Energy profile of a fleet of forestry trucks

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SUMMARY

In the summer of 2016, FPInnovations conducted a study in order to quantify the fuel consumption and calculate the energy intensity of part of the forestry transport fleet of Resolute Forest Products on the North-Shore. The purpose of the study was to establish a benchmark that would serve as a basis of comparison among the different trucks and drivers. Previous studies by FPInnovations had already shown that individual driving habits have a considerable impact on fuel consumption and energy intensity. For the purposes of the study, fuel consumption was measured by filling at the pump and by the readout from the engine control module (ECM).

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INTRODUCTION

In the summer of 2016, FPInnovations conducted a study in order to quantify the fuel consumption and calculate the energy intensity of part of the forestry transport fleet of Resolute Forest Products in the North Shore operation. The purpose of the study was to establish a benchmark that would serve as a basis of comparison among the different trucks and drivers. Previous studies by FPInnovations had already shown that driving habits have a considerable impact on fuel consumption and energy intensity. For the purposes of the study, fuel consumption was measured by filling at the pump and by the readout from the engine control module (ECM). The two methods were compared in order to establish a factor that can be used to calibrate the ECM value and inform users of possible variations in the data drawn from it. The results of this study are presented in the report.

OBJECTIVE

The objective of the study was to determine fuel consumption, energy intensity and to establish the correction factor for the ECM by comparing the values from the two different methods:

- Data from filling the tank at the pump.
- Data from the ECM.

The data from filling at the pump were the reference measure, and served to calibrate and confirm the fuel data taken from the ECM. Scale data from the mill were used to calculate the energy intensity. The fuel consumption data that were collected will also be useful if an energy efficiency improvement program is planned.

METHODOLOGY

Data were collected in July 2016 from 20 log trucks from the transport fleet of Resolute Forest Products. FPInnovations asked the trucks to stop after each trip to fill up on fuel at the tank located outside the mill yard. At each stop, the ECM data were downloaded using an Ultra-Link portable data collection device. Among other data, this device records fuel consumption, distance travelled, and engine hours. FPInnovations was not able to read the ECM for certain trucks in the fleet. Information was collected on both day and night shifts in order to cover the entire period of operation for the observation week. After fuel consumption data were collected, the scale readings for all trips were sent to FPInnovations so that energy intensity could be calculated (L/tonne-100 km).

Table 1 provides a list of the trucks that participated in the study.

Table 1: List of trucks that participated in the study.

Truck ID	Drivers	Brand	Engine	Power (hp)
1	Driver A Driver B	Westernstar	DD-15	550
2	Driver A Driver B	Westernstar	DD-15	550
3	Driver A	Kenworth	DD-15	550
4	Driver B Driver A	Westernstar	Caterpillar	475
5	Driver A Driver B	Westernstar	DD-15	560
6	Driver A	Westernstar	DD-15	550
7	Driver A	Westernstar	DD-15	550
8	Driver A Driver B	Kenworth	Caterpillar	475
9	Driver A	Kenworth	Caterpillar	550
10	Driver A Driver B	Westernstar	DD-16	600
11	Driver A Driver B	Westernstar	DD-15	550
12	Driver A	Westernstar	DD-15	550
13	Driver A	Westernstar	DD-16	600
14	Driver A	Kenworth	Caterpillar	500
15	Driver A Driver B	Kenworth	Caterpillar	550
16	Driver A Driver B	Kenworth	Caterpillar	475
17	Driver A Driver B	Westernstar	DD-15	550
18	Driver A Driver B	Westernstar	DD-15	550
19	Driver A	Westernstar	DD-15	550
20	Driver A Driver B	Kenworth	Caterpillar	550

RESULTS

Table 2 presents the average fuel consumption calculated for all trucks and drivers. Fuel consumption in litres per hour varied from 24.4 to 33.7 L/h, with an average of 27.8 L/h. Fuel consumption in litres per 100 km, meanwhile, varied from 50.8 to 75.6 L/100 km, with an average of 61.3 L/100 km over all trucks.

