

## CO<sub>2</sub> footprint Comparison

### 1. Cement production

- (1) The cement industry is one of the two largest producers of carbon dioxide (CO<sub>2</sub>), creating up to 5% of worldwide man-made emissions of this gas, of which 50% is from the chemical process and 40% from burning fuel. <sup>[2][13]</sup> The CO<sub>2</sub> produced for the manufacture of structural concrete (using ~14% cement) is estimated at 410 kg/m<sup>3</sup> (~180 kg/tonne @ density of 2.3 g/cm<sup>3</sup>) (reduced to 290 kg/m<sup>3</sup> with 30% [fly ash](#) replacement of cement). <sup>[14]</sup> The CO<sub>2</sub> emission from the concrete production is directly proportional to the cement content used in the concrete mix; 900 kg of CO<sub>2</sub> are emitted for the fabrication of every ton of cement, accounting for 88% of the emissions associated with the average concrete mix.

Source: [https://en.wikipedia.org/wiki/Environmental\\_impact\\_of\\_concrete#cite\\_note-15](https://en.wikipedia.org/wiki/Environmental_impact_of_concrete#cite_note-15)

- (2) The IPCC Guidelines recommends two possible methods for calculating the emission factor. The Tier 1 method uses the IPCC default value for the fraction of lime in clinker, which is 64.6 percent. This results in an emission factor of 0.507 tons of CO<sub>2</sub>/ton of clinker,

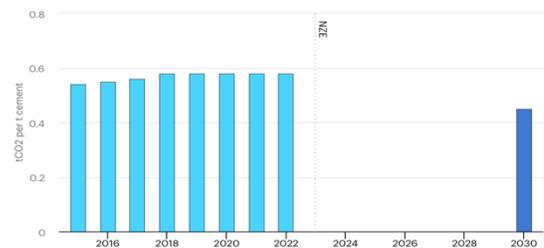
Source: [https://www.ipcc-nggip.iges.or.jp/public/gp/bgp/3\\_1\\_Cement\\_Production.pdf](https://www.ipcc-nggip.iges.or.jp/public/gp/bgp/3_1_Cement_Production.pdf)

- (3) Cement emissions intensity has remained relatively stable since 2018, at just under 0.6 t CO<sub>2</sub> per tonne of cement produced, following several years of modest increase largely due to an increasing clinker-to-cement ratio in China.

Source: <https://www.iea.org/energy-system/industry/cement>

Direct emissions intensity of cement production in the Net Zero Scenario, 2015-2030

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● Historical ● Net Zero Scenario

- (4) U.S. Cement Industry Carbon Intensities (2019) EPA report

Quartile	Metric Ton CO <sub>2</sub> / Metric Ton of Clinker	Metric Ton CO <sub>2</sub> / Metric Ton of Cement	Carbon Intensity
75 <sup>th</sup> percentile	0.787	0.722	Low
50 <sup>th</sup> percentile (median)	0.838	0.776	Midpoint
25 <sup>th</sup> percentile	0.934	0.886	High

Source: <https://www.epa.gov/system/files/documents/2021-10/cement-carbon-intensities-fact-sheet.pdf>

(5) Conclusion

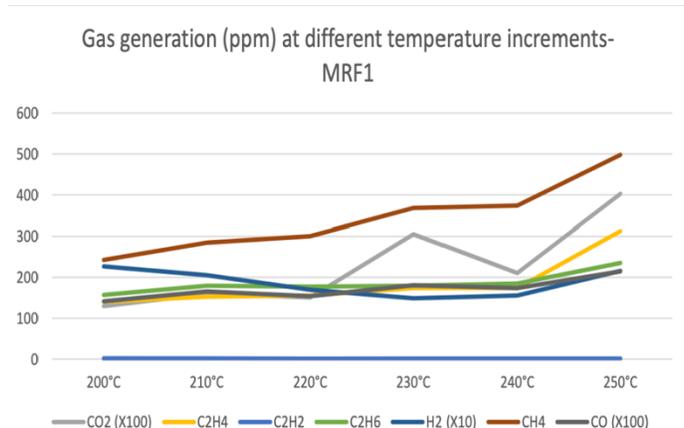
Samsara uses 0.776 ton of CO<sub>2</sub> emission per ton (median data shown on 2019 EPA report) , which is equals to **0.776kg of CO<sub>2</sub> emission per kg of cement production** for comparison purpose.

2. Cement brick making

- For a brick sized 4" x 8" x 2" (64 cubic inches or 0.037 cubic feet)
- From the specification of Home Depot, such kind of brick weigh 5 lb=2.27kg
- A standard concrete brick typically uses a mixture of cement (Portland cement), sand and aggregate:
- A common concrete mix ratio of 1:2:3 (cement:sand:aggregate) by volume: 1/6 of the volume would be cement = 0.037/6 = 0.0062 cubic feet of cement. Source:
- Portland cement weighs approximately 94 lbs per cubic foot, 0.0062 cubic feet × 94 lbs/cubic foot = 0.58 lbs of cement per brick
- **Calculate the Cement Weight Based on Mix Ratio:** For a **1:5** mix ratio, cement makes up 1 part out of 6 parts in total (cement + sand). i.e. **Cement proportion~16.7%**
- **Apply Cement Proportion to Brick Weight:** For a 2.5 kg brick, the cement content would be: 2.5 kg×0.167=0.4175 kg 2.5kg×0.167=0.4175kg
- Thus, for a 2.5 kg cement brick made with a **1:5** cement-to-sand ratio, approximately **0.42 kg of cement** is used. for a **3.0 kg cement brick made with a 1:5 cement-to-sand ratio, approximately 0.50 kg of cement is used.**
- Therefore, the caron footprint per cement brick is 0.42kg×0.776kg=0.326kg=326g of CO<sub>2</sub> emission per brick

3. EcoBrik making

- (1) Based on PTL report, by using the melting temp of 205°C, the CO<sub>2</sub> emission is around 15000ppm
- (2) Determine CO<sub>2</sub> Emissions for Plastic Melting: 0.5 g of plastic at 210°C releases 15,000 ppm of CO<sub>2</sub>, 15,000 ppm means 15,000 parts per million, or 1.5% CO<sub>2</sub> by weight.



- (3) Calculate the Mass of CO<sub>2</sub> Released for 0.5 g of Plastic:  $CO_2 = 0.5 \text{ g} \times 0.015 = 0.0075 \text{ gCO}_2$   
 $= 0.5 \text{ g} \times 0.015 = 0.0075 \text{ g}$
- (4) Scale up for the Weight in EcoBrik: EcoBrik contains 45% of 1.55 kg of plastic, which is:  $1.55 \text{ kg} \times 0.45 = 0.6975 \text{ kg}$   
 $1.55 \text{ kg} \times 0.45 = 0.6975 \text{ kg}$
- (5) Calculate the Total CO<sub>2</sub> Emissions for EcoBrik: We have the CO<sub>2</sub> emissions per 0.5 g of plastic, so for 0.6975 kg of plastic, the CO<sub>2</sub> emission will be:  
 $0.0075 \text{ g} \times 0.6975 \text{ kg} \times 1000 \text{ g/kg} = 5.233125 \text{ g}$   
 $0.0075 \text{ g} \times 0.5 \text{ g} \times 0.6975 \text{ kg} \times 1000 \text{ g/kg} = 5.233125 \text{ g}$
- (6) The carbon footprint for the plastic component of the EcoBrik (0.6975 kg) based on CO<sub>2</sub> emissions is approximately **10.46 g of CO<sub>2</sub> (CO is not considered as carbon footprint by definition).**