Real-world fuel economy of heavy trucks

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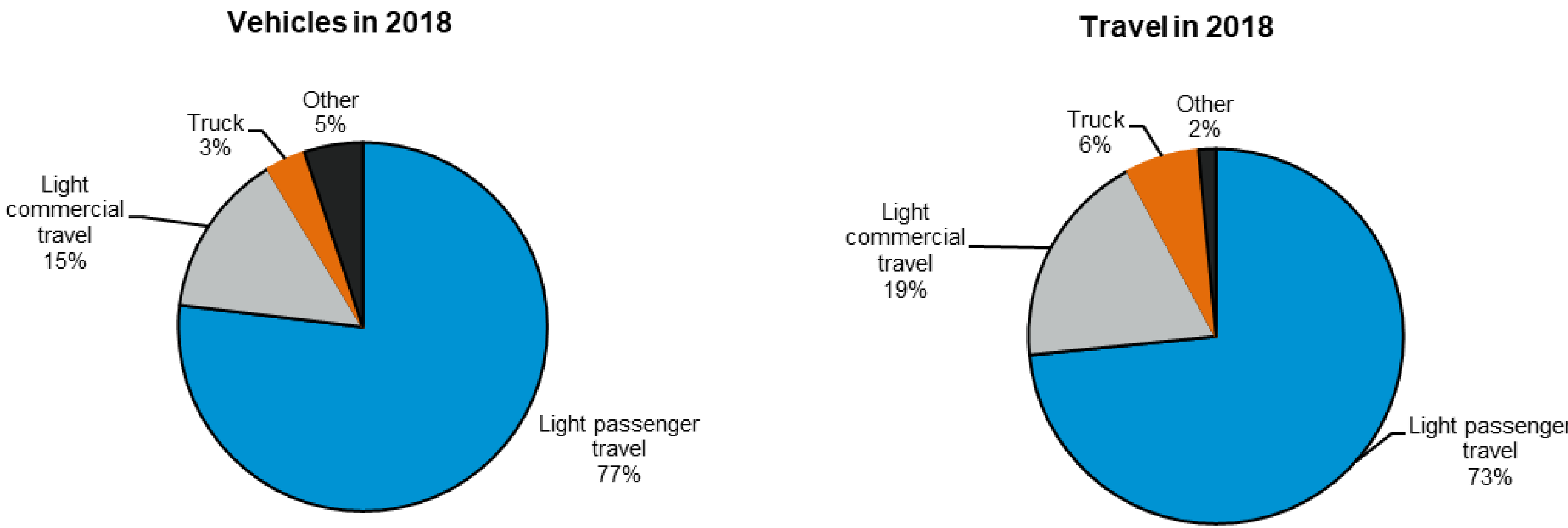
Background

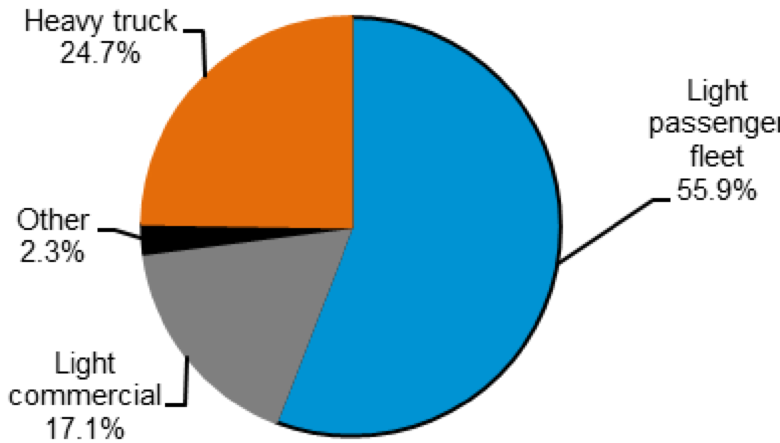
Vehicle fleet mix and travel



- Heavy trucks accounted for 3% of vehicles, but 6% of vkt
- They used a lot more fuel for every km travelled

Heavy trucks are gross emitters

2017 CO_2 emissions



Source : VFEM (Vehicle Fleet Emission Model)

- Road transport contributed about 18% of national GHG emissions
- Heavy trucks contributed roughly a quarter of the road emissions

Study fuel economy in terms of litres/100km

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Heavy diesel trucks surveyed in EROAD data

