



## Carbon Neutral Concrete

*What does it really mean?*

*By Andrea Schokker, PhD, P.E., LEED AP*

We're hit with a plethora of terms: green, resilient, low carbon footprint, sustainable, low emissions, carbon offset, eco-conscious, net-zero, renewable, global warming potential, carbon neutral, and the list goes on. The first thing to note is that the word carbon is being used to represent CO<sub>2</sub>, or in some cases CO<sub>2</sub> equivalents (combined impact of all greenhouse gases). Given our name, NEU: An ACI Center of Excellence for Carbon Neutral Concrete, I will focus on the term **carbon neutral**. Note that NEU in the name is not an acronym but is from the word **NEU**tral, as that is our goal.

In the context of the concrete industry, there are focused efforts around lowering the CO<sub>2</sub> emissions during the production of portland cement, specifically the combustion of fossil fuels when converting limestone to cement (calcination). Knowing that calcination produces the majority of the carbon emissions in this process and that cement is a component in concrete, it can be hard to envision how we expect to get to carbon neutral concrete. Let's start by defining two terms:

- **Carbon neutral** means a neutral effect of CO<sub>2</sub> on the atmosphere. Any CO<sub>2</sub> emissions released must be balanced by an equal amount of CO<sub>2</sub> being removed from the atmosphere through carbon sinks, carbon sequestration (CS), or offsets. Sinks include forests, oceans, and soil which all absorb CO<sub>2</sub>. Concrete itself also acts as a sink but does not absorb CO<sub>2</sub> fast enough or in great enough amounts to balance the emissions from its production.
- **Net-zero** carbon emissions refers to an activity that releases a net of zero CO<sub>2</sub> into the atmosphere.

These two terms are very similar, and the result for both is to balance carbon emissions. The difference is that in the net-zero case, no carbon was emitted from the activity in the first place. To get to net-zero, we must start by implementing carbon neutral practices. Figure 1 shows a simplified example of this concept. The first two cases are carbon neutral if the left side (emissions) is balanced with the right side (carbon sequestration and offsets). The third case is net zero and doesn't need CS or offsets to be carbon neutral. The more we can reduce from the

emissions side, the less we need in CS and offsets. A net zero contribution to carbon emissions is not likely to be feasible worldwide for concrete in the near term, but the science behind net zero concrete and associated pilot projects are on the horizon.

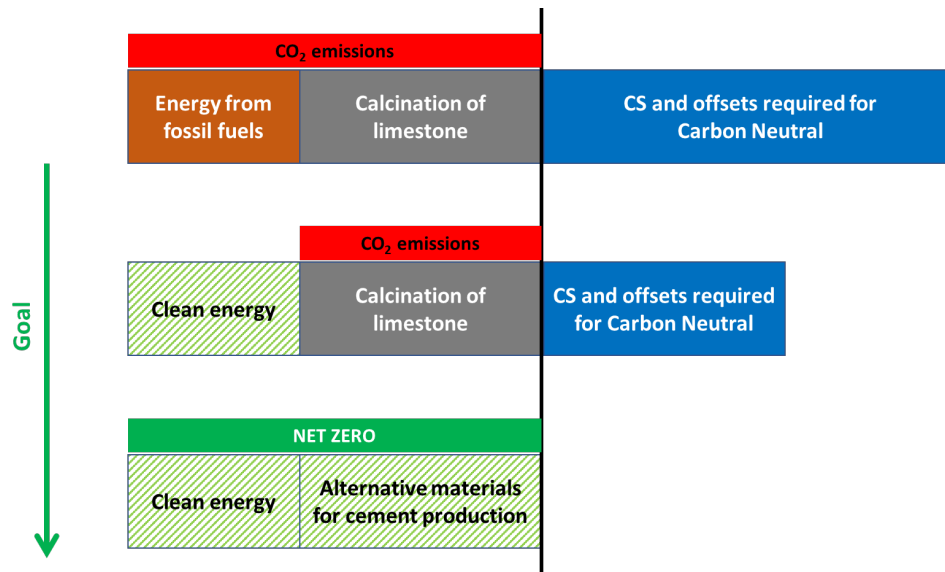


Figure 1. Balance for carbon neutrality of cement.

It's important to understand that carbon neutral concrete and carbon neutral cement are different levels of scope. In the case of carbon neutral cement, carbon reductions would need to offset the emissions from the cement production. The cement industry has reduced its carbon footprint through reduction of the use of fossil fuels, modernizing plants and many other changes. These reductions have been critical in reducing the embodied carbon of the end product: concrete. In the future, we will have a scalable solution for producing cement from a different base material that is net-zero. In the interim, we need to continue to act on all possible fronts while considering the larger scope of concrete and the products in which concrete is used. Any carbon reduction in cement will directly apply to concrete.

NEU's focus is on the bigger picture of carbon neutral concrete. Cement is obviously an important part of this, but if we don't consider all the components of concrete, we lose sight of the whole picture. Much of the current and proposed language around reducing the carbon footprint of concrete focuses on embodied carbon rather than the end product and its performance (a building, pavement, bridge, etc.). As the most used construction material, we know that concrete cannot simply be replaced with another material at a large scale. More importantly, concrete has a role in providing a durable and resilient solution at a reasonable cost that other materials cannot match. The life cycle of carbon emissions of an end product, as evaluated through whole building (or other structure) modeling, must be at the forefront of our goals of carbon neutrality for the planet. To stop at embodied carbon emissions is to focus only on the short-term rather than the more important longer-term future. A building that has a long service life that can

withstand extreme storms, flooding, fire damage, and reduce energy for heating and cooling is the path we must take for a carbon neutral future while reducing carbon footprints

Carbon capture, utilization and storage (CCUS) will play an important part in a carbon neutral future. NEU's goal is to support a reduction of carbon emissions from concrete as much as possible so that the amount of CCUS needed is minimized. The focus of NEU is to support efforts to reach carbon neutrality in concrete by considering all of the points in the process from the raw materials through the life cycle of the concrete product and beyond to a potential new life. This includes all stages including materials, construction, repair, and end use. The result of these efforts will not only be the necessary evolutionary change needed for concrete, but also a revolutionary change of the concrete industry.

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