Table 2: Fuel consumption and ECM correction factor.

Truck ID	Drivers	Consumption at the pump		ECM correction factor (%)
		Litres/h	Litres/100 km	
1	Driver A	30.9	62.5	-2.7
	Driver B	26.2	58.0	
2	Driver A	27.6	60.6	4.8
	Driver B	24.4	50.8	
3	Driver A	26.1	58.8	-8.5
4	Driver B	26.5	60.9	-2.7
	Driver A	26.9	60.2	
5	Driver A	26.6	59.0	-4.2
	Driver B	26.6	59.3	
6	Driver A	28.8	67.0	-2.9
7	Driver A	27.8	61.7	-2.6
8	Driver A	33.7	75.6	-
	Driver B	26.1	58.1	
9	Driver A	25.5	58.5	-
10	Driver A	26.0	57.6	-3.5
	Driver B	30.8	63.0	
11	Driver A	27.2	58.0	-13.4
	Driver B	25.4	61.4	
12	Driver A	27.8	64.4	-
13	Driver A	26.9	63.2	3.4
14	Driver A	26.1	57.6	-12.3
15	Driver A	30.6	67.1	-
	Driver B	28.6	60.3	
16	Driver A	25.9	59.7	-
	Driver B	30.8	63.2	
17	Driver A	26.9	56.5	-7.4
	Driver B	31.9	72.2	
18	Driver A	27.5	60.0	-
	Driver B	27.7	59.3	
19	Driver A	29.0	65.2	-1.9
20	Driver A	28.3	63.0	-3.5
	Driver B	27.8	62.6	

For trucks with equivalent configurations, i.e. a 3-axle tractor and a 4-axle semitrailer, earlier studies by FPInnovations showed average fuel consumptions of 28 L/h and 60 L/100 km with no back haul. We observe that the variation between fuel pump data and ECM data ranges from -12.3% to 4.8%. These variations are considered normal. However, by calculating a calibration factor, it is possible to use this factor and the data from vehicle telemetry to obtain a fuel consumption figure that is closer to actual consumption at the pump. To this end, FPInnovations produced a report explaining the procedure to follow (Surcel and Michaelsen, 2009).

Factors such as driving techniques (progressive shifting) and habits (speed and acceleration/deceleration), the truck's empty weight, the load being carried and the idling time have a direct influence on fuel consumption. Driving habits and techniques can be tracked through the use of an on-board computer, and corrective actions can be taken through a continuous improvement program. With regard to the loaded and unloaded weight, energy intensity is an indicator that can be used to relate these two elements to fuel consumption, since it is expressed in terms of litres of fuel consumed per tonne hauled per 100 kilometres. Table 3 shows the energy intensity of the different trucks and drivers.

Table 3: Energy intensity and variation among drivers.