- Fuel use and VKT for each truck were recorded in each month from Jan 2015 to Aug 2018
- Actual loads were not recorded
- Data was analysed for more than 35,000 heavy trucks, with several thousands trucks surveyed each year; overall, more than one thousand trucks were surveyed for each GVM category
- EROAD data are fairly representative of NZ heavy truck fleet

	NZ truck fleet (Sep 18)		EROAD data	
Gross vehicle mass (GVM)	GVM_Mean	GVM_Median	GVM_Mean	GVM_Median
<5000kg	4,401	4,495	4,395	4,495
<7500kg	5,825	5,700	5,869	5,995
<10000kg	8,698	8,900	8,370	8,500
<12000kg	10,653	10,600	10,622	10,600
<15000kg	13,203	13,210	13,055	13,200
<20000kg	16,284	16,000	16,282	16,000
<25000kg	23,298	24,000	23,610	24,000
<30000kg	26,901	26,000	27,179	26,500
>=30000kg	32,210	32,000	31,891	31,780

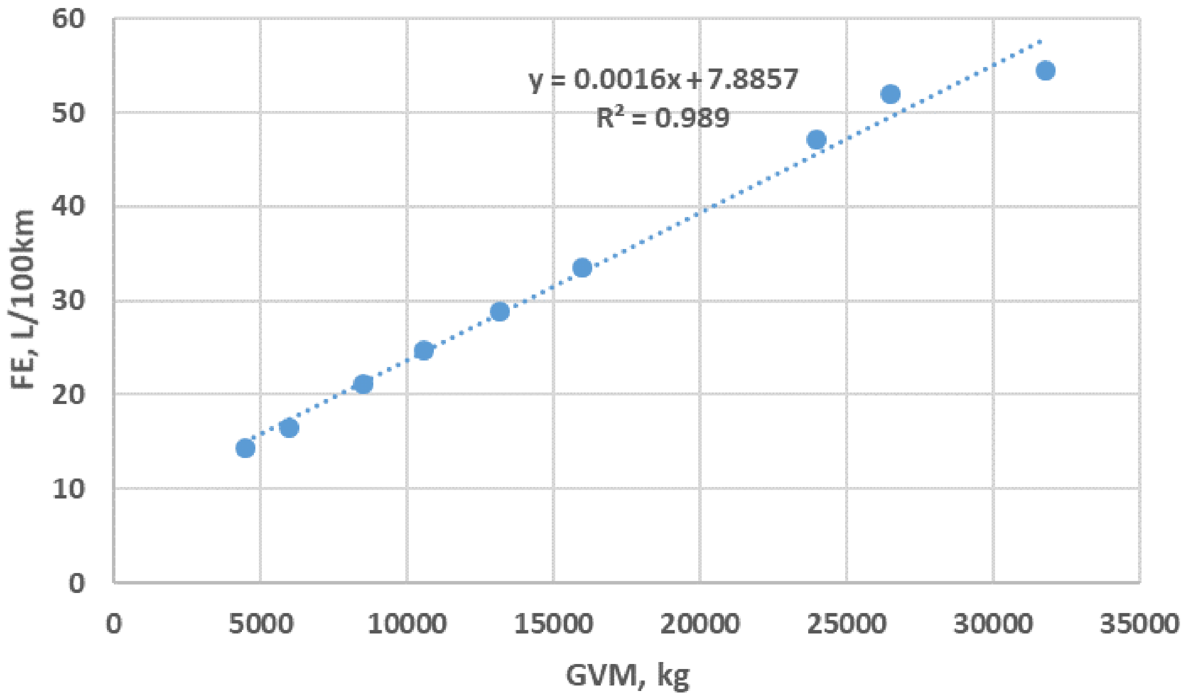
Real world fuel economy of heavy diesel trucks

- They were operating in actual configurations, with trailers, semi-trailers and loads

					Adjusted for NZ fleet GVM	
	FE_Mean	FE_Median	GVM_Mean	GVM_Median	Adj_FE_Median	Adj_FE_Mean
<5000kg	14.83	14.38	4,395	4,495	14.38	14.85
<7500kg	17.05	16.46	5,869	5,995	15.65	16.92
<10000kg	22.40	21.11	8,370	8,500	22.10	23.27
<12000kg	26.44	24.80	10,622	10,600	24.80	26.52
<15000kg	31.17	28.83	13,055	13,200	28.83	31.52
<20000kg	36.65	33.60	16,282	16,000	33.60	36.65
<25000kg	47.33	47.23	23,610	24,000	47.23	46.70
<30000kg	51.62	51.96	27,179	26,500	50.98	51.09
>=30000kg	54.91	54.58	31,891	31,780	54.96	55.46

