SAE COMVEC Chicago, NYC Climate Week, MOVE Austin
- Initial Report at ATA MCE October 26-28
- Workshops & Conferences
- Analyses and publish reports in 2022
Electrification waves drive RoL-E scope

1. Forklifts
2. **Yard Tractors**
3. **MD Urban Delivery**
4. **Drayage**
5. **Regional Haul Tractors**
6. Long Haul Tractors

April 2021
MD & HD Industry Segments

- **MD Delivery** (Box trucks & step vans)
  - Total Population: 1,900,000
  - Miles: 125/day 25K/year

- **Regional Haul** (Day cabs & some sleepers)
  - Total Population: 800,000
  - Miles: 450/day 80K/year

- **Long Haul** (Sleeper Tractors)
  - Total Population: 1,200,000
  - Miles: 600/day 100K/year

- **Vocational Class 8** (Construction, waste, dump…)
  - Total Population: 800,000
  - Miles: 300/day 65K/year

- **MD Delivery** (Box trucks & step vans)
  - Total Population: 1,900,000
  - Miles: 125/day 25K/year

- **Regional Haul** (Day cabs & some sleepers)
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- **Long Haul** (Sleeper Tractors)
  - Total Population: 1,200,000
  - Miles: 600/day 100K/year

- **Vocational Class 8** (Construction, waste, dump…)
  - Total Population: 800,000
  - Miles: 300/day 65K/year

- **MD Work Trucks** (Dump, stake, service, waste…)
  - Total Population: 470,000
  - Miles: 125/day 25K/year

- **Yard Tractors** (holsers, shuttles…)
  - Total Population: 35,000
  - Miles: 10-20/day @ 10 MPH

- **School Bus** (yellow or white)
  - Total Population: 480,000
  - Miles: ??/day 12K/year

- **Transit Bus** (public transportation)
  - Total Population: 150,000
  - Miles: ??/day 35K/year

- **Expeditors Class 5-8** (MD & HD rush deliveries…)
  - Total Population: 25,000
  - Miles: tbd/day 25K/year

**Electrification Time Frame**

- **Market Size**

This slide is under development
Pathways to HD Truck Charging

1) Fleet Depot Based
2) Opportunity Charging Stores, Ports, Warehouses...
3) Shared Card Lock Locations
4) Truck Stops
5) Toll Road Rest Areas
6) Interstate Rest Areas
7) Mobile Roadside Charging (emergencies & service calls)
8) In Motion Charging
Electric Truck Bootcamp

1. Why Electric Trucks?
2. Charging 101 - Planning & Buildout
3. Charging 201 - Power Management & Resilience
4. Working with Your Utility
5. Incentives for Electrification
6. Maintenance, Training & Safety
7. Finance & Innovative Business Models
8. Battery Supply Chains & End of Life
9. Global Perspectives
10. Drivers & Electric Trucks

Register at: https://subscribe.act-news.com/NACFE-RoL-e-2021

All sessions:
• Start at 1 PM EDT
• Can be viewed later
# Guidance on Electric Trucks

<table>
<thead>
<tr>
<th>#1</th>
<th>Electric Trucks: Where They Make Sense</th>
<th>May 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2</td>
<td>MD Electric Trucks: Cost Of Ownership</td>
<td>October 2018</td>
</tr>
<tr>
<td>#3</td>
<td>Electric Trucks: Charging Infrastructure</td>
<td>March 2019</td>
</tr>
<tr>
<td>#4</td>
<td>Viable Class 7 &amp; 8 Electric, Hybrid &amp; Alt Fuels Tractors</td>
<td>December 2019</td>
</tr>
<tr>
<td>#5</td>
<td>High Potential Regions</td>
<td>November 2020</td>
</tr>
<tr>
<td>#6</td>
<td>Heavy-Duty Hydrogen Fuel Cell Tractors</td>
<td>December 2020</td>
</tr>
</tbody>
</table>

Now Free Online at [https://nacfe.org/emerging-technology/electric-trucks-2/](https://nacfe.org/emerging-technology/electric-trucks-2/)
• Complex
• Large amount of power fast
• Involve all stakeholders early
• Time to complete with truck availability
• Be flexible
HD Tractors Green Future

**PRESENT:** 2020
- Technology immature
- Many unknowns & challenges

**“MESSY MIDDLE”: 2030**
- Many optimized solutions
- Growing infrastructure
- Multi fuel choices

**FUTURE:** 2040
- Innovation & maturation
- Facts replace estimates
- Learning curves

- Fast charging everywhere
- Long life, low cost batteries
- Acceptable weights

<table>
<thead>
<tr>
<th>Legacy Diesels</th>
<th>Diesel Advancements</th>
<th>Battery Electric</th>
<th>CBEV from Clean Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>Natural Gas</td>
<td>Hydrogen Fuel Cells</td>
<td>Renewable Natural Gas &amp; Diesel</td>
</tr>
</tbody>
</table>
Alternative Fuels

TRADITIONAL PETROLEUMS
- Gasoline
- Diesel
- Ethanol Blends
- Methanol Blends
- Bio-Diesel
- Renewable Diesel
- LP Injection into Diesel
- Diesel & BEV Hybrid
- Gasoline & BEV Hybrid
- Solar Charging

GASEOUS FUELS
- CNG
- LNG
- DME
- Renewable Natural Gas
- Renewable Liquid Propane
- Liquid Propane

