Updating and extending Vehicle Fleet Emission Model

November 2018 | By Haobo Wang, Tim Denne[1], Adolf Stroombergen[2], Iain McGlinchy, Ralph Samuelson, Sina Mashinchi, and Stuart Badger

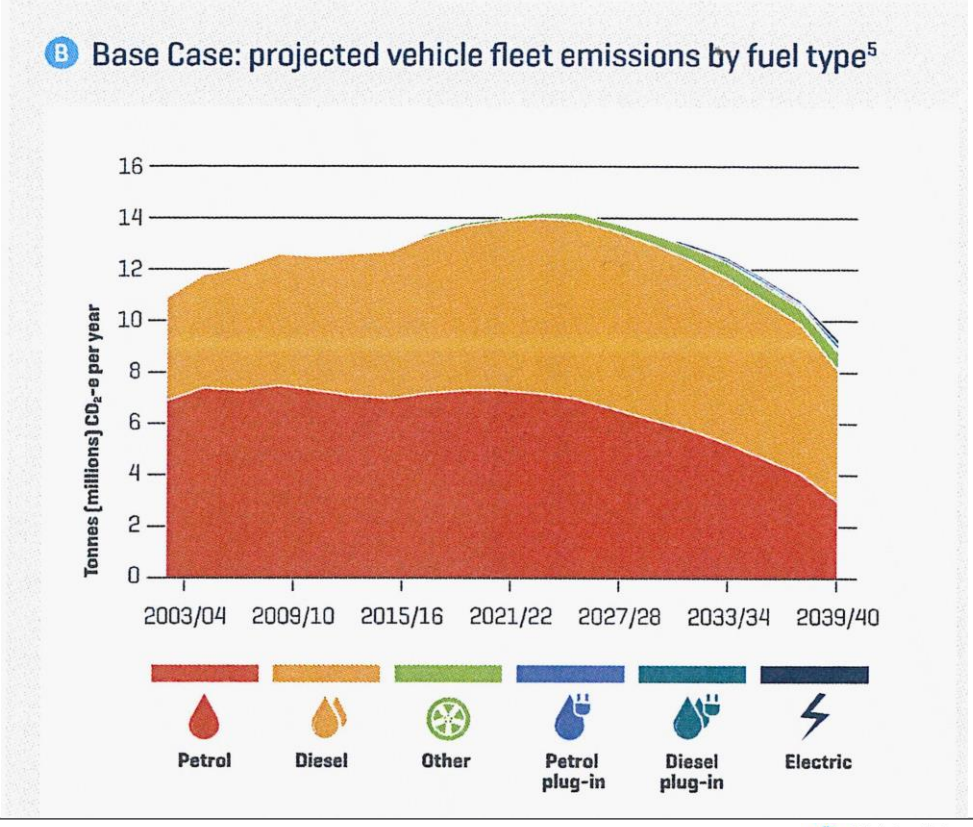
Ministry of Transport
TE MANATŪ WAKA

[1] Resource Economics
[2] Infometrics

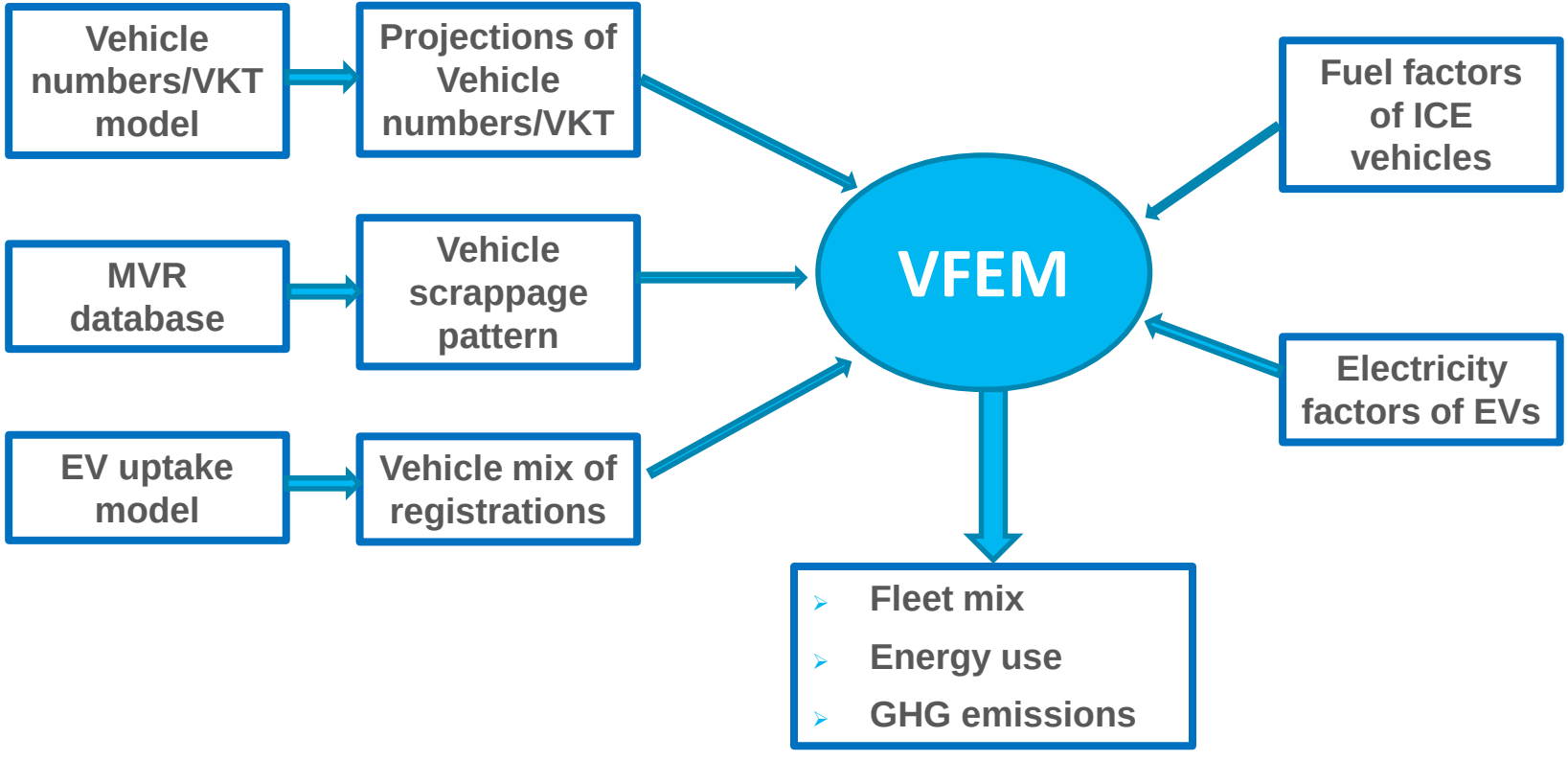
What is VFEM?

- MoT's Vehicle Fleet Emission Model can project vehicle fleet composition, energy (fuel and electricity) use, and greenhouse gas emissions
- VFEM has been used extensively for low carbon policy developments and related CBAs, as well as international reporting

Base Case



How does VFEM work?



Why does VFEM need to be updated and extended?

- **Currently it can only project up to 2040**
  - Need to support low carbon policy for net zero emissions by 2050
- **An EV uptake model was developed in 2015, mainly for light passenger vehicles**
  - EV technology/market has developed fast
  - Light commercial vehicles
  - Heavy vehicles
- **A study for real-world fuel efficiency was carried out in 2014**
  - A large body of more recent data is available