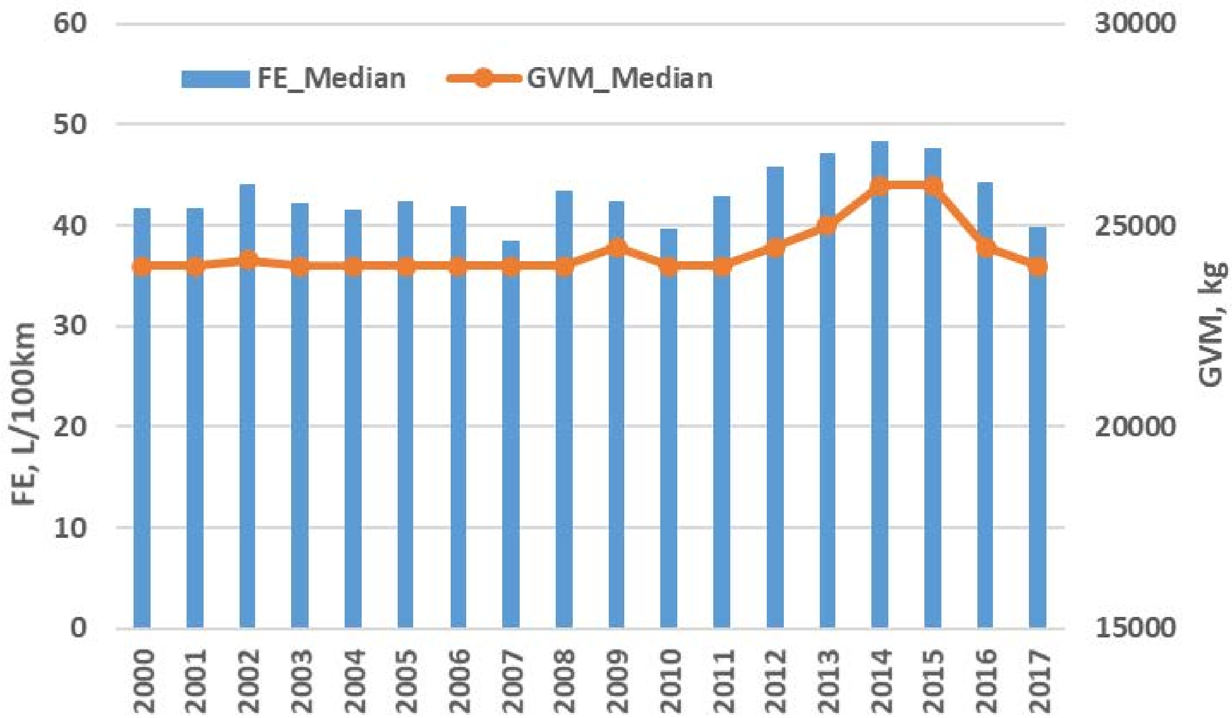
- Fuel economy (FE) in L/100km
- Gross vehicle mass (GVM) in kg
- Data was analysed for more than 35,000 heavy trucks, with several thousands trucks surveyed each year; overall, more than one thousand trucks were surveyed for each GVM category

Good linear relationship between FE (L/100km) and GVM (kg)



