

Carbon Conversion Calculator Errors Report

for <http://www.carboncapture.us/?page=converter&sub=1>

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Introduction

Three types of calculation can be found in the website of www.carboncapture.us. These include calculation of:

1. carbon tax
2. fuel unit conversion
3. comparison of C tax and CO2 tax

The purpose of this report is to verify the accuracy of each calculation from these web pages, as well as to identify mistakes and error and to propose further adjustment and improvement.

A separate calculation was made in an Excel spreadsheet, which included higher significant digits. In this Excel spreadsheet is also explained literally about the background of each calculation using keywords, which can be leaded to their meaning and in which cell it can be found. Some of them included also some comparison, which show a slightly differences with the calculation from the web pages because of the higher significant digits.

CO2 Content in Gasoline and Diesel

This calculation the CO2 content of gasoline and diesel was determined based on Energy Information Association (EIA) CO2 emission coefficients, which are: 19.564 lbs CO2 / gallon for gasoline and 22.384 lbs CO2 / gallon for diesel fuel. ^[1]

These values are slightly different from the values reported by Environmental Protection Agency (EPA). EPA determined that 1 gallon gasoline contains 2421 grams carbon and 2778 grams carbon content in 1 gallon diesel. ^[2]

1 ton (short) is equal to 907.1847 kg and equals to 2000 lbs, which means 1 lb equals to 453.59235 gram. ^[3]
The molecular weight comparison of CO2 to C is 44/12.
The oxidation factor used is 0.99 (99 percent of the carbon in the fuel is eventually oxidized, while 1 percent remains un-oxidized.)

The calculation for CO2 content in 1 gallon gasoline based on the value from EPA is:

$$\frac{\text{carbon content}}{1 \text{ gallon gasoline}} \times \text{oxidation factor} \times \frac{\text{molecular weight CO2}}{\text{molecular weight C}} \times \frac{1 \text{ ton}}{907184.7 \text{ gram}} \times \frac{2000 \text{ lbs}}{1 \text{ ton}} =$$
$$\frac{2421 \text{ gram C}}{1 \text{ gallon gasoline}} \times \frac{99 \text{ gram CO2}}{100 \text{ gram CO2}} \times \frac{44 \text{ molecular weight CO2}}{12 \text{ molecular weight C}} \times \frac{2000 \text{ lbs}}{901784.7 \text{ gram}} = \frac{19.374 \text{ lbs CO2}}{\text{gallon gasoline}}$$

The calculation for CO2 content in 1 gallon diesel:

$$\frac{\text{carbon content}}{1 \text{ gallon diesel}} \times \text{oxidation factor} \times \frac{\text{molecular weight CO2}}{\text{molecular weight C}} \times \frac{1 \text{ ton}}{907184.7 \text{ gram}} \times \frac{2000 \text{ lbs}}{1 \text{ ton}} =$$
$$\frac{2778 \text{ gram C}}{1 \text{ gallon diesel}} \times \frac{99 \text{ gram CO2}}{100 \text{ gram CO2}} \times \frac{44 \text{ molecular weight CO2}}{12 \text{ molecular weight C}} \times \frac{2000 \text{ lbs}}{907184.7 \text{ gram}} = \frac{22.232 \text{ lbs CO2}}{\text{gallon diesel}}$$

Comparing these values with the values reported by EIA brings slightly 0.98% difference for CO2 content in gasoline and 0.69% in diesel.

Web Page 1: Carbon Tax Calculator

This web page provides the carbon tax calculation given in USD and EUR per ton and tonne masse, and calculates the carbon tax for 1 gallon and liter gasoline and diesel.

The conversion factor is calculated by comparing the CO2 weight in lbs.

