

From: [van Oss, Hendrik](#)
To: [GHGInventory](#)
Subject: Revised commentary--please ignore March 9 email. Thanks.
Date: Thursday, March 16, 2017 4:31:21 PM

1) In the Ch. 1 Introduction, I was struck by the EPA's adoption of the phrase "**Global Warming Potential**" (Sec. 1, p. 8) for the title of the table of GHG equivalences. I would urge the EPA to use a less prejudicial phrase. Popular as this phrase may be, it is not well-grounded in science.

Logically, a global warming potential of a GHG ought to be cast in terms of °C/ton or even °C/ton-year, but the units instead are given as tons of CO₂e (equivalents), where CO₂ itself is defined as 1. This, then, forces the user to rely on whatever warming is ascribed to CO₂ by this or that model, over some specified time frame. There is no well-defined global warming potential for a single ton of CO₂; the argument is made that XXX zillion tons of anthropogenic releases of CO₂ over ZZ years has led to a Y°C increase in average world temperature over that which was occurring naturally (post-Little Ice Age etc...). How long does it take 1 ton of CO₂ to begin to have an effect? There are a vast number of variables; the models dealing with these require supercomputers, and come up with different answers. And none of these models have much to go on re. dealing with most of the other GHGs.

Regarding CO₂ itself, one cannot, of course, define a °C/ton relationship, and one does not know the destiny of a specific ton of emitted CO₂--it may be sucked up by the nearest forest, get absorbed into the ocean, stay in the lower atmosphere, etc...etc.... All of this is poorly constrained.

Thus, the EPA should **STICK TO WHAT YOU KNOW**. The relative (vs. CO₂) heat retentions of the various GHGs can be demonstrated in the lab under controlled conditions--**this is what you know!**--although different studies come up with somewhat different equivalences, as your table shows. What you don't know is the effect, real or potential, of these various gases on the climate; the lab is NOT the global climate. The assumption is made that all the GHGs remain in the atmosphere (long-term) and are uniformly mixed therein, and that there are essentially no sinks--all of which are dubious, especially for some of the more exotic GHGs.

I would thus urge the EPA to drop the phrase "Global Warming Potentials" and instead provide the same data under non-prejudicial phrasing such as:

Greenhouse Gas Equivalences

or

Greenhouse Gas Heat Retention Equivalences

And then you can use straightforward phrasing such as "...emissions of CO₂ and CH₄ (in terms of CO₂-equivalents)....."

You can measure (or calculate reasonably well) the emissions, right now, this year, next year... **The emissions are what you know.**

2) I looked also at the **Ch. 4 Industrial Processes & Product Use**, most closely at the section on Cement (I developed the cement methodology for the IPCC). I have a few minor quibbles:

Table 1-4 and in the cement section (Sec. 4, p. 3): the USGS has yet to publish a (Minerals Yearbook--MYB) production number for clinker for 2015, but the USGS monthly reporting (December 2016 edition) now shows USA (including Puerto Rico) production of clinker = **76,603,356 mt**; if past MYB reporting is a guide, the MYB number for 2015 will be very close to this number (because I allow no more than a 5,000 short ton/year difference for a specific plant's monthly vs. annual reporting and most agree within a few tons). Where larger (> 5,000 st) discrepancies are found, I ask the companies to review their data, and usually some revisions are then forthcoming. This comparison and revisions to 2015 data have been ongoing throughout 2016, and with the December 2016

monthly report, the final monthly data for **2015** are provided. Unfortunately, we are still missing nearly 20 annual forms for the 2015 survey as of 3/16/2017, so I do not know when the 2015 MYB tables will be available. Anyway, this new monthly data total for 2015 would yield process emissions of 39.9 Mt CO₂, using the 0.5101 EF and a CKD adjustment of 2% (i.e., clinker x 0.5101 x 1.02), not the 39,587 kmt/39.6 Mt CO₂ figure that you give (which was based on a now obsolete clinker number).

Monthly data for 2016, by the way, show a small (1.22%) decline for 2016 vs. 2015, but the 2016 data remain subject to revision for the next 12 months. The 2016 decline was a surprise--our 2017 Mineral Commodity Summaries had a small estimated increase for 2016, as indeed was indicated at the time of its writing (data in hand at that time were for 1-8/2016, I believe).