HYDROGEN
- Compressed Hydrogen
- Liquid Hydrogen

ELECTRIC
- Battery Electric
- Nitrogen & BEV Hybrid

LIQUID NITROGEN
- CNG & BEV Hybrid

April 2021
“ZETI”

Calstart on-line tool

Part of Drive to Zero program at Calstart

Launched March 2020

Current & future production models

Links to OEM web pages

https://globaldrivetozero.org/resources/zero-emission-technology-inventory/
Some CBEVs will be “Range Extended”

Hyliion “Hypertruckle” is being called ERX: Electric Range Extender and runs on CNG or RNG

Several OEMs and suppliers are working on hydrogen fuel cell powered electric trucks

CNG Infrastructure
From DOE Alt Fuels Data Center
# Hydrogen & Battery Electric Trucks

## Both Competitors AND Teammates

<table>
<thead>
<tr>
<th>Hydrogen Fuel Cell Trucks</th>
<th>Truck Subsystem</th>
<th>Battery Electric Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (but less)</td>
<td>Rechargeable Batteries</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Electric Drive Motors</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>High Power Cables</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Software Management</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Regenerative Braking</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Hydrogen Fuel Cell</td>
<td>--</td>
</tr>
<tr>
<td>Yes</td>
<td>Hydrogen Fuel Tank</td>
<td>--</td>
</tr>
<tr>
<td>Hydrogen Station</td>
<td>Refueling</td>
<td>Electric Charging Station</td>
</tr>
<tr>
<td>Large</td>
<td>Electricity Consumption</td>
<td>Large</td>
</tr>
</tbody>
</table>
Guidance on Hydrogen

Hydrogen Color Spectrum

**GREEN**
Hydrogen produced by electrolysis of water, using electricity from renewable sources like hydropower, wind, and solar. Zero carbon emissions are produced.

**TURQUOISE**
Hydrogen produced by the thermal splitting of methane (methane pyrolysis). Instead of CO₂, solid carbon is produced.

**PINK/PURPLE/RED**
Hydrogen produced by electrolysis using nuclear power.

**BLACK/GRAY**
Hydrogen extracted from natural gas using steam-methane reforming.

**YELLOW**
Hydrogen produced by electrolysis using grid electricity.

**BLUE**
Grey or brown hydrogen with its CO₂ sequestered or repurposed.

**WHITE**
Hydrogen produced as a byproduct of industrial processes.

**BROWN**
Hydrogen extracted from fossil fuels, usually coal, using gasification.

Note: There are no official definitions of these colors, but the above represents common industry nomenclature.
Megaregions with particularly high potential

• Northern California
• Southern California
• Texas Triangle
• Cascadia (WA, OR & BC)
• Front Range (CO & NM)
• Northeast
• Toronto & Montreal

Report Link: https://nacfe.org/downloads/high-potential-regions-for-electric-truck-deployments-technical-appendix/
Transition to Zero-Emission Trucks (& Buses)

15 States & Washington DC working together via:
California Air Resources Board (CARB) &
Northeast States for Coordinated Air Use Management (NESCAUM)

Memorandum Of Understanding signed July 14th, 2020
Why Consider Electrification Now?

Financial
• Incentives are/will be available that can cover some of the costs of conversion

Facilities
• Obtain required power levels BEFORE your neighbors
• Obtaining power/infrastructure can take years
• Might be easier to relocate than upgrade
• Physical layout of your lot will change

Change is Coming: Even with diesel
• Regulations & tech changes for NOx & GHG
Electric Trucks

Collaboration

• Fleets
• OEMs (Existing & New)
• Suppliers
• Dealerships (Sales/Service)
• Governments

• Charging System Suppliers
• Utility Companies

April 2021
Regional Haul

More Regional Haul: An Opportunity for Trucking?

- Drop in Length of Haul
- Warehousing
- Technology Trends
- An Opportunity
  - Drivers
  - Alternative Fuels
  - Others?


https://nacfe.org/regional-haul/
Day 18 of 18

Congratulations to Our Drivers!

OCTOBER 7 – 25 2019

Run on Less Regional Sets Impressive Efficiency Benchmark

RESULTS

8.3
Average MPG

$8,249
Dollars saved

$9,003,550,961
Annualized Potential Savings

Potential savings represents the savings that are possible across the industry if all regional-haul trucks operated at this level.
Run on Less Regional Reports

Conclusions
1. High efficiency requires commitment
2. Optimize performance using big data and connectivity
3. Understand and act on the variety in duty cycles
4. Drivers are attracted to regional haul
5. Return to base is ideal for electric trucks
6. Growth in Regional Haul is Good

Run On Less Data Benefits
• Run on Less Regional data analysis: RoLR final report
• NREL/NACFE Report: Battery Electric Powertrains
• Ballard/NACFE Report: Hydrogen Fuel Cell Trucks in Regional Haul
• Free downloadable data set

April 2021
Getting to Know Each Other

Primer: UTILITIES on FLEETS

FLEETS

NACFE
NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

Primer: FLEETS on UTILITIES

UTILITIES

April 2021
Wave Of Changes Coming

Covid-19
Autonomous Vehicles
Driver Retirement
Electrification
IMO 2020
2 Truck Platooning
Hours Of Service
BIG DATA
Greenhouse Gas Phase 2
Blockchain
Cameras
Driver Retention
Lightweighting
Parking Shortage
Solar

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