Value comparison between web calculator with excel proof spreadsheet

Using default input currency exchange:		0.733	EUR / USD	1.364	USD / EUR				
Input:	103.273								
		GASOLINE				DIESEL			
		USD /gallon	USD / liter	EUR / gallon	EUR / liter	USD /gallon	USD / liter	EUR / gallon	EUR / liter
103.273	USD/ton CO2	1.010	0.267	0.740	0.196	1.156	0.306	0.847	0.224
	Calculation factor	0.00978	0.00258	0.00717	0.00189	0.01119	0.00296	0.00820	0.00217
	web calculation	1.010	0.267	0.740	0.196	1.156	0.305	0.847	0.224
	difference	0.00%	0.00%	0.00%	0.00%	0.00%	-0.33%	0.00%	0.00%
	web calculation corrected	1.01	0.267	0.74	0.196	1.156	0.305	0.847	0.224
	difference after correction	0.00%	0.00%	0.00%	0.00%	0.00%	-0.33%	0.00%	0.00%
103.273	USD/tonne CO2	0.916	0.242	0.671	0.177	1.048	0.277	0.768	0.203
	Calculation factor	0.00887	0.00234	0.00650	0.00172	0.01015	0.00268	0.00744	0.00196
	web calculation	1.111	0.294	0.815	0.215	1.272	0.336	0.246**	0.246
	difference	17.55%	17.69%	17.67%	17.67%	17.61%	17.56%	-212.20%	17.48%
	web calculation corrected*	0.918	0.243	0.673	0.178	1.051	0.278	0.763	0.203
	difference after correction	0.22%	0.41%	0.30%	0.56%	0.29%	0.36%	-0.66%	0.00%
103.273	EUR/ton CO2	1.378	0.364	1.010	0.267	1.577	0.417	1.156	0.306
	Calculation factor	0.01334	0.00353	0.00978	0.00258	0.01527	0.00404	0.01119	0.00296
	web calculation	1.378	0.364	1.010	0.267	1.577	0.417	1.156	0.305
	difference	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.33%
	web calculation corrected	1.378	0.364	1.01	0.267	1.577	0.417	1.156	0.305
	difference after correction	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.33%
103.273	EUR/tonne CO2	1.250	0.330	0.916	0.242	1.430	0.378	1.048	0.277
	Calculation factor	0.01210	0.00319	0.00887	0.00234	0.01385	0.00366	0.01015	0.00268
	web calculation	1.516	0.400	1.111	0.294	1.734	0.458	1.272	0.336
	difference	17.55%	17.50%	17.55%	17.69%	17.53%	17.47%	17.61%	17.56%
	web calculation corrected*	1.253	0.331	0.918	0.243	1.433	0.379	1.051	0.278
	difference after correction	0.24%	0.30%	0.22%	0.41%	0.21%	0.26%	0.29%	0.36%

*) This correction was made by switch the division from ton to tonne

***) This calculation has fatal error because it calculates the output volume unit in liter.

There are still some differences after the division from ton to tonne was corrected, this is because the excel spreadsheet is using higher significant digits.

Web Page 2: Fuel Price Unit Conversion

This web page provides the fuel price conversion between gallon volume unit and liter with US Dollar currency and in Euro.

1 gallon is equal to 3.785412 liter. ^[3]

For conversions between two different currencies: “a” is the euro currency exchange rate for 1 dollar and “b” is the dollar currency exchange rate for 1 euro

Value comparison between web calculator with excel proof spreadsheet

Using default input currency exchange:		0.733	EUR / USD	1.364	USD / EUR	
Input:		3.362				
			USD /gallon	USD / liter	EUR / gallon	EUR / liter
3.362	USD/gallon			0.888	2.464	0.651
	Calculation factor			0.26417	0.73300	0.19364
	web calculation			0.888	2.464	0.651
	difference			0.00%	0.00%	0.00%
3.362	USD/liter		12.727		9.329	2.464
	Calculation factor		3.78541		2.77471	0.73300
	web calculation		12.725		9.328	2.464
	difference		-0.02%		-0.01%	0.00%
3.362	EUR/gallon		4.587	1.212		0.888
	Calculation factor		1.36426	0.36040		0.26417
	web calculation		4.586	1.212		0.888
	difference		-0.02%	0.00%		0.00%
3.362	EUR/liter		17.362	4.587	12.727	
	Calculation factor		5.16427	1.36426	3.78541	
	web calculation		17.357	4.586	12.725	
	difference		-0.03%	-0.02%	-0.02%	

The differences are caused by the higher significant digits, that the excel spreadsheet was using.

