3. CO₂ Mineralisation vs. Climate Change

Man-made carbonation can potentially lead to the permanent sequestration of very significant quantities of CO₂ into useful products. Another key advantage is that the reaction itself does not require any energy. If deployed to its full potential, man-made carbonation could lead to a net reduction of global CO₂ emissions estimated at around 250 - 500 Mtons/year in 2030.

4. Conclusions

Accelerated carbonation can transform CO₂ from industrial flue gases into useful materials for a large variety of applications, using a simple and low energy demanding transformation process.

After many years of research and development effort, this highly promising technology is now becoming a reality with commercial plants already producing materials for the building industry in Europe and in North America.

Industrial residue streams of today are the raw materials of tomorrow. Carbonation can greatly contribute to two important challenges for Europe: the mitigation of climate change and the development of a circular economy.

Policy makers at EU and Member State levels together with industry should work actively to lift the existing regulatory and economic barriers that inhibit the rapid deployment of carbonation at industrial scale across Europe.
1. What is CO₂ mineralisation?

CO₂ mineralisation, also known as carbonation, is one of the less known Carbon Capture & Utilisation (CCU) technologies. Let’s discover how it transforms the climate change molecule CO₂ into valuable products for the construction industry, in a real application of the circular economy and without requiring any significant external energy input!

- Carbonation is a natural phenomenon, where Ca (calcium)- or Mg (magnesium)-containing minerals react with carbon dioxide (CO₂) to produce calcium or magnesium carbonate (CaCO₃ or MgCO₃), also known as limestone or dolomite, one of the most abundant rock types formed throughout the 4000 million year history of the Earth.

- This natural carbonation reaction, which happens in nature over thousands of years, can be purposefully accelerated to take only a few minutes in man-made manufacturing processes (accelerated carbonation) by using high CO₂ concentrations and optimized reaction conditions. The reaction is exothermic, meaning that it releases energy as heat and leads to the creation of stable products in which the CO₂ is permanently captured.

- Over the last 15 years, novel industrial processes have been developed to use CO₂ as an input in the manufacture of products which meet the technical requirements of the building sector. Unlike other CCU technologies, these carbonation processes do not need any significant input of renewable energy.

CO₂ can be injected during the curing of concrete in traditional ready-mix or precast processes without major changes needed to the process or ingredients with the effect of accelerating the hydration of the cement. Other technologies exist for curing of concrete with CO₂ instead of water: this requires a novel cement and special curing chambers, but the amount of CO₂ taken up in the product is higher - up to 250 kg of CO₂ for every ton of cement used.

CO₂ can also be injected as part of the recycling process of a large range of Ca/Mg-rich mineral waste (e.g. slags, ashes, kiln dust, tailings, etc.) coming from various industrial sectors (power, steel, cement, mining, etc.) or from the construction/demolition sector to create diverse products such as aggregates (which can be used in road foundations or in the preparation of fresh concrete), construction bricks and blocks, concrete fillers, etc.

2. CO₂ Mineralisation in a Circular Economy

From a circular economy perspective, accelerated carbonation can bring a significant contribution to three major societal challenges: the mitigation of climate change, the management of waste materials and the reduction of the consumption of natural resources. This is illustrated in the figure below.

CO₂ can be taken directly from flue gas emissions coming from industrial processes (such as power, steel, cement or chemical plants). It can remain diluted among other flue gas components, so there is no need for expensive concentration or purification steps. The CO₂ used in the carbonation process gets permanently sequestered (under the form of stable carbonate) in the end products and this CO₂ is therefore no longer emitted to the atmosphere (climate mitigation benefit).

Mineral waste coming from various industry sectors are transformed into valuable construction materials, so they no longer have to be disposed of in landfills (waste management benefit). Similarly, construction and demolition waste can also be looped back into the production of fresh construction materials and diverted from landfills. This also reduces the need for extracting fresh mineral resources from quarries (natural resources benefit).