# Natural Gas for Heavy Duty Trucking Comparative Economics and Trade-offs

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October 1, 2015

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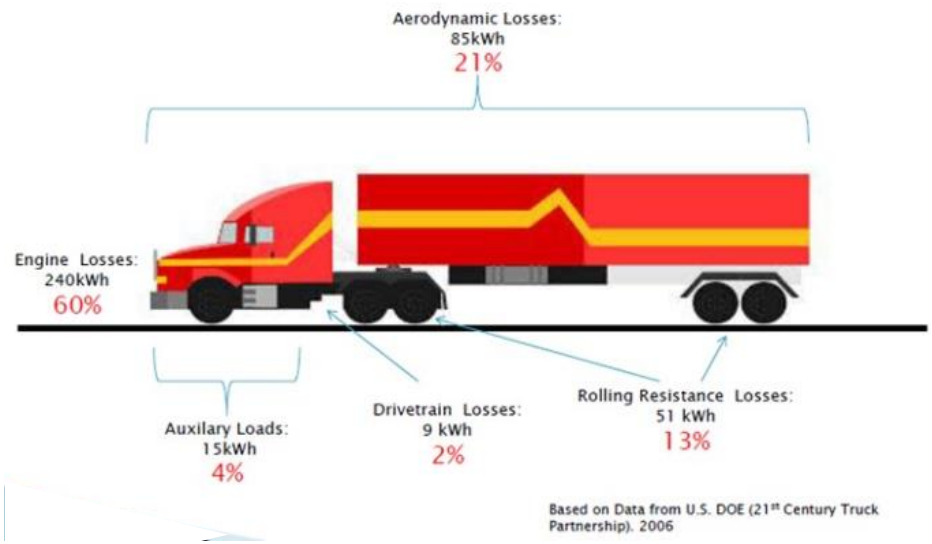
# Methane as a transportation fuel can address 2050 goals through total vehicle system improvements and RNG fuel blends

# Fuel economy improvement will be critical for all vehicle platforms -- Natural Gas platforms have similar fuel economy potential to diesel platforms

