Executive Summary

CarbinX Lifecycle Analysis

Technology Overview

CleanO2® has developed CarbinX™, a small-scale carbon capture system for use in building heating systems. Deploying carbon capture technology at the level of individual buildings allows building owners to reduce greenhouse-gas (GHG) emissions while continuing to operate their existing heating systems.

Carbon Capture and Energy Savings

Heating systems, which warm both a building's interior climate and domestic hot water, are commonly fueled by natural gas. Natural gas is a great energy source, but its combustion releases the GHG carbon dioxide, contributing to climate change.

CarbinX technology captures carbon dioxide (CO_2) in a one-step reaction. It reacts potassium hydroxide (KOH) with carbon dioxide from flue gas to produce non-toxic potassium carbonate (K_2CO_3). In this form, the carbon is permanently sequestered, even if the compound is used as an ingredient in manufactured products downstream. The only other output of the carbon-capture reaction is water.

CarbinX also reclaims heat energy from two sources, reducing the overall energy demand of the building. The reaction between potassium hydroxide and carbon dioxide produces heat. CarbinX uses a heat exchange system to recover this reaction energy plus the waste heat of flue gas and feeds the energy back into the heating system.

Analysis

The University of British Columbia (UBC) assessed a CarbinX systems in operation in an office building in Calgary, Alberta, Canada. UBC used the information they collected to build a model that simulated the devices operation in each province of Canada. The highest GHG reduction was observed in British Columbia and the lowest was in Nova Scotia, reflecting the varying CO_2 emissions produced by the locale's electricity source (natural gas, coal, hydroelectric, etc.).

Overall Lifecycle Analysis

⇩ 21–27%

Net emissions reductions

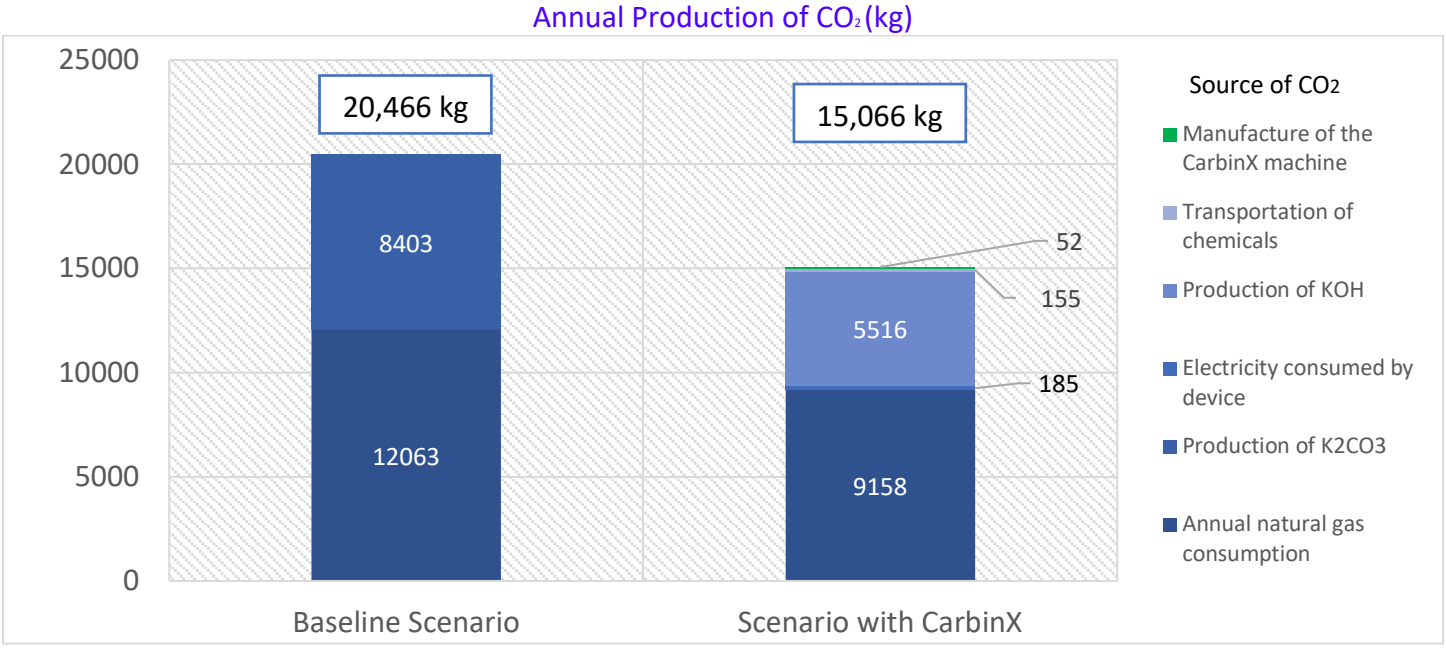
The UBC assessment accounted for the following sources of lifetime GHG emissions:

- Material extraction
- Manufacturing
- Lifetime operations

These sources are presented in the following table. The table is based on a CarbinX carbon capture system in operation in a 30,000-square-foot office building in Calgary.

Analysis Breakdown

Source of CO_2	Δ CO_2 (kg/year)	Explanation:
Annual natural gas consumption	↓ **2,905 kg**	UBC found domestic hot water heating in an office produced 12,063 kg CO_2 per year in the baseline case. With the CarbinX system in place, emissions dropped by 2,905 kg CO_2 each year. UBC simulations showed 905 kg CO_2 were directly captured from the flue gases in the chemical reaction, and 2,000 kg CO_2 emissions were avoided through heat recovery.
Electricity consumed by device	↑ **185 kg**	This number is based on the Canadian average. In areas where this electricity is generated primarily using hydrocarbons, this number will be greater. Alternatively In areas where electricity production is carbon neutral this number will be close to zero kg of CO_2/yr.
Production of potassium hydroxide (KOH)	↑ **5,516 kg**	KOH is manufactured from naturally occurring potassium chloride rock salt using an electrolysis process.
Production of potassium carbonate (K_2CO_3)	↓ **8,403 kg**	K_2CO_3 is used industrially around the world. The traditional method of manufacturing this compound is to burn natural gas to generate CO_2, and then bubble the gas through a solution of KOH. The CarbinX system offers a way to displace traditional K_2CO_3 manufacturing with a method that uses waste CO_2 and does not require the burning of virgin natural gas.
Transportation of chemicals	↑ **155 kg**	A technician is dispatched regularly to harvest K_2CO_3 and replenish KOH. UBC assumed that this travel involves a 50-km trip in a light commercial vehicle within the city. Global shipping from overseas chemical manufacturers is assumed to have a trip distance and mode types of: • Marine: 5337 km (11%) • Rail: 426 km (21%) • Truck: 285 km (73%)
Manufacture of the CarbinX machine	↑ **52 kg**	UBC calculated that 1,040 kg of CO_2 are produced in the manufacture of a unit and amortized this one-time CO_2 production over the machine's 20-year lifetime.



CleanO2