Web Page 3: C and CO2 Tax Comparison

This web page provides the carbon and carbon-dioxide tax calculation per ton and tonne weight unit.

The molecular weight comparison of CO2 to C is 44/12

1 tonne is equal to $2000 * (1000 / 907.1847) = 2204.622719$ lbs = 1.10233114 ton.

The multiplication factor has to be multiply once again with the currency exchange rate if the currencies from both sides are different. An example shows this conversion between USD / ton C to EUR / ton CO2, and EUR / ton C to USD / ton CO2.

Value comparison between web calculator with excel proof spreadsheet

Using default input currency exchange:		0.733	EUR / USD	1.364	USD / EUR				
Input:	43.256								
		USD				EUR			
		USD/ton C	USD/ton CO2	USD/tonne C	USD/tonne CO2	EUR/ton C	EUR/ton CO2	EUR/tonne C	EUR/tonne CO2
43.256	USD/ton C		11.797	47.682	13.004	31.707	8.647	34.951	9.532
	Calculation factor		0.27273	1.10233	0.30064	0.73300	0.19991	0.80801	0.22037
	web calculation		158.620**	39.320*	144.185**	31.707	116.268**	28.821*	105.688**
	difference		92.56%	-21.27%	90.98%	0.00%	92.56%	-21.27%	90.98%
	web calculation corrected		11.797	47.682	174.832	31.707	8.647	34.951	9.532
	difference after correction		0.00%	0.00%	92.56%	0.00%	0.00%	0.00%	0.00%
43.256	USD/ton CO2	158.605		174.835	47.682	116.258	31.707	128.154	34.951
	Calculation factor	3.66667		4.04188	1.10233	2.68767	0.73300	2.96270	0.80801
	web calculation	11.796**		10.723**	39.320*	8.646**	31.707	7.860**	28.821*
	difference	-1244.57%		-1530.47%	-21.27%	-1244.64%	0.00%	-1530.46%	-21.27%
	web calculation corrected	158.605		174.835	47.682	116.258	31.707	128.154	34.951
	difference after correction	0.00%		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
43.256	USD/tonne C	39.241	10.702		11.797	28.764	7.845	31.707	8.647
	Calculation factor	0.90719	0.24742		0.27273	0.66497	0.18136	0.73300	0.19991
	web calculation	47.586*	174.499**		158.620**	34.881*	127.908**	31.707	116.268**
	difference	17.54%	93.87%		92.56%	17.54%	93.87%	0.00%	92.56%
	web calculation corrected	39.241	10.702		11.797	28.764	7.845	31.707	8.647
	difference after correction	0.00%	0.00%		0.00%	0.00%	0.00%	0.00%	0.00%
43.256	USD/tonne CO2	143.885	39.241	158.605		105.468	28.764	116.258	31.707
	Calculation factor	3.32636	0.90719	3.66667		2.43822	0.66497	2.68767	0.73300
	web calculation	12.977**	47.586*	11.796**		9.512**	34.881*	8.646**	31.707
	difference	-1008.77%	17.54%	-1244.57%		-1008.79%	17.54%	-1244.64%	0.00%
	web calculation corrected	143.885	39.241	158.605		105.468	28.764	116.258	31.707
	difference after correction	0.00%	0.00%	0.00%		0.00%	0.00%	0.00%	0.00%
43.256	EUR/ton C	59.012	16.094	65.051	17.741		11.797	47.682	13.004
	Calculation factor	1.36426	0.37207	1.50386	0.41014		0.27273	1.10233	0.30064
	web calculation	59.012	16.093	53.642*	196.706**		158.620**	39.320	144.185**
	difference	0.00%	-0.01%	-21.27%	90.98%		92.56%	-21.27%	90.98%
	web calculation corrected	59.001	216.338	65.038	17.741		11.797	47.682	13.004