**Breakdown of Energy Loss for Long Haul**



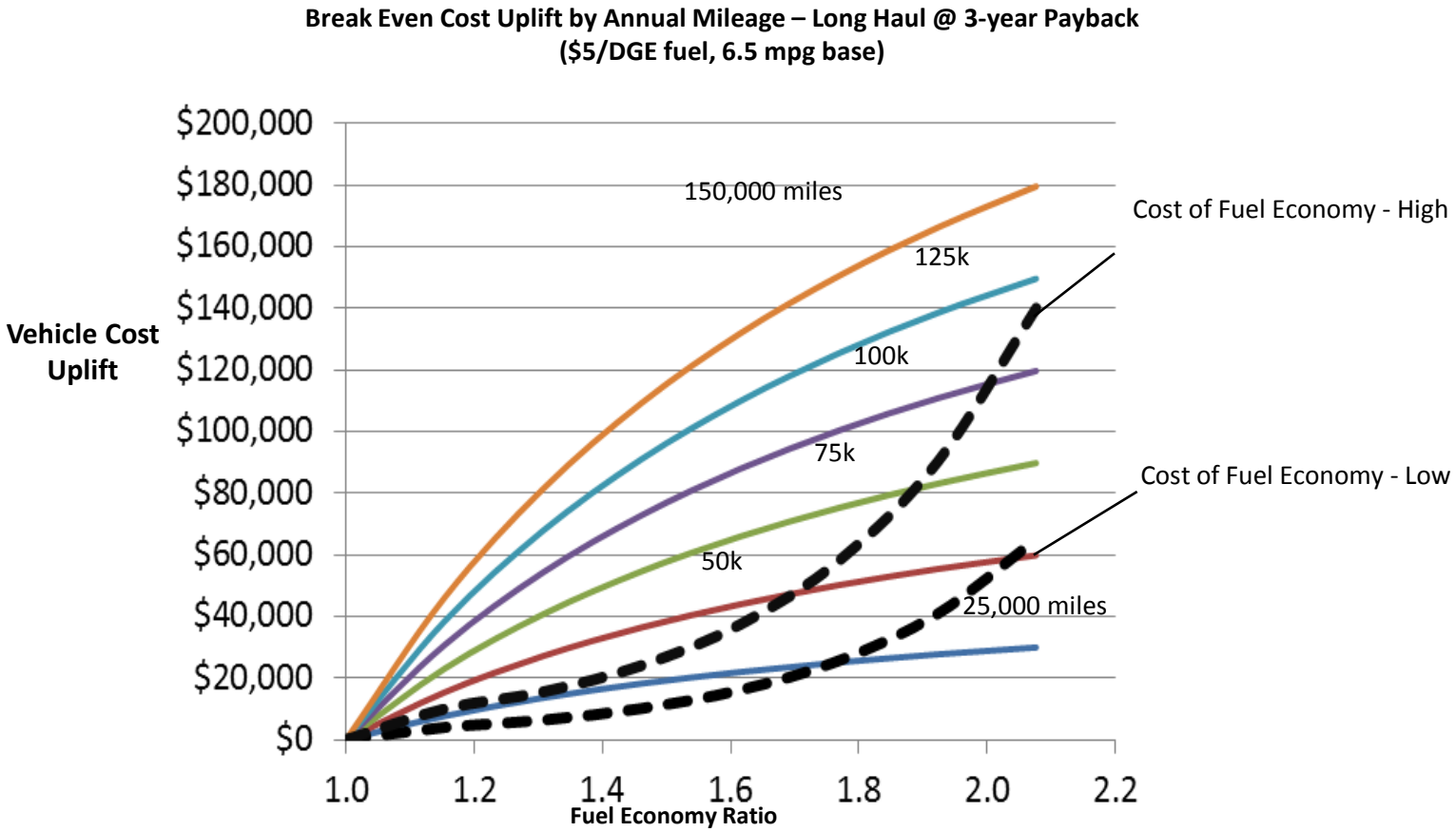

Source: Department of Energy "Super Truck" program

**Sources of Fuel Economy Improvement**

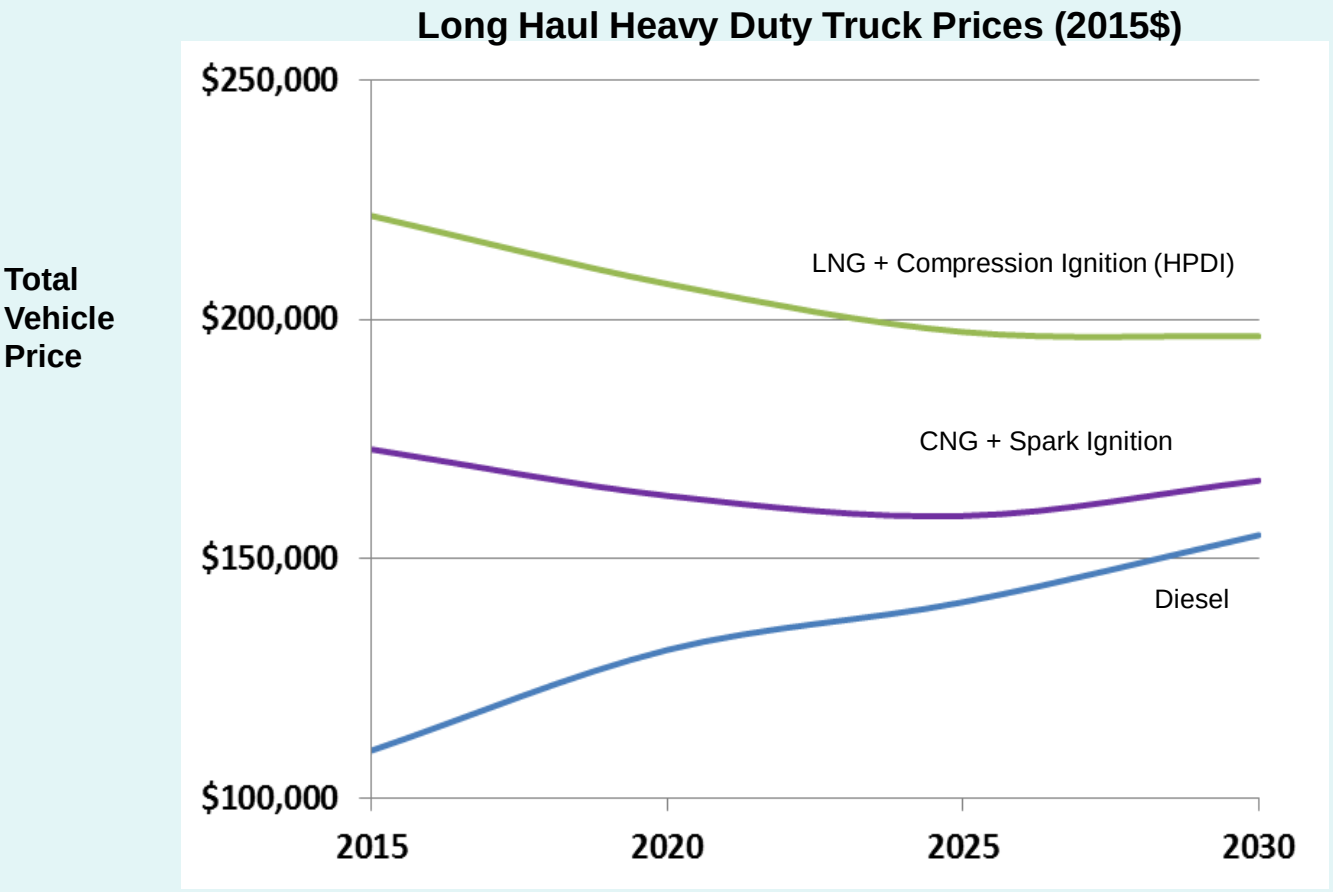
| Fuel Economy Contributor | Highway | Urban Vocation |
|---|---|---|
| Engine | 15% - 20% | 15% - 20% |
| Hybridization | 10% | 30% - 35% |
| Aerodynamics | 12% | 0% - 6% |
| Transmission | 7% | 4% |
| Rolling Resistance | 11% | 2% - 3% |
| Weight | 1% | 1% - 4% |

