Diesel and Energy Analysis for CRMCA

Developed by James Salazar – Athena Institute

The Canadian Ready-Mix Association (CRMCA) and the Athena Institute have recently completed an industry average LCA and EPDs for 7 Canadian regions. As part of this analysis, Athena calculated the use of energy in the raw materials extraction and production (A1), transportation (A2) and mixing plant operations (A3). Diesel is a significant source of fossil fuel consumption in the overall production of ready mixed concrete. This analysis summarizes the use of diesel in various steps in the life cycle as well as the overall significance of diesel relative to other energy sources. Finally, we have shared several factors and example calculations so users can estimate the carbon footprint and diesel use of delivered concrete.

To complete the analysis, we first selected representative non-air entrained 25 MPa mixes in the various regions. The analysis shows that the selection of a specific mix was less important than other factors.

A. Diesel Use

The estimation of diesel use in concrete production is limited by the fact that EPDs were used as the data source for the cement inputs. In the cement EPDs, diesel use is not separated, the energy use is only reported as renewable and non-renewable. This portion of the analysis thus excludes cement production diesel use. Admixtures are similarly excluded as they are also based on EPDs.

We were able to estimate the diesel used in aggregate production as well as the trucking of materials to concrete plants as well as their operations. The overall diesel use in the 7 regions is shown in Table 1 below and their relative contribution to overall diesel use in Table 2.

Table 1: Diesel Use Data for Cradle-to-Gate Concrete Production (Excluding Cement and Admixtures)

Inputs	Units	AB	Atl.	BC	MB	ON	QC	SK
A1								
Aggregate	l/m3	0.66	0.67	0.63	0.73	0.70	0.68	0.66
A2								
Aggregate Transport	l/m3	3.02	1.28	2.05	4.83	5.65	6.31	5.86
Cement Transport	l/m3	1.55	4.46	1.35	2.16	1.34	1.66	5.49
Other Transport	l/m3	0.01	0.01	0.03	0.06	0.00	0.00	0.07
A3								
Diesel in Fleet (Mixing)	l/m3	1.61	2.12	1.11	1.19	1.15	1.17	2.64
A4								
Diesel in Fleet (Delivery)	l/m3	3.77	4.95	2.58	2.77	2.67	2.72	6.15
Total Diesel Use	l/m3	10.63	13.49	7.75	11.73	11.51	12.54	20.87

Table 2 shows the use of contribution to total diesel use of the different processes. As expected, the delivery of the highest mass materials (aggregate and mixed concrete) cause the most diesel use. Its important to consider that transportation-related energy use can vary significantly depending on whether a concrete plant is near an aggregate quarry or cement supplier, and more importantly whether the construction site is near to the concrete facility.

Table 2: Relative Contribution to Diesel Use for Cradle-to-Gate Concrete Production (Excluding Cement and Admixtures)

Inputs	Units	AB	Atl.	BC	MB	ON	QC	SK
A1								
Aggregate	% of total	6%	5%	8%	6%	6%	5%	3%
A2								
Aggregate Transport	% of total	28%	9%	26%	41%	49%	50%	28%
Cement Transport	% of total	15%	33%	17%	18%	12%	13%	26%
Other Transport	% of total	0%	0%	0%	0%	0%	0%	0%
A3								
Diesel in Fleet (Mixing)	% of total	15%	16%	14%	10%	10%	9%	13%
A4								
Diesel in Fleet (Delivery)	% of total	35%	37%	33%	24%	23%	22%	29%

B. Overall Energy Use

As we noted previously, the estimation of diesel use in concrete production is limited by the fact that EPDs were used as the data source for the cement inputs. This section summarizes the overall energy balance which shows the relative significance of diesel use to other energy sources. The overall energy use in the 7 regions is shown in Table 3 below and their relative contribution to overall energy use in Table 4.

Table 3: Energy Use for Cradle-to-Gate Product System

Inputs	Units	AB	Atl.	BC	MB	ON	QC	SK
A1								
Cement and Other	mj/m^3	1,606	1,387	1,073	1,129	1,079	792	1,177
Aggregate	mj/m^3	28	28	27	31	29	29	28
A2								
Agg Transport	mj/m^3	127	54	86	203	237	265	246
Other Transport (incl. cement)	mj/m^3	66	188	58	93	57	70	234
A3								
Electricity	mj/m^3	29	13	19	9	19	23	29
Natural Gas	mj/m^3	77	19	20	53	69	35	199
Diesel in Fleet	mj/m^3	226	297	155	166	160	163	369
Other	mj/m^3	6	29	20	3	13	13	5
Total Energy Use	mj/m^3	2,163	2,014	1,457	1,687	1,664	1,389	2,287

Table 4: Contribution of Energy Use for Cradle-to-Gate Product System

Inputs	Units	AB	Atl.	BC	MB	ON	QC	SK
A1								
Cement and Other	%	74%	69%	74%	67%	65%	57%	51%
Aggregate	%	1%	1%	2%	2%	2%	2%	1%
A2								
Agg Transport	%	6%	3%	6%	12%	14%	19%	11%
Other Transport (incl. cement)	%	3%	9%	4%	6%	3%	5%	10%
A3								
Electricity	%	1%	1%	1%	1%	1%	2%	1%
Natural Gas	%	4%	1%	1%	3%	4%	3%	9%
Diesel in Fleet	%	10%	15%	11%	10%	10%	12%	16%
Other	%	0%	1%	1%	0%	1%	1%	0%

C. Delivery Energy Use

Tables 1 and 2 gave the estimated use of diesel in mixing trucks, with 30% allocated to mixing and the remaining 70% allocated to delivery. This 70/30 breakdown is specified by the PCR. To calculate a custom delivery scenario, Table 5 provides the background factors assumed in our model regarding transportation diesel use.

Table 4: Conversion factors to consider custom transportation scenarios

Diesel Use in Transport	Fuel use to transport 1 ton	Fuel use to transport 1 m^3 concrete 1 km	Fuel use to transport 1 m^3 concrete 10 km
Mode of Transport	l/ton	l/m3	l/m3
Truck	5.14E-02	1.21E-01	1.21
Rail	6.48E-03	N/A	N/A
Ocean	4.93E-03	N/A	N/A
Barge	9.59E-03	N/A	N/A