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### **A Brief on wax votive candles and carbon dioxide.**

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The Pope has reiterated a call for a transition from fossil fuels “to a greater use of energy sources that are highly efficient while producing low levels of pollution, presenting an opportunity to promote the sustainable development of renewable forms of energy.”

In his 2015 encyclical, Francis, a vocal supporter of the Paris accord, warned that climate change represented “one of the principal challenges facing humanity in our day, and calls for a model of energy transition.”

To date, according to [the Global Catholic Climate Movement](#), dozens of Catholic institutions have divested from fossil fuels, including Caritas Internationalis, a confederation of relief organizations; Catholic banks with more than 7 billion euros, or \$8.3 billion, on their balance sheets; archdioceses; religious orders; and lay movements.

“We received the earth as a garden-home from the Creator,” Francis said. “Let us not pass it on to future generations as a wilderness.”

**A question:** Are the emissions from these candles worse for the climate - candles emit carbon dioxide?

**An answer:** A 5 day votive candle is equal to 1,200 grams of carbon dioxide. A typical Parish might use 50 candles per week producing 60,000 grams every 5 days or a Shrine may use 10,000 5 day votive candles producing 1M grams or 1 tonne each 5 day cycle.

In contrast, a tonne of carbon dioxide is approximately the amount that would be emitted by a Honda Civic driving from Vancouver to Halifax or commuting 10 kilometres each way to work for a little over a year.

In 2013, Canada reports that it emitted the equivalent of 726 million tonnes of carbon dioxide [or 20.7 tonnes per person](#). In 2017 that amount was 716 million tonnes.

Let's not think that by burning wax votive candles for religious purposes we are not contributing to the growth of the world's green house gases. We hope that our product electronic candles has helped in some small way.

This hypothesis is based on the following argument. A blogger has pointed out after last year's Earth Hour that on average those who try to replace all the light produced by an incandescent bulb with light cast by paraffin candles will result in about 10 times the greenhouse emissions

So what if you just replace a single paraffin candle with a single bulb? This was the question Zeke Hausfather, the executive vice president of energy science for Climate Culture, an online carbon measurement and reduction utility, tried to answer for the Bright Green Blog.

Mr. Hausfather noted that emissions vary widely, depending on where you live.

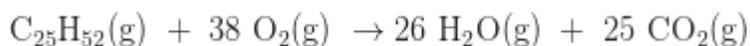
California - a 60-watt incandescent bulb for an hour would emit about 24 grams of CO<sub>2</sub>.

Kansas - has some of the highest emissions would emit almost 60 grams.

Therefore, Hausfather concludes "using a candle instead of an incandescent bulb unambiguously reduces your carbon emissions."

Consider just how much, quantitatively, this use of candles during Earth Hour is responsible for increased emissions of greenhouse gases.

A typical candle produces about 13 lumens of visible light, from a total power output of about 40 W, most of which is heat. A 40 W electric incandescent light bulb consumes 40 W of electric power, and produces approximately 500 lumens of visible light output. The overwhelming majority of candles are made from petroleum, in the form of paraffin wax. Paraffin wax has a heat of combustion of approximately 42 kJ/g, and can be assumed to consist, chemically, entirely of pentacosane – C<sub>25</sub>H<sub>52</sub>. The average greenhouse gas emissions intensity for electric power generation is about 1000 g CO<sub>2e</sub>/kWh, and electricity is transmitted with transmission losses of about 7%.



$$M(\text{C}_{25}\text{H}_{52}) = 352.68 \text{ g/mol};$$

$$M(\text{CO}_2) = 44.0 \text{ g/mol}.$$

Thus, we know the emission of carbon dioxide from burning candles:

$$\frac{40 \text{ W/candle} \cdot 25 \text{ mol/mol} \cdot 44 \text{ g/mol} \cdot 3600 \text{ s/h}}{4.2 \times 10^4 \text{ J/g} \cdot 352.68 \text{ g/mol}} = 10.69 \text{ gCO}_{2e} \text{ – per candle per hour.}$$

And the rate of carbon dioxide emissions from the electricity generation corresponding to the use of 13 lumens worth of lighting – the equivalent of one candle – for one hour:

$$\frac{13 \text{ lumens/candle} \times 1000\text{g/kWh} \times 107\% \times 40 \text{ W} \times 10^{-3} \text{ kW/W}}{500 \text{ lumens}} = 1.11 \text{ gCO}_{2e} \text{ – per candle-equivalent of electric light per hour.}$$

Therefore, for every candle that is burned to replace electric lighting greenhouse gas emissions over the course of the one hour are **increased** by 9.6 g of carbon dioxide.

If the light output from a 40 W light bulb was to be completely replaced by candles, this will lead to the emission of an extra 295 grams of carbon dioxide over simply using the electric lights – if the equivalent of one thousand 40 W bulbs are replaced by candles, that's an extra 295 kilograms of CO<sub>2</sub> emitted. Modern technology is adapting LED technology to the votive candles currently in use in various religious institutions, which results in even a more profound saving of carbon emissions: The power of a 7.5 watt incandescent bulb uses 450 watts of power whereas an LED uses .054 watts, and with 100% duty power, 3.26 watts.