Source: National Petroleum Council

# Virtually all vocations show positive payback for fuel economy improvements of 50%+ for both NG and diesel

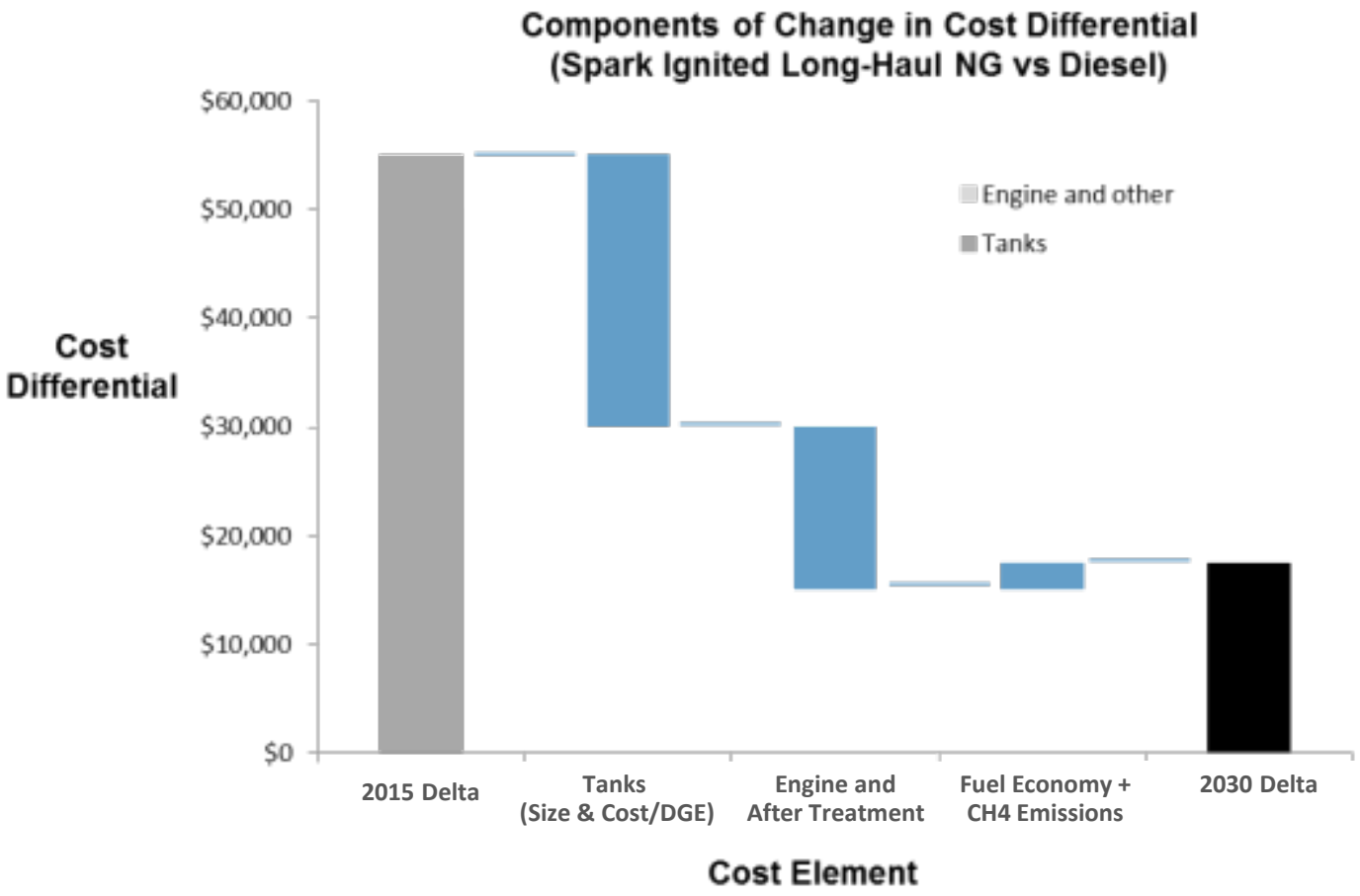


# Netting technology improvements, cost of fuel economy and cost of emissions control, natural gas truck costs will converge with diesel



