Direct Air Capture: Construction, Testing and Optimizing of a Prototype

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Purpose The emission of carbon dioxide into the atmosphere increases the greenhouse effect and warms the earth. In addition to reducing CO2 emissions, it is possible to actively remove the greenhouse gas directly from the atmosphere. This process is called Direct Air Capture (DAC). In the aforementioned process, a fan moves air through a special filter, which separates the CO2 from the air. The objective of my work was to build a small-scale prototype DAC unit to investigate if measurable amounts of CO2 can be removed from ambient air. Additionally, I aimed to improve the overall efficiency of the CO2 capturing process. Procedure In my project measurements with a self-built DAC unit are carried out and the system is optimized. Designing the apparatus was accomplished with a CAD program. The structural parts then were 3D-printed. The DAC machine and the sensors are controlled by a self-written program running on a microcontroller. Results With the self-built DAC plant, I demonstrated carbon capture from the ambient air and steadily increased the CO2 capture rate through improvements to the system. The most efficient setup separates between 2.5 and 3.2 grams of CO2 within one hour, with an energy consumption of 5,000 to 6,000 joules per gram captured (without regeneration of the filter). Conclusions With my self-built DAC unit, I was able to actively remove measurable amounts of CO2 without exceeding material costs of 400$. Thus, this project provides valuable insights into the subject of DAC and contributes to research on the technology, which can provide a solution for the climate problem.