Natural Gas for Transportation

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Facts:

- Proven U.S. reserves have grown enormously over the last several years
- Natural gas is far cheaper than in recent past & far cheaper than petroleum
- Reserves suggest it will remain cheap for a long time

What do we do with all this natural gas???

- **Reason to believe we will be using more of it in the transportation sector**

Issue:

How to use in Transportation?

- CNG/LNG
- Gas-to-various liquids (diesel, gasoline, propane, methanol, etc.)
- Make electricity for EVs
- Others?

Outlook for Natural Gas in Transportation

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- Current activity
  - Medium- and heavy-duty engine & vehicle-integration awards
  - Update of HD engines and vehicle product offerings long overdue
  - Create competition in the >9 liter engine space

- Future thoughts
  - LNG for heavy-duty, long-haul trucks
  - Limited-range bi-fuel CNG/gasoline for light duty with home fueling – a natural gas "Pipe-In Vehicle"
    - Range of ~100 miles on CNG
    - Currently, 3 gallon gasoline equiv. tank for CNG is $300 retail
    - Limits cost differential with NG car but enables cheaper fuel for daily use – per EPRI study 40 mile range covers vast majority of light-duty miles traveled

Back of Envelope Energy Analysis – Current Technology

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Difference between using NG for power generation and in vehicle

Power plant (η=45%)

X

Transmission (η=92%)

X

Electric propulsion (η=65%)

= 27%

3600 psi comp. (η=95%)

X

LD Engine (η=20%)

X

Drivetrain (η=90%)

= 17%

LNG (η=70%)

X

HD Engine (η=26%)

X

Drivetrain (η=90%)

= 16%

Heavy Truck in 2020 – LNG ICE

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~30% WTW η

Petroleum reduction: 99%

Fuel+Tank Weight: 1600 lbs

Fuel+Tank Volume: 200 gal

Lifecycle Cost of Driving:
Payback Period: 1.5 years
Breakeven diesel price: $2.95

NG liquefaction

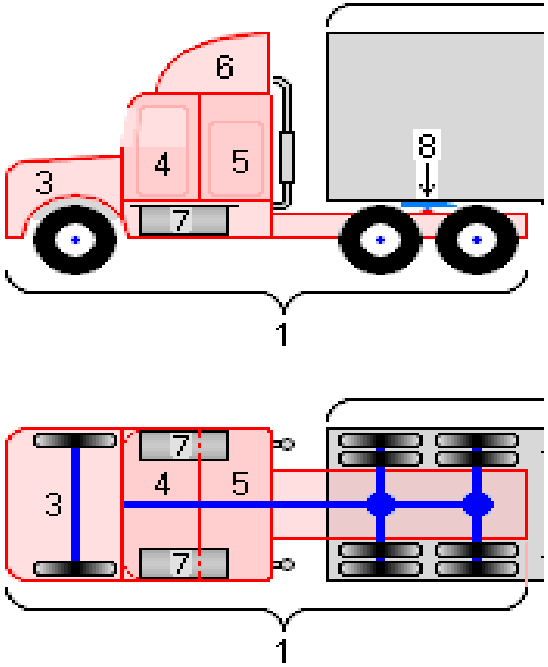
70%

Advanced engine efficiency

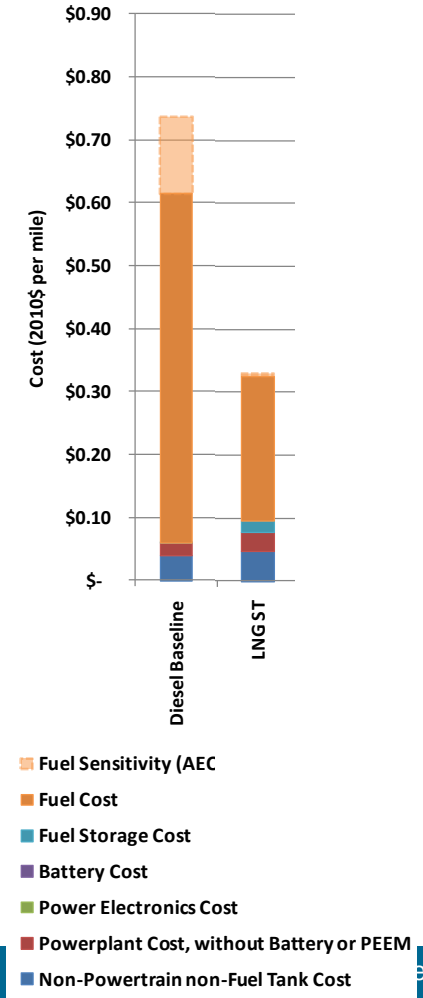
48%

Drivetrain efficiency

97%



Cryogenic Fuel Storage:

Several days before boil-off

Current incremental cost ~$18K