	difference after correction	-0.02%	92.56%	-0.02%	0.00%		0.00%	0.00%	0.00%
43.256	EUR/ton CO2	216.378	59.012	238.520	65.051	158.605		174.835	47.682
	Calculation factor	5.00227	1.36426	5.51416	1.50386	3.66667		4.04188	1.10233
	web calculation	16.093**	59.012	14.628**	53.642*	11.796**		10.723**	39.320*
	difference	-1244.55%	0.00%	-1530.57%	-21.27%	-1244.57%		-1530.47%	-21.27%
	web calculation corrected	216.378	59.001	238.520	65.038	158.605		174.835	47.682
	difference after correction	0.00%	-0.02%	0.00%	-0.02%	0.00%		0.00%	0.00%
43.256	EUR/tonne C	53.535	14.601	59.012	16.094	39.241	10.702		11.797
	Calculation factor	1.23764	0.33754	1.36426	0.37207	0.90719	0.24742		0.27273
	web calculation	64.920*	238.062**	59.012	216.398**	47.586*	174.499**		158.620**
	difference	17.54%	93.87%	0.00%	92.56%	17.54%	93.87%		92.56%
	web calculation corrected	53.525	14.601	59.001	16.094	39.241	10.702		11.797
	difference after correction	-0.02%	0.00%	-0.02%	0.00%	0.00%	0.00%		0.00%
43.256	EUR/tonne CO2	196.296	53.535	216.378	59.012	143.885	39.241	158.605	
	Calculation factor	4.53801	1.23764	5.00227	1.36426	3.32636	0.90719	3.66667	
	web calculation	17.704**	64.920*	16.093**	59.012	12.977**	47.586*	11.796**	
	difference	-1008.77%	17.54%	-1244.55%	0.00%	-1008.77%	17.54%	-1244.57%	
	web calculation corrected	196.296	53.525	216.378	59.001	143.885	39.241	158.605	
	difference after correction	0.00%	-0.02%	0.00%	-0.02%	0.00%	0.00%	0.00%	

*) This correction was made by switch the division from ton to tonne

***) These calculations have fatal error because it calculates as if it's a conversion from CO2 to C instead C to CO2.

There are still some differences after the division from ton to tonne was corrected, this is because the excel spreadsheet is using higher significant digits.

Conclusion

Conclusion from the examination of the three web pages shows that most of the calculations are accurate despite these following errors:

1. The division factor ton and tonne is used inverted in the calculation
2. The division factor between ton to tonne is 0.907 and not 0.909
3. Fatal errors in the carbon tax calculator and comparison web pages must be fixed
4. The first web page (carbon tax calculator) can't be displayed in firefox web browser.
5. There are some imprecision in multiplication factor's significant digit, depends on the situation these can be neglected.

For further improvement, fixing the errors in conversion calculation is crucial. It's also crucial to make the carbon tax calculator web page compatible with other web browser than Internet Explorer because the fuel price conversion and the carbon/carbon-dioxide tax calculator are linked from this web page.

Further improvements in term of restructure the conversions web pages are also needed:

1. Take the calculation web pages out of the front box
2. Link the calculation web pages from the carboncapture main site (should be placed above as major link)
3. Add significant web page title to be matched with web search engines

This further improvement will come to more details in separate proposal document.

References

¹ <http://www.epa.gov/otaq/climate/420f05001.htm#calculating>

² <http://www.eia.doe.gov/oiaf/1605/coefficients.html>

³ Guide for the Use of the International System of Units (SI); National Institute of Standards and Technology (NIST)