Infometrics covec

A Model for Projecting the Uptake of Electric Vehicles

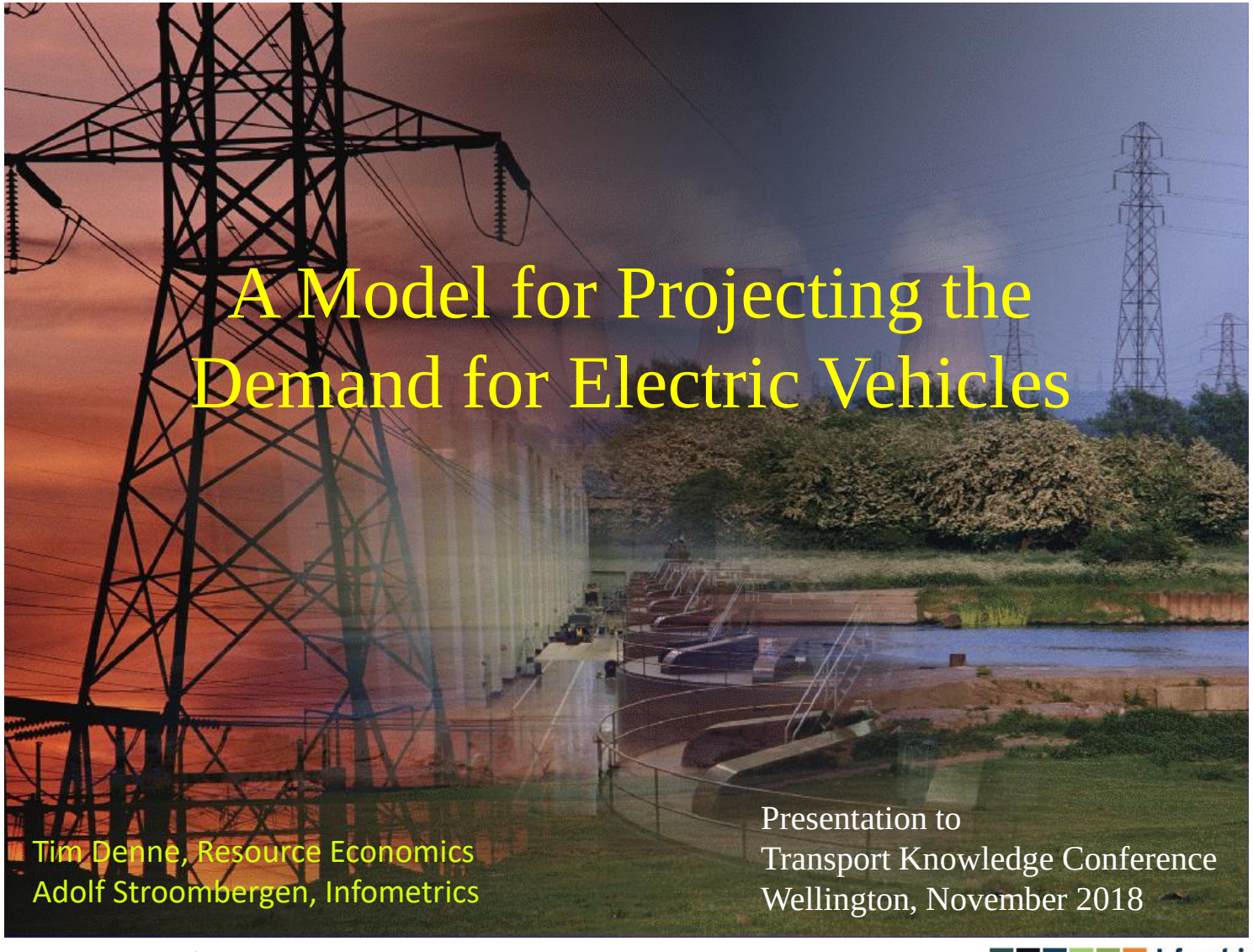
for Ministry of Transport

August 2015

What are we doing for VFEM?

Four work streams are underway to extend VFEM to 2055

- Updating and extending of EV uptake model
  - *Detailed economic/market analysis*
  - *LPVs, LCVs, and HCVs*
- Updating of the study on real-world fuel efficiency
  - *A large amount of data has been obtained from three sources*
- Extending of the vehicle numbers and VKT model
- Revision of VFEM model structure