- Exception at the top end

Real world FE (L/100km) *vs.* Year of Manufacture



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

Study fuel economy / emission intensity in terms of grams CO_2/tonne-km

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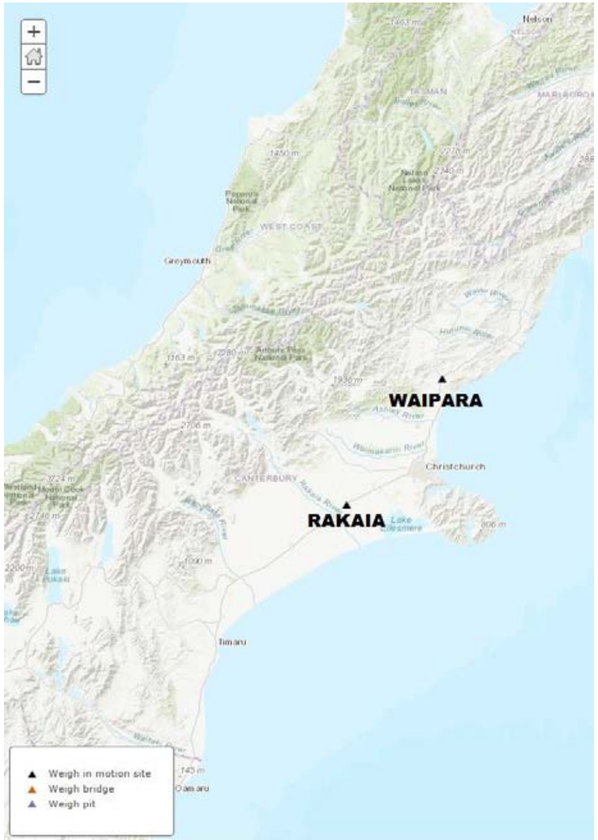
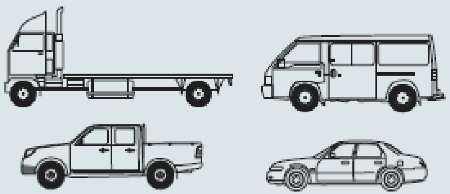
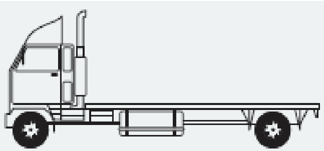
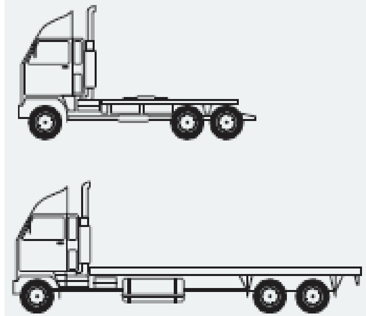
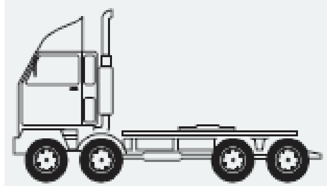
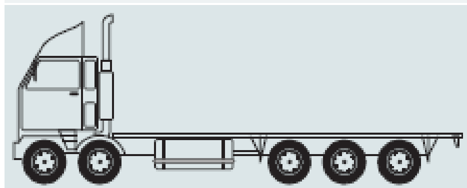
Load factors are essential – Weight in Motion data



- Seven WiM sites are managed by NZTA
- Load factors can be determined by RUC type (together with tare weight data in Motor Vehicle Register)

