Deep Decarbonization of Commercial (On-Highway) Transportation

• Vehicles and Candidate Technologies

• Infrastructure Implications

• Business and Public Policy/Regulations
Commercial Transportation Vehicles
Candidate Power Technologies

• Battery Electric – Product credible up through Urban Class 7 tractors

• Fuel Cell Hybrid Electric – Bridge / Range extender where batteries cannot make a full shift / route

• Biofuels – Biofuels – includes alcohols, but “drop-in” important for Intercity Class 8 and legacy fleet *(and not “all or nothing”)*
BEVs Being Introduced / Demonstrated Now
Infrastructure Implications

- Grid capacity
- \( \text{Grid CO}_2 \)
- Local charging infrastructure
Grid Capacity and Transportation Demand (EIA Data)

- US Retail electricity delivery = 13 quads
- On-highway transportation consumption = 22 quads
- Assume electric vehicles are 3x as efficient vs gasoline (EERE) and 2-2.5x diesel (JCW) and setting aside intercity Class 8 —> 6.5 quads electricity demand

- **US Retail electricity bulk generation and delivery must increase 50% (...ish, not accounting for battery charging losses...)** to support personal and urban commercial vehicle electrification
Grid Capacity and Transportation Demand (EIA Data)

• “Data plate capacity” of US grid ~ 1TW @ 24/7 → ~30 quads

• So what’s the problem?

• Current grid is ~30% efficient (38 quads in → 13 out!!)
• 2/3 fossil, half that coal
• Gas turbine “peakers” less efficient than on-road diesels, even before transmission and battery in/out losses
• “Duck curve” defines charging schedule on “hot days”

• That’s the problem

John Wall, MIT Climate Action Symposium, February 25, 2020
Grid Capacity and Transportation Demand (EIA Data)

- “Data plate capacity” of US grid ~ 1TW @ 24/7 → ~30 quads
- So what’s the problem:
  - Current grid is ~30% efficient (38 quads in → 13 out!!)
  - 2/3 fossil, half that coal
  - Gas turbines “peakers” less efficient than on-road diesels, even before transmission and battery in/out losses
  - “Duck curve” defines charging schedule on “hot days”
- That’s the problem

Grid-scale storage for “dispatchable intermittent renewables”
Infrastructure Implications

• Grid capacity

• Grid CO$_2$

• Local charging infrastructure

• Fuel Infrastructure (especially Hydrogen)
  • CNG “Model”
Business/Public Policy/Regulation

• Driving force cannot be purely business economics
• Good regulatory policy creates a “level playing field” for businesses and drives technology innovation and introduction

• **Looking back:** EPA, CARB, progressive businesses drove Diesel NOx and PM down 99% over two decades and created new jobs in the process

• **How to duplicate this going forward for “deep decarbonization” across sectors?**