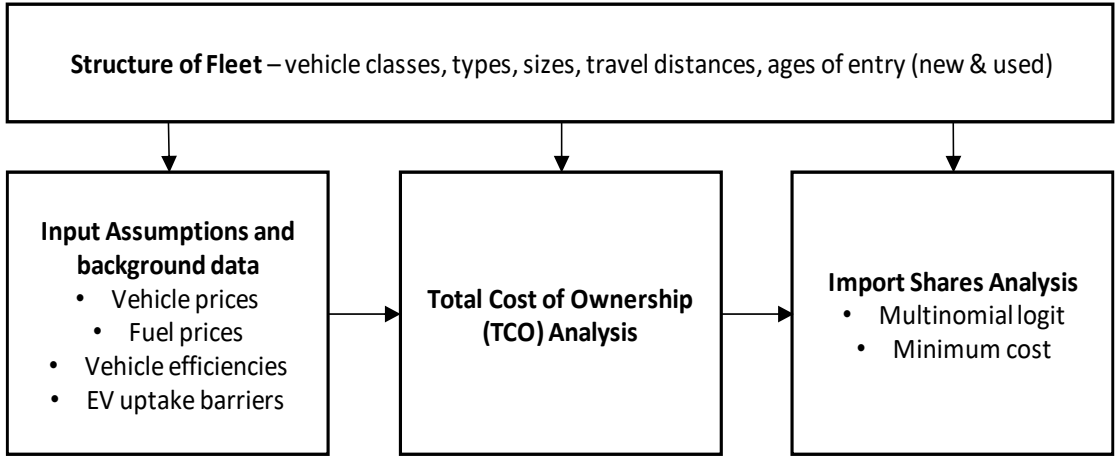


A Model for Projecting the Demand for Electric Vehicles

Tim Denne, Resource Economics
Adolf Stroombergen, Infometrics

Presentation to
Transport Knowledge Conference
Wellington, November 2018

Model Structure



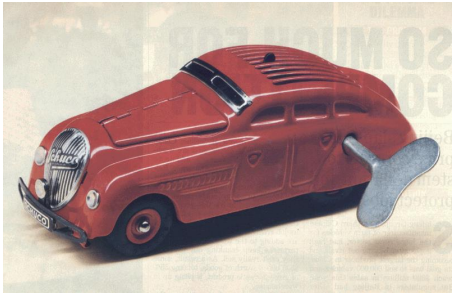
The model has different worksheets for:

- Inputs (yellow tabs)
- Results (green tabs)
- Scenarios (grey tabs)
- Data (red tabs)
- Workings (blue tabs).

Vehicle Demand

Demand V_i may be expressed as:

$$V_j = f(X_{ij}, Z_{ij})$$
$$Z_{ij} = f(distance\ travelled)$$



where:

- V_j is the demand for vehicles of type j; petrol IVEV, diesel ICEV, BEV & PHEV-P and PHEV-D.
- X_{ij} are explanatory variables with a unit cost (per km) that does not depend on distance travelled (such as fuel prices).
- Z_{ij} are explanatory variables with a unit cost (per km) that does depend on distance travelled – essentially variables such as the cost of the vehicle.

All costs are converted to total operating costs (TOC) per km

Multinomial Logit Model

The utility (U) of individual i who selects vehicle option j is given by:

$$U_{ij} = V_j + \varepsilon_{ij}$$

where j is ICEV-P, ICEV-D, BEV, PHEV-P or PHEV-D.

From the standard multinomial logit model the share of buyers (S) who select option j is given by:

$$S_j = \frac{P_j}{\sum_j P_j} = \frac{e^{V_j}}{\sum_j e^{V_j}}$$

So the share of buyers choosing any option j is:

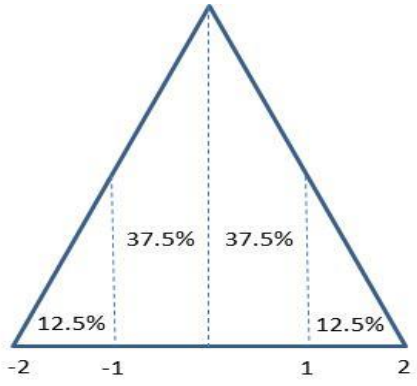
$$Ln(S_j) = \alpha_j + \sigma Ln(U_j)$$

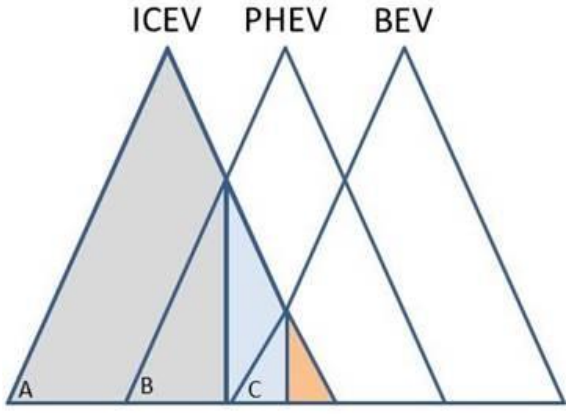
Here α is a calibration parameter and σ is the elasticity of the share of buyers choosing option j with respect to the utility associated with that option.

By Roy's Identity:

$$Ln(S_{jt}) = \beta_{j0} - \eta Ln(TOC_{jt})$$

Minimum Cost Model

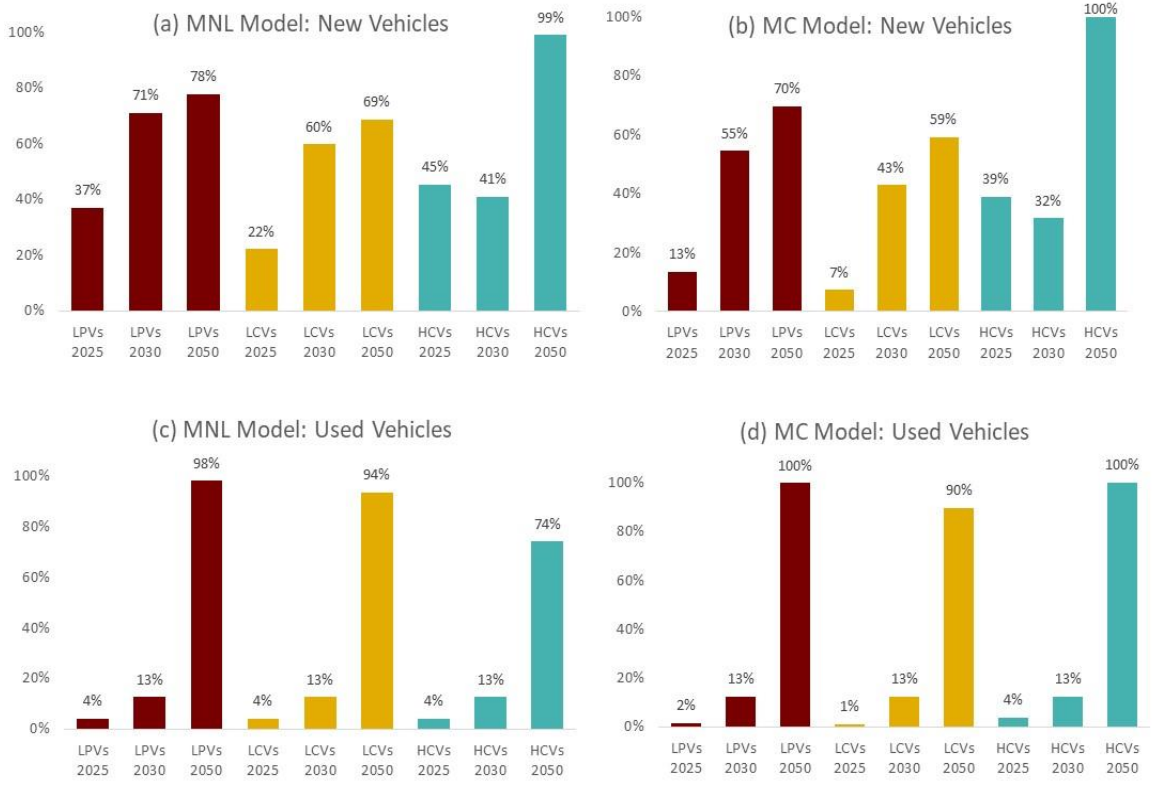




Split of ICEV triangle:

- ICEV gets 100% of triangle A, less 50% of triangle area B (the grey area).
- PHEV gets 50% of triangle B, less 50% of triangle C (the blue area).
- BEV gets 50% of triangle C (the orange area).