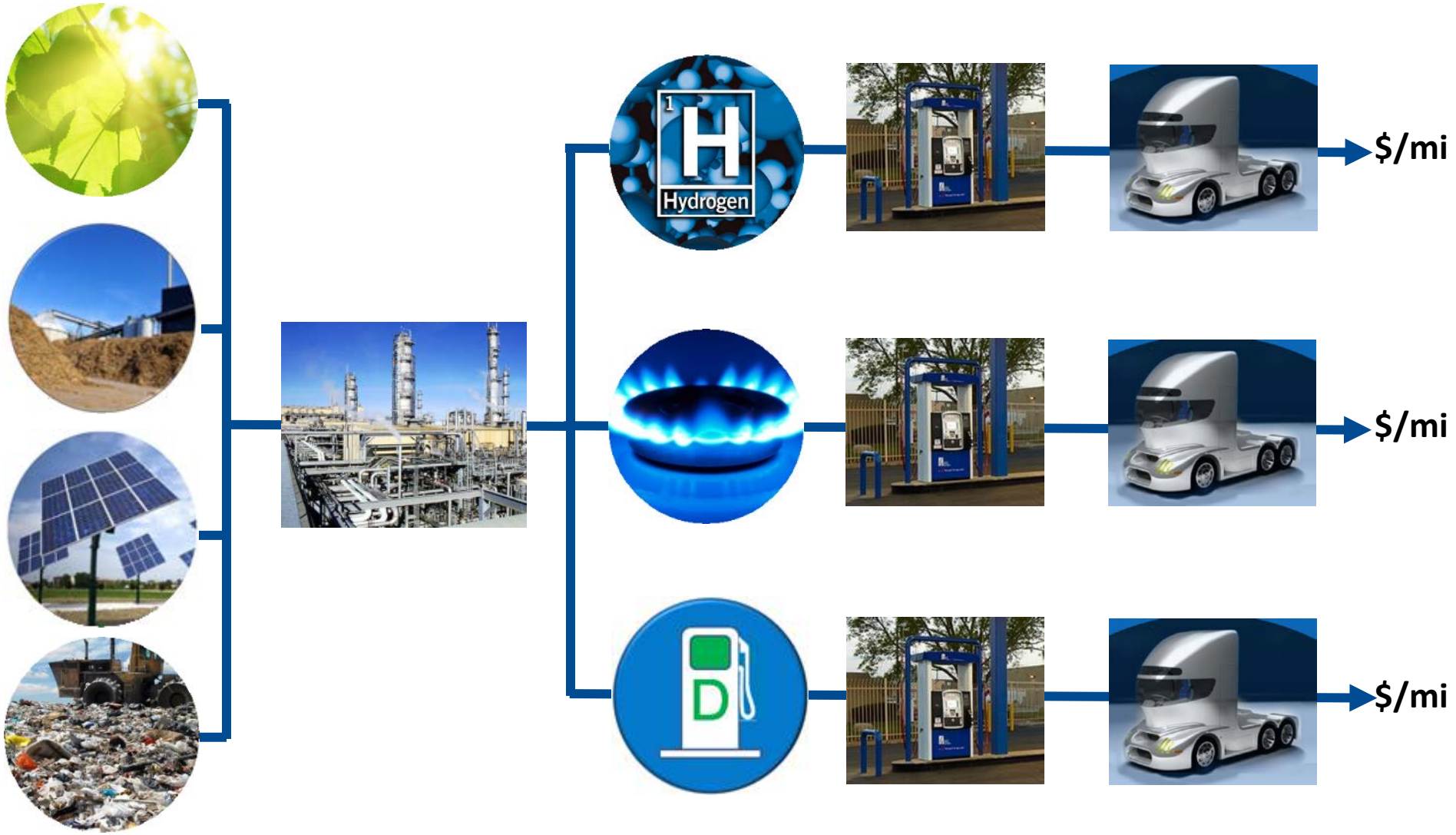

Sources: NPC and GNA; internal estimates for NOx control

# Elements of Cost Differential to Diesel