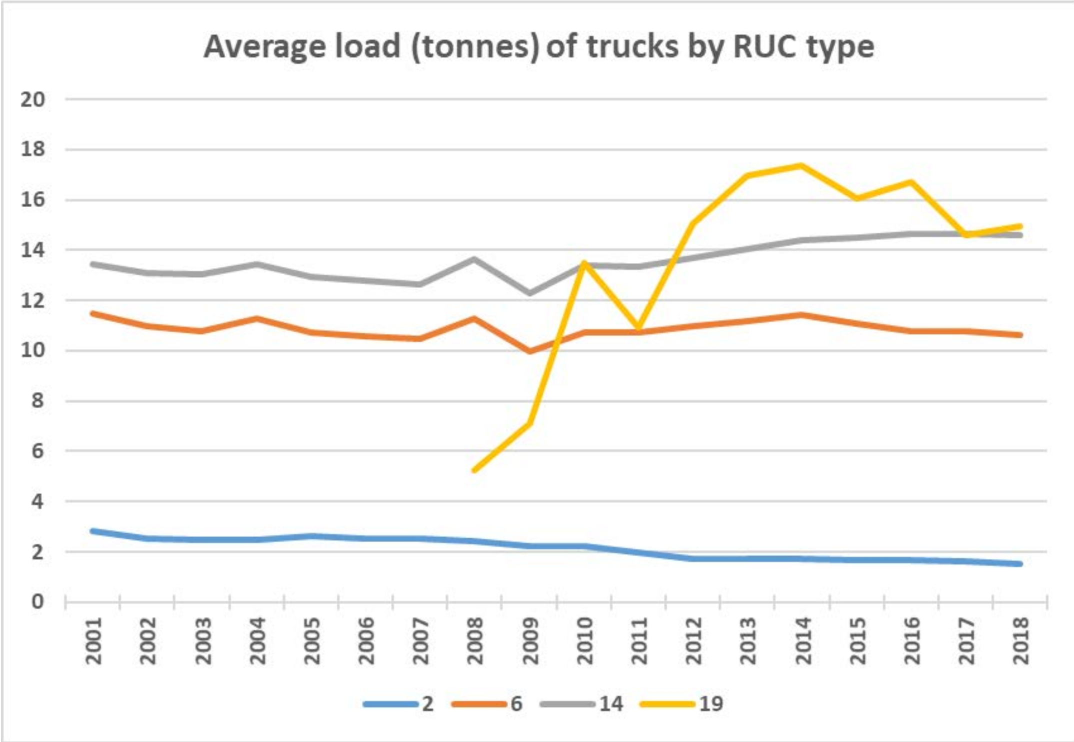
Typical RUC types for powered trucks

Vehicle sample	RUC vehicle type number	Description
	1	Powered vehicles with 2 axles (except type 2 or type 299 vehicles)
	2	Powered vehicles with 1 single-tyred spaced axle and 1 twin-tyred spaced axle

Vehicle Sample	RUC Vehicle type number	Description
	6	Powered vehicles with 3 axles (except type 308, 309, 311, 399 or 413 vehicles)
	14	Powered vehicles with 4 axles (except type 408, 414 or 499 vehicles)
	19	Powered vehicles with 5 or more axles (except type 599 vehicles)

- Heavy trucks of RUC type 1 grouped into RUC type 2
- Other RUC types are grouped into these types

Average load factors by RUC type (WiM data)



- The average load for RUC type 2 trucks has decreased over time
- Average loads of RUC type 19 have been subject to large fluctuations due to the small numbers of these trucks

Freight volume (tonne-km) by RUC type in NZ

Freight volume in 2018 NZ heavy truck fleet

Ruc type	Tonne-km (Million)	Share
2	1,949	7.7%
6	8,302	32.8%
14	15,012	59.3%
19	67	0.3%

- Overall, more than 10,000 trucks were surveyed in each of RUC categories 2, 6, and 14 in the EROAD data set
- Use of RUC type 19 trucks has been very limited in NZ, so the EROAD fuel use survey included very few of them

Emission intensity (EI) of heavy diesel trucks

- Assume the average load factors in EROAD data are the same as those determined in WiM data for each RUC type

EI (g CO_2/tkm) for all trucks

Survey year	EI_Mean	EI_Median
2015	188	118
2016	195	120
2017	220	127
2018	236	135

EI (g CO_2/tkm) by RUC type

	2		6		14	
Survey year	EI_Mean	EI_Median	EI_Mean	EI_Median	EI_Mean	EI_Median
2015	378	336	114	116	98	99
2016	413	370	119	121	98	98
2017	427	384	120	120	99	98
2018	432	389	119	118	98	97

Urban delivery *vs.* long haul (g CO_2/tkm)

	Urban delivery		Long haul	
Survey year	EI_Mean	EI_Median	EI_Mean	EI_Median
2015	378	336	106	104
2016	413	370	108	105
2017	427	384	109	106
2018	432	389	108	105

Assumptions:

- Urban delivery: RUC type = 2 (including heavy trucks of RUC type 1)
- Long haul: RUC type = 6, 14, and 19

Heavy truck emissions vs. other NZ freight modes

Mode	Typical g CO_2/tkm
Coastal shipping (oil products)	16
Coastal shipping (other bulk)	30
Coastal shipping (container freight)	46
Rail (electric)	7
Rail (diesel)	29
Rail (NZ average)	28
Long-haul heavy truck	105
Urban delivery heavy truck	390

- Coastal shipping figures based on international data for ships comparable to those used in NZ
- Rail figures based on data provided by Kiwirail; electric includes indirect emissions

Summary

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Main conclusions

- Heavy trucks contribute about a quarter of GHG emissions from road, despite representing only 6% of vkt
- On average, heavy trucks' fuel economy in terms of litres/100km has a strong linear relationship with GVM
- It appears heavy trucks' fuel economy in terms of litres/100km does not change with YoM
- This is the first time, CO_2 emissions per tonne-km have been studied for NZ's heavy trucks
- For all trucks, the emission intensity could be around 135 g CO_2/tkm in 2018
- RUC type=2: 390 g CO_2/tkm (upper bound); RUC type=6: 120 g CO_2/tkm; RUC type=14: 100 g CO_2/tkm
- The upper bound for urban delivery could be 390 g CO_2/tkm (increased over time due to decreased load); while for long haul the emission intensity could be 105 g CO_2/tkm
- Compared to road, emission intensity of freight transport by rail and coastal shipping is significantly lower
- Emission saving of shifting long-haul road freight to rail/shipping will vary with commodity type
- Emissions from urban delivery could be reduced by operation efficiency improvement, EV and biofuel uptake

Acknowledgement:

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Thank you