Selected Outputs:
EV% of New Registrations



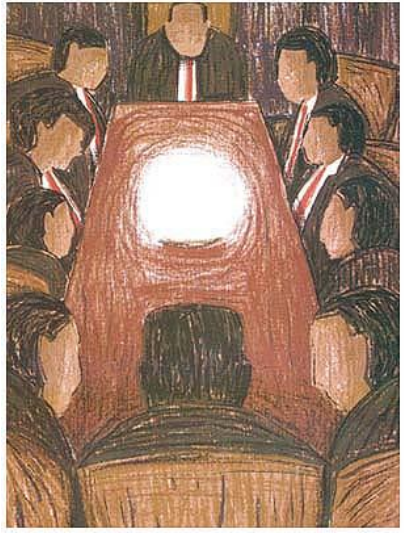
Summary

The model projects a long way into the future. There is considerable uncertainty. For example:

- Oil prices
- Electricity prices
- Carbon price
- Rate of change in EV battery storage capacity
- Rate of price decline of EV batteries
- Battery depreciation (physical and economic)
- Future policy settings (eg excise taxes)

We don't have a crystal ball so:

- Many inputs may be changed by the user
- But there is a risk of silly results
- Users should be careful!



Updating of real-world fuel efficiency study

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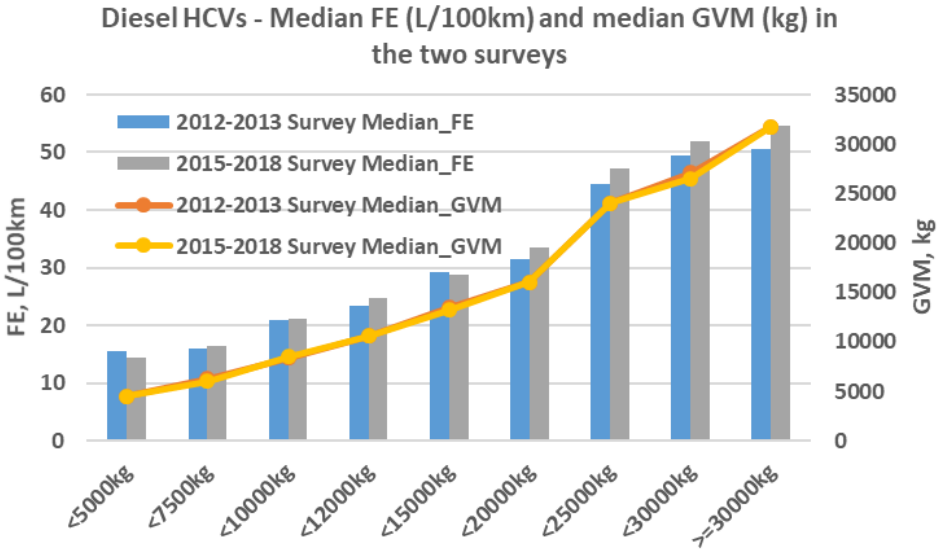
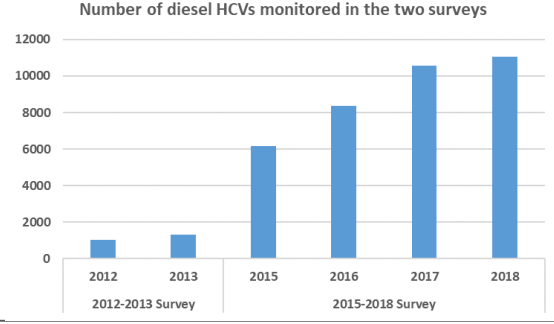
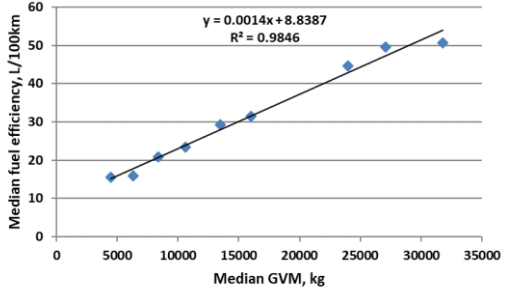
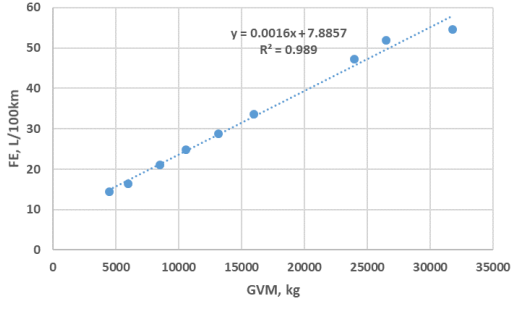
Real-world fuel use data from EROAD