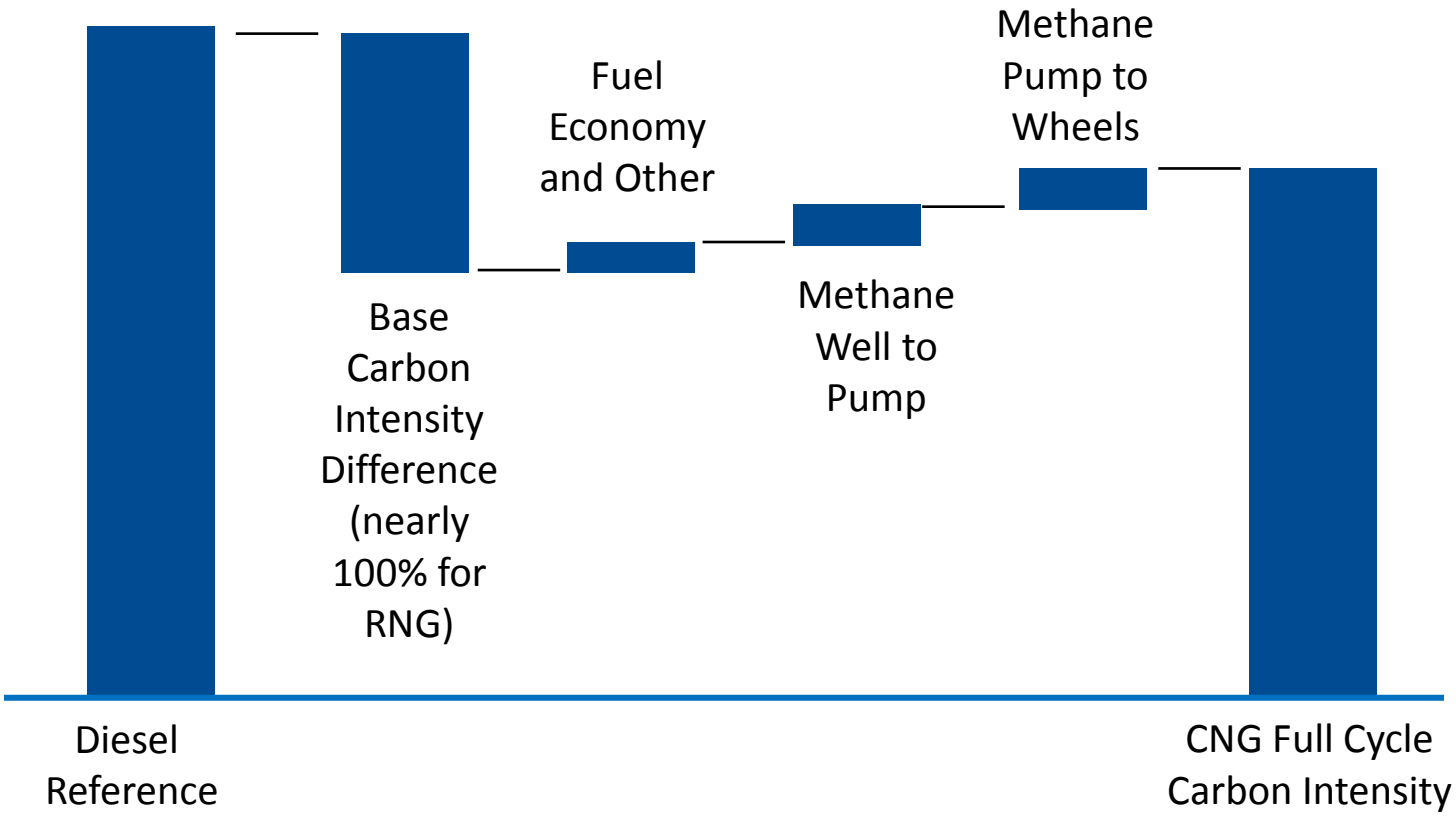


# GHG Trade-offs

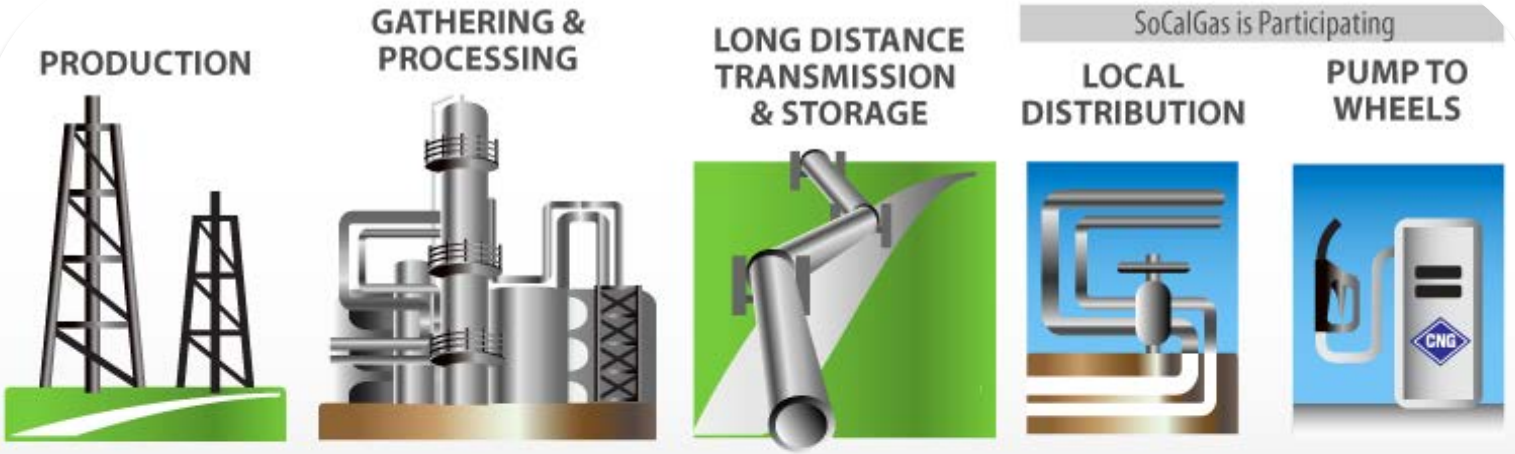
# Comparative Economics of Low-Carbon Pathways