Truck ID	Drivers	Average load (kg)			Energy intensity	Difference between drivers
		Tare	Payload	GVW	L/t-100 km	(%)
1	Driver A	18,463	39,575	58,038	1.58	8.0
	Driver B	18,390	39,925	58,315	1.45	
2	Driver A	17,830	40,590	58,420	1.49	14.0
	Driver B	17,913	39,597	57,830	1.28	
3	Driver A	18,426	40,504	58,930	1.45	n/a
4	Driver B	18,845	39,436	58,282	1.54	0.1
	Driver A	18,985	39,000	57,985	1.54	
5	Driver A	18,780	39,119	57,899	1.51	0.8
	Driver B	18,830	39,000	57,830	1.52	
6	Driver A	18,315	39,093	57,408	1.71	n/a
7	Driver A	18,765	39,125	57,890	1.58	n/a
8	Driver A	18,260	41,120	59,380	1.84	19.5
	Driver B	18,404	39,269	57,673	1.48	
9	Driver A	19,518	39,618	59,135	1.48	n/a
10	Driver A	18,377	39,895	58,272	1.44	10.1
	Driver B	18,428	39,625	58,053	1.59	
11	Driver A	18,590	39,711	58,301	1.46	8.1
	Driver B	18,563	38,903	57,466	1.58	
12	Driver A	18,683	38,476	57,159	1.67	n/a
13	Driver A	18,857	39,627	58,484	1.59	n/a
14	Driver A	17,883	40,928	58,811	1.41	n/a
15	Driver A	18,604	39,529	58,133	1.70	10.2
	Driver B	18,613	39,568	58,182	1.52	
16	Driver A	18,938	39,230	58,168	1.52	6.4
	Driver B	18,805	39,075	57,880	1.62	
17	Driver A	18,230	39,837	58,067	1.42	26.6
	Driver B	18,237	40,177	58,413	1.80	
18	Driver A	18,740	40,095	58,835	1.50	0.5
	Driver B	18,751	39,810	58,561	1.49	
19	Driver A	18,952	39,357	58,308	1.66	n/a
20	Driver A	18,016	39,843	57,858	1.58	1.2
	Driver B	17,914	39,140	57,054	1.60	

*: Significant difference between the two unladen truck weights for each driver, but the data does not show any reason not to include certain trips.

The energy intensity of the different trucks and drivers participating in the study varied from 1.41 to 1.84 L/tonne-100 km. Previous studies for equivalent truck configurations show an average of about 1.60 L/tonne-100 km. As mentioned earlier, this indicator is influenced by fuel consumption, distance and the load being carried.

According to Table 3, the difference between the unloaded weights of the lightest truck (truck 2), at 17,830 kg, and the heaviest truck, at 19,518 kg (truck 9), is 1,688 kg. The heaviest truck is hauling 1.6 tonnes more when it is empty and 1.6 fewer tonnes of wood when it is loaded, which has a significant impact on the trucker's income. However, these two trucks have equivalent energy intensity values of 1.49 and 1.48 L/tonne-100 km, respectively. We observe that the heavier truck also had a gross vehicle weight (GVW) that exceeded the legal limit of 57,500 kg by about 1.6 tonnes. A load that exceeds the legal limit may cause damage and higher maintenance costs for the truck, in addition to violating provincial law. In this regard, out of 32 drivers, four had a GVW below the allowed legal limit of 57,500 kg, while the other 28 were hauling an average load in excess of the legal limit (without taking into account the tolerance of roadside inspectors).

The last column in the table shows the difference in energy efficiency (as a percentage) between two drivers using the same truck. This figure varies from 0% to 27%, which indicates that two drivers can show efficiency differences of over 27% for the same truck and the same route. The 27% difference is primarily explained by driving habits. The least efficient driver hauls an average of 346 kg more per trip, but consumes an additional 4.9 L/h or 3.5 L/100 km. Comparing the energy intensity of multiple drivers provides certain clues as to the factors that could be targeted to make improvements.

CONCLUSION

This study, conducted on a part of the truck fleet of Resolute Forest Products in the North-Shore, has allowed us to quantify the average fuel consumption for a given route, as well as the energy intensity. It was shown that there are important variations between different trucks and drivers in terms of unloaded weight (truck configurations and equipment) and fuel consumption, thereby shedding light on reference indicators for the implementation of a system for improving energy efficiency in trucking.

Installing on-board computers (OBC) in forestry trucks may be an effective means of determining fuel consumption in real time. Data from the OBC can be used to ensure that the estimated fuel consumption for a given route is correctly accounted for in haul rates, both for the mill and for the carrier. However, it is important that readings from the ECM be correctly calibrated, as indicated in the present report.

Data on fuel consumption drawn from OBCs can serve as an integral part of an energy efficiency management program aimed at reducing fuel consumption. For such a program to be effective, drivers must first be taught eco-friendly and energy-efficient driving techniques, and results must then be tracked using OBCs so that drivers can compare notes on their own fuel consumption.

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