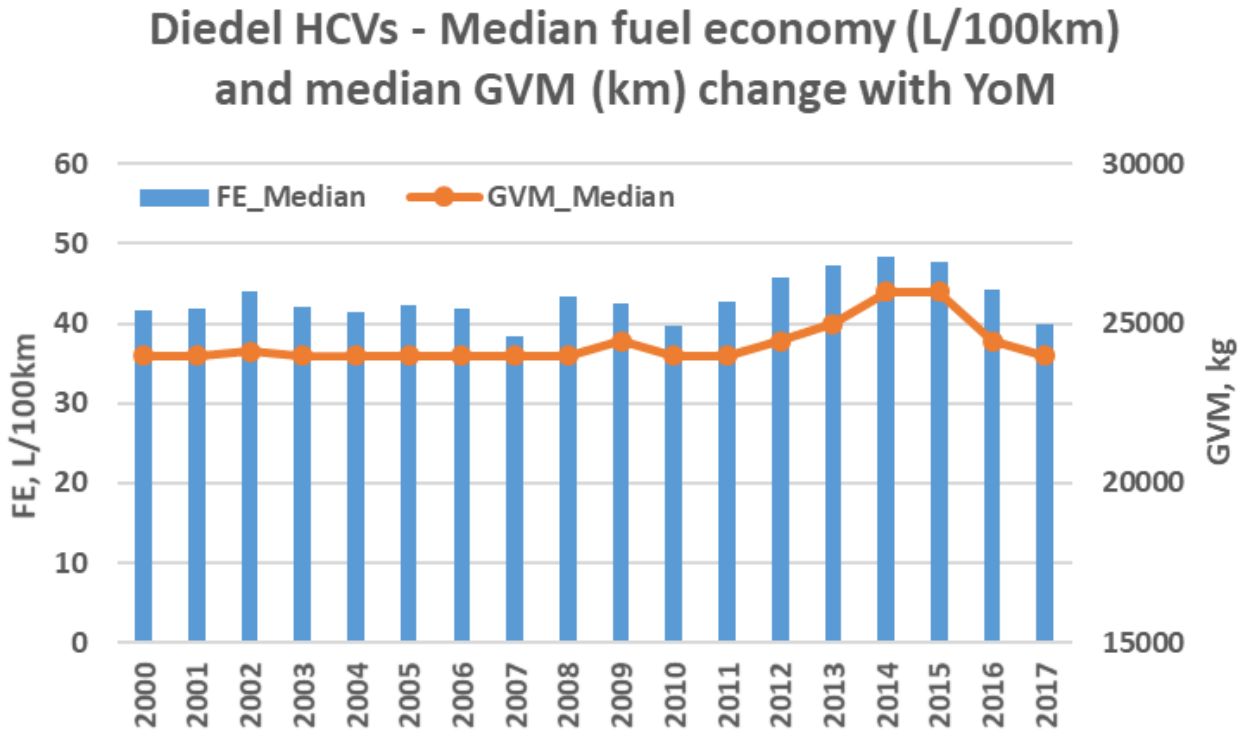








Real-world fuel use data from EROAD – Cont'd



- Variation in FE is likely caused by GVM changes
- **Further confirm that FE seems not to change with YOM for heavy diesel trucks**

Contact:

h.wang@transport.govt.nz

Thank you