Increasing freight activity, increasing emissions

- Truck freight activity, emissions will greatly increase over coming years
- Ambitious emissions reduction plans for trucks necessary to meet climate goals

Using the 2-degree scenario from International Energy Agency, Energy technology perspectives 2017 (June 2017); www.iea.org/etp/. LDV, MDV, and HDV denote light-, medium-, and heavy-duty road vehicles, respectively.
How can we bridge the gap?

- Conventional technology
  - Important in near-term, diminishing long-term opportunities
  - Issues with enforcement
- Low-carbon fuels
  - Limited availability of low-carbon biofuel feedstocks
  - Power-to-liquids has poor round-trip efficiency
- Zero-emissions technologies
  - Many options, all at early stages
Many paths to zero-emissions

Plug-in electric
- Pure electric (BEV) or range-extended?
- Ultra-fast charging, depot charging, or battery swapping?

Hydrogen fuel cell
- Renewable electrolysis or biomethane reformation?
- Centralized or distributed H₂ production?
- What size of battery?

E-road
- Overhead catenary, dynamic induction, or something else?
- Battery backup or range-extender?
Do these technologies cut emissions?

Battery electric most similar to dynamic induction; not originally included in long-haul analysis

Are heavy-duty ZEVs affordable?

Assumptions: 4% discount rate, 10 year vehicle ownership, 83,000 km average annual mileage, 10% interest rate, tractor-trailer, infrastructure not included
## Relative advantages of technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Vehicle technology benefits</th>
<th>Prevailing barriers to widespread viability</th>
<th>Promising segments for widespread commercialization</th>
</tr>
</thead>
</table>
| Electric (plug-in)          | ↓ Greenhouse gas emissions  
↓ Local air pollution  
↓ Fueling costs  
↓ Maintenance costs  
↑ Energy efficiency  
↑ Renewable energy use | ↓ Electric range  
↑ Vehicle cost  
↑ Charging time  
↑ Cargo weight and size | • Medium-duty regional delivery trucks  
• Tractors and drayage trucks around ports  
• Urban delivery trucks, refuse trucks |
| Electric (catenary or in-road charging) | ↓ Greenhouse gas emissions  
↓ Local air pollution  
↓ Fueling costs  
↓ Vehicle maintenance costs  
↑ Energy efficiency  
↑ Renewable energy use  
↑ Range without charging | ↑ Catenary or road infrastructure cost (upfront and maintenance)  
↑ Standardization requirements across regions  
↑ Infrastructure requirements  
↑ Visual obstruction (catenary) | • Medium-duty trucks and heavy-duty tractor-trailers on high-utilization routes  
• Drayage trucks around ports |
| Hydrogen fuel cell          | ↓ Greenhouse gas emissions  
↓ Local air pollution  
↑ Vehicle range  
↑ Renewable energy use  
↓ Refueling time | ↑ Infrastructure cost  
↑ Hydrogen cost  
↑ Vehicle cost  
↓ Lifecycle energy efficiency | • Heavy-duty tractor-trailers with long-haul operation  
• Drayage trucks around ports |
Learning from other sectors

- Buses
- Heavy-duty trucks
- Specialty HDVs
- Light-duty passenger vehicles
Who’s building what?

Fuel cell
- Scania
- Toyota
- Hyundai
- Kenworth
- Nikola

E-road
- Siemens
- Volvo
- Tesla
- Scania
- TransPower

Battery electric
- BYD
- Mitsubishi Fuso
- Mercedes-Benz
- Freightliner
- Navistar
- Cummins
- MAN
Zero-emission trucks in fleets and on the streets

- SIEMENS eHighway: Battery electric
- Loblaw: Battery electric
- ERevue: Battery electric
- ASKO: Hydrogen
- SIEMENS eHighway: Battery electric
- Heineken: Battery electric
- TOYOTA: Hydrogen
- UPS: Battery electric
- Delanchy: Battery electric
- FritoLay: Battery electric
- Seven Eleven: Hydrogen
- BYD: Battery electric
Progress on electric heavy-duty trucks is “happening faster than we expected.” –Roger Nielsen, CEO of Daimler Trucks, November 2018

9 of the 10 largest truck manufacturers have announced firm plans for zero-emission trucks

Can policy and infrastructure keep up?
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ICCT electric vehicle page: http://theicct.org/electric-vehicles

Acknowledgements

Analysis by Marissa Moultak, Nic Lustey, and Dale Hall
Full report available at: https://www.theicct.org/publications/transitioning-zero-emission-heavy-duty-freight-vehicles