Clearing up Some Carbon Confusion

Written by Maggie Romuld

It's hard to make it through a daily news cycle without hearing some mention of carbon dioxide and its relationship to climate change. It's also hard to keep up with the latest strategies, technologies, and techniques to measure, mitigate, or remove atmospheric carbon dioxide. Carbon-neutral? Net-zero? Biologic versus geologic carbon sequestration? Perhaps we can clear up a little confusion with a bit of a plain-language primer about carbon dioxide and climate change in general.

There is a well-known expression – "climate is what you expect, the weather is what you get". Climate is the typical range of weather conditions found in an area. It is essentially the result of interactions between the oceans, land surfaces, and the atmosphere. The exchanges are dynamic and, as we now know, quite delicately balanced. To better understand our world, we have divvied it into well-established climate zones based on recognizable regional and geographic differences: Deserts are dry, tropical jungles are wet. We also know that monsoons are somewhat predictable, and the Rockies are snowy in winter.

When people talk about climate change, they are usually referring to the shift from those expected "typical" conditions. While we used to talk about global warming, we now realize that "warming" doesn't tell the whole story. In addition to increasing temperatures, there are other conditions and risks associated with climate change, including sea-level rise, increasing variability (and volatility) of rainfall, increasing instances of extreme weather events such as hurricanes, and the acidification of seawater.

The evidence suggests that the warming of the past century is unusual by the standards of the past few thousand years and almost certainly caused by increasing greenhouse gases, including (primarily) atmospheric CO2 concentrations (Emanuel, 2016). Carbon dioxide is a greenhouse gas of particular concern because of its long residence time in the atmosphere, and that's why there is a great deal of focus on it. Without the technology to remove it from the atmosphere or reduce how much we are emitting, we will have to live with the effects of ever-higher atmospheric concentrations of CO2 and an altered climate for many thousands of years.

And that leads us to the myriad terms regarding ways to reduce, remove, or mitigate emissions and the accompanying jargon surrounding the various strategies. In recent years, many countries worldwide have pledged to go "net-zero" or "carbon-neutral". But what does that mean?

Zero carbon or **zero-emissions** means that no carbon emissions are being produced from a product or service. A completely renewable energy source could, in theory, provide zero-carbon electricity. However, no current technology exists that is truly zero emission. Renewable resources produce no *ongoing* emissions after installation, but they have embedded emissions created during the manufacture of the technology, e.g., wind turbines.

Net carbon-neutral or **carbon-neutral** mean that while some emissions are still being generated, the emissions are offset somewhere else, making the overall *net* emissions zero. If a company has a net-zero goal or net carbon-neutral goal, they will remove as much carbon from the atmosphere as they put into it. A recent article from Yale e360, well worth a read, debates the virtue of a net-zero emissions strategy. Carbon neutrality is often achieved through **offsets**, where climate-beneficial projects are funded to make up for greenhouse gases being emitted.

Carbon negative means that more carbon is removed from the atmosphere than is emitted. This could include a bioenergy process with both carbon capture and storage.

One way (among many) that carbon can be removed is through **carbon sequestration** - defined as the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. The purpose of sequestration is to delay the accumulation of greenhouse gases in the atmosphere and avoid extreme climate change. It is generally intended as long-term storage, and other types of carbon, not just CO2, are stored during the process of sequestration. There are different types of sequestration, and one broad division is between two major types, geologic and biologic.

According to the USGS, geologic carbon sequestration is the process of storing carbon dioxide in underground geologic formations. The CO2 is usually pressurized until it becomes a liquid. Then it is injected into porous rock formations in geologic basins. This carbon storage method is also sometimes a part of enhanced oil recovery because it is typically used later in the life of a producing oil well. In enhanced oil recovery, the liquid CO2 is injected into the oil-bearing formation to reduce the oil's viscosity and allow it to flow more easily to the well.

It is worth noting that one of the world's first commercial-scale carbon capture and storage projects is located in Saskatchewan. The Boundary Dam Carbon Capture Storage Project commissioned on a coal-fired plant owned by SaskPower, aims to reduce emissions by 40% below 2005 levels, by 2030.

Biologic carbon sequestration refers to the storage of atmospheric carbon in vegetation, soils, woody products, and aquatic environments. For example, by encouraging the growth of plants – typically reforestation or tree-planting—advocates of biologic sequestration hope to help remove CO2 from the atmosphere. Plant-rich landscapes, including forests, rangelands, and grasslands, naturally absorb approximately 25% of global carbon emissions, as do oceans (Conserve Energy Future, n.d.).

Carbon capture also includes other strategies such as direct air capture and storage (through things like scrubbing towers and artificial trees) and other technologies still under development. The hope is that one day CO2 could be removed and stabilized to use in building materials and plastics. Other engineered solutions include graphene production, using CO2 as the raw material, and biochar. This charcoal-like material is added to soil to promote microbial activity and prevent organic matter from breaking down and releasing carbon.

There is no shortage of information "out there" about carbon dioxide and climate change. Still, some articles (and concepts!) are easier to understand than others. The following list includes a few referenced above and a few others that are worth your time if you would like to dive a little deeper into the subject:

Conserve Energy Future. What is Carbon Sequestration?

Emanuel, K. 2016. Climate Science and Climate Risk: A Primer

Kleinman Center for Energy Policy. A Primer on Carbon Dioxide Removal Speaks to Curious Minds

Sustainability Matters. Net zero, carbon-neutral, carbon-negative... what do they mean exactly?

The Conversation. Net-zero, carbon-neutral, carbon-negative … confused by all the carbon jargon? Then read this

USGS. What is carbon sequestration?