Line 4-5: please refer to the USGS as the U.S. Geological Survey **National Minerals** Information Center. You have a slightly different wording.

On line 7 your wording (as to what goes on in the kiln) is slightly misleading--you need to describe the calcination reaction as (from a GHG process emissions perspective) as being the key reaction (current wording makes it sound like a lime kiln). The equation given ($\text{CaCO}_3 + \text{heat} = \text{CaO} + \text{CO}_2$) is correct, but this reaction takes place in the temperature range of about **700 - 1000°C**, not 1450°C. The 1450°C is the temperature that the raw materials are then (post-calcination) taken to so as to achieve a reasonable rate of formation of the alite mineral phase (C3S in shorthand via the reaction $\text{C}_2\text{S} (\text{belite}) + \text{C} = \text{C}_3\text{S}$, where C = CaO and S = SiO₂)--this is the so-called sintering phase of clinker formation, and includes partial melting. Alite starts to form at 1338°C, but because there is only slight melting at that temperature, the reaction is very slow; given practical residence times in the kiln, they take the temperature higher (to 1450°) so as to have 20-30% melting, which speeds the reaction significantly. But, the sintering reaction has essentially no effect on process emissions.

Although the emissions from fuel combustion are, of course, dealt with in a separate section, some mention of them should be made because clinker manufacture is highly heat-intensive. The fuel combustion emissions will, however, depend on the kiln technology (re-use of heat, hence less fuel; use of a precalciner) and the type of fuels. What likely is not estimated adequately are emissions from burning of waste fuels (the data are poor), and the contribution of kerogen in the raw materials (as well as any other carbon, such as graphite, or soot in, say, fly ash) fed into the kiln.

If we are using a wet kiln, the 30-40% slurry water will first need to be evaporated (c. 1.8 GJ/ton clinker), the now-dry raw material mix needs to be raised to calcination temperatures (i.e. preheating), which is another ~ 1.8 GJ/ton clinker, then the calcination is done while raising the temperature to about 1000°C (yet another 1.8 GJ/t), and then the sintering is done (to 1450°C)--which only adds ~ 0.2 GJ/t because the alite-forming reaction noted above is highly exothermic. Anyway, depending on the technology, a lot of fuel gets burned to provide this heat--typically 150-200 kg of coal or similar per ton of clinker. So the process emissions are only about half the story!

Line 16: you earlier describe clinker as being 65% CaO (all from CaCO₃) and quote me as saying that this is reasonable (which it is). You should thus adjust the EF_{clinker} derivation equation to use the CaO factor of 0.65 and NOT 0.6460. The latter number is inherited from older summaries, and derives from a straight arithmetic average of a few sample clinker analyses given on an old cement chemistry book--it is too precise. We can justify an average of 65%, but cannot justify 64.60%.

Using the rounded CaO content of 0.65 changes the derived EF clinker to 0.5101 t CO₂/t clinker (and then we multiply this by 1.02 to given a token accounting for "lost" CKD).

3) **Other carbonate use:** you show a CO₂ fraction of limestone of 0.43971--this implies that the limestone is 100% CaCO₃, which it will almost never be. I'd round it to something more like 0.43 (= 98% CaCO₃), or deduct a couple of percent from the calculated CO₂ to better represent an actual high-purity limestone.

4) Iron and Steel:

Sec. 4-60, line 9-2--I noted a statement along the lines of "...62% of U.S. steel was produced in one of seven States..." -- I think you meant to say: "...62% of steel produced in the USA was from seven States..." (I do not

believe that 1 of these 7 did 62%...).

I did not have time to review the iron and steel section very thoroughly.

One issue not addressed, and as the Fe slag specialist at the USGS, I cannot actually answer, is the possibility that there is a small carbon content of blast furnace and steel furnace slags--either as a minor component of the silicate slag phases or as a modest component of any entrained metal. Perhaps one of your steel company specialists can address this possibility. All of my books on slag have chemical analyses that make no mention of carbon. But because we would, in the carbon balance of the blast furnace, deduct c. 4-5% C in the crude (or pig) iron (although most of this will be subsequently burned off in the steel furnace), there is a possibility that some elemental C gets caught up in the slag (possibly as entrained kish or even within entrained crude iron).

Regards,

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