Vehicle Electrification in BC

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Outline

• Context
• BC all-sector, on-road transport to 2040
  • Baseline electrification scenario
  • Crash-program electrification scenario
• Class 8 vehicle options
Context

BC has a large on-road transport GHG footprint
In BC, we plug into WECC

- Emissions are source dependent
- Complicated market operations
  - Energy trades
  - Ramping
  - Regulation
  - Intertie constraints
- Ongoing research
  - Demand response
  - Renewables penetration
- BC Hydro
  - Domestic 30 t CO2e/GWh average

BC On-road Transport Electrification Scenarios
Project fleet sales based on fitting GDP-sales relation to obtain banded stock projections

ICEs will continue to improve: assume we meet US EIA targets & regulations in Canada/US
Fit sales adoption curves to 2030 BC Gov’t & McKinsey targets/projections

- 2030 passenger sales share
  - Agrees with REPAC model @ 30%
- Heavy duty fleet aggregation
  - Should separate by trip length, etc.
- Disruptors?
  - Mode shifts
  - Commuting distances
  - km/yr and t-km/yr travelled
    - Internet shopping deliveries
    - Ride sharing/hailing

1) Baseline scenario

2) Crash program scenario: 99% share in 2032 to meet 2030 GHG transport sector target

In the baseline scenario, medium duty (MT) trucks play a key role due to MT fleet size
The baseline scenario is slow to get going, but important sectors emerge

Bad news: we are going to miss our GHG targets...
The 2030 crash program (solved for 2032 99% sales share) is much more impactful

And sets the stage for deep GHG reductions
Class 8 Vehicle Drivetrain Options

Vancouver Fraser Port Authority, Container Truck GPS Data: 1598 trucks Nov. 2016

- Class 8 lumping too coarse
  - Drayage vs. long-haul routes
  - Elevation changes
  - City vs. highway conditions
- Electric drivetrain suitability
  - Battery cost/weight
  - Plug-in hybrid options
Selected six protoypical routes selected, including elevation and real speeds

Various drivetrain options & models, including battery sizing assumptions

A) Conventional drivetrains (Natural gas or diesel)
B) Battery electric drivetrains
C) Parallel hybrid (Natural gas or diesel)
D) Series hybrid (Natural gas or diesel)
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A) Conventional drivetrains (Natural gas or diesel)
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D) Series hybrid (Natural gas or diesel)
E) Parallel hybrid Catenary (Natural gas or diesel)
F) Series hybrid Catenary (Natural gas or diesel)
G) Parallel hybrid FC
H) Series hybrid FC

Range of fuel & component scenarios

- High-carbon fuel scenario
  - Standard diesel, CNG
  - H2 from methane reforming
  - WECC electricity mix
- Low-carbon fuel scenario
  - 20% biodiesel
  - Landfill R-CNG
  - H2 from electrolysis in BC
  - BC Hydro electricity
- Variations in expected drivetrain component efficiencies

- Cost data
  - Fuel
  - O&M
    - Differential with technology
  - Infrastructure fleet amortization
    - CNG fueling station
    - H2 fueling station
    - Catenary
    - 60 kW charging station for parallel hybrid
    - 500 kW charging station for series hybrid
Ongoing work

- Final costs & sensitivity study
  - Spoiler alert
    - Diesel & CNG win on total costs
    - Plug-in (catenary) parallel hybrid diesel later
    - Infrastructure are key – catenary looks quite good if you’re not the one paying for it!

- Market penetration analysis
  - Input drivetrain performances & costs into CIMS
  - Simulate up-take for heavy-duty market segments
    - Differentiate by trip length, etc.
  - Refine rollout to 2040/2050 for heavy duty
    - Identify key electrification target segments
    - Electrical & fuel usage
Questions?

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  • Dr. Julian Julian-Alberto Fernandez-Orjuela  
  • Dr. Ned Djilali

• Class 8 vehicles study  
  • Mojtaba Ladjevardi  
  • Dr. Jonn Axsen

Component sizing assumptions required

• Commercially available CNG engine  
  • 11.9 L Cummins comparatively undersized

• Plug-in parallel combustion hybrids  
  • Battery provides power below 20% ICE engine power

• Parallel fuel cell hybrid  
  • < 30 kW only battery power to avoid part-load fuel cell operation

• Series combustion & fuel cell hybrids  
  • Fixed (larger, standard) ICE engines  
  • Sized to maintain minimum battery SOC @ end of cycle  
  • Leads to larger battery packs for series compared to parallel ICE hybrids

• Catenary  
  • Fully electric operation with battery charging depending on road load