# Elements of CI difference between natural gas (and NG-derived hydrogen) and diesel

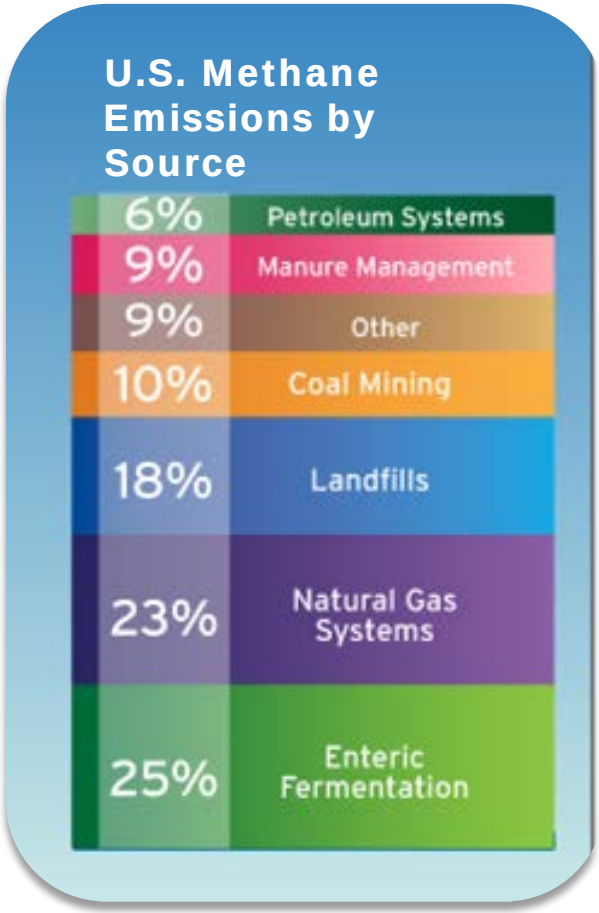


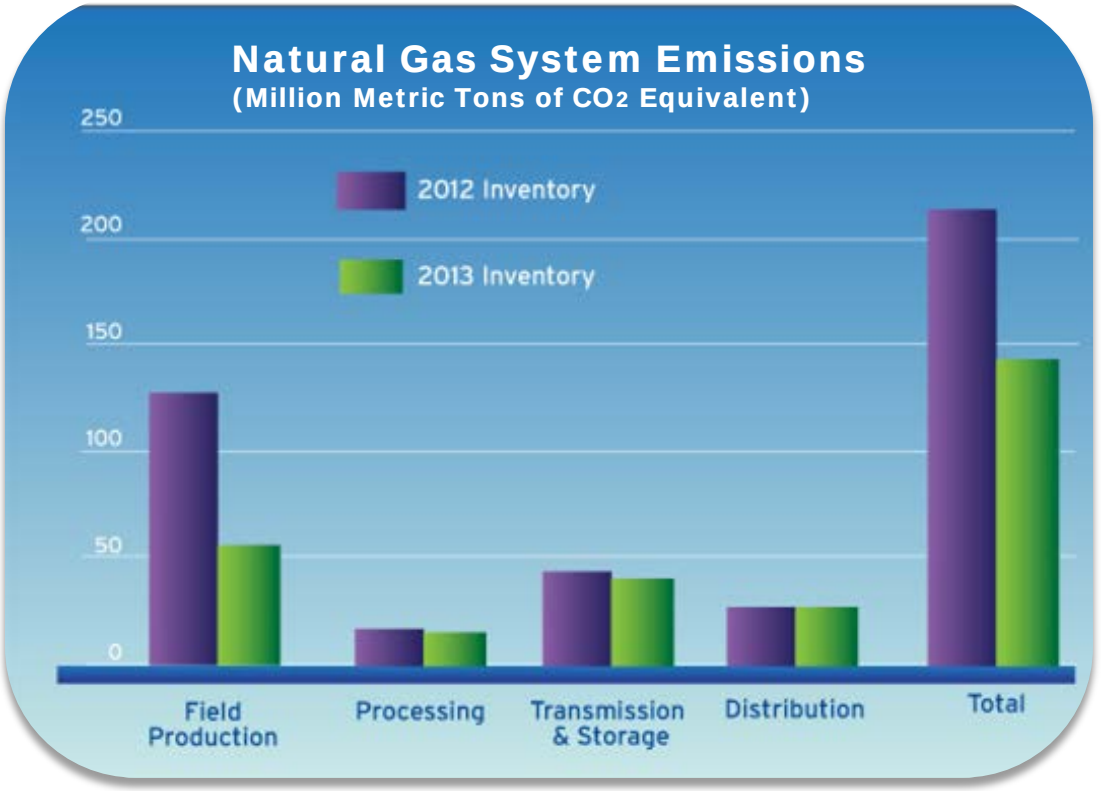
# Methane emissions are an issue to address but policy needs to consider mitigation potential and “cause and effect” relative to new uses of Natural Gas




- **Time.** What is the short, medium and long-term potential for reduction in system leakage?
- **Marginal Impact.** How much will methane emissions increase with deployment of DG and NGV technologies and how much is not driven by throughput (event-based emissions / time based emissions)?

# Time Dimension -- National data shows methane emissions declining



# “Cause and Effect” Dimension – will not deploying NGV’s reduce upstream emissions?


| Mostly event-based | tbd | tbd | Mostly time based | Volume-based/ incremental |
|---|---|---|---|---|

**Need economy wide scenario analysis to determine marginal impact on methane emissions of aggressive NGV deployment versus base case**