IEAGHG 8th Post Combustion Capture Conference

16th to 18th September 2025 Marseille, France

Techno-economic evaluation of electrified carbon capture in cement production

Bhurisa Thitakamol, Mania Neisiani, Becky Gardiner, Peter Cave

Svante Technologies Inc., 8800 Glenlyon Parkway, Burnaby and V5J 5K3, Canada

Abstract

Svante's technology is targeted to industrial decarbonization including oil & gas, hydrogen, pulp & paper, lime, cement, steel, petrochemicals, and more. Svante's filters are applicable to both direct air capture (DAC) and point source industrial carbon dioxide capture applications. DAC and point source however use different adsorbent materials.

The cement industry is a significant contributor to global CO_2 emissions, accounting for approximately 7-8% of total emissions. To address this challenge, Svante has developed a Rapid Cycle Temperature Swing Adsorption (RC-TSA) process using structured solid sorbents as an alternative to traditional technologies. This study focuses on scaling up the CALF-20 Metal-Organic Framework (MOF) sorbent process for cement flue gas applications, which demonstrates high resistance to steam, oxygen, and acidic gas contaminants such as NO_x and SO_x—making it particularly well-suited for cement flue gas applications.

The study presents a detailed techno-economic assessment of a fully electrified carbon capture system to evaluate its feasibility and cost-effectiveness in large-scale cement production. This paper will discuss the use of low-grade energy sources (such as inlet flue gas, product CO_2 cooling, and CO_2 compressor trains) which is a unique feature that allows energy that would typically be considered a "waste product" and rejected to cooling system to be re-used for the regeneration step of the process and reduces the overall energy requirement for the system..

Commented [MC1]: @Becky Gardiner See my comment in the begnning, may be this could mover there but u guys have more experience so feel free to ignore.

Commented [MC2]: @Becky Gardiner May be if u have enough words would formulate it first a bit more generic and then zoom into cement ?

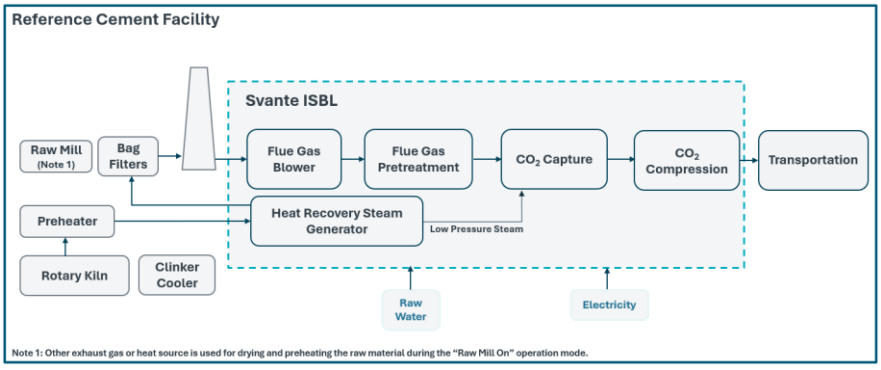
Commented [BG3R2]: @Mania Neisiani think this is for you

Commented [BG4R2]: @Mania Neisiani done

Commented [MC5]: @Becky Gardiner I dare not to correct a english native speaker, but does this miss "which"

Commented [BG6R5]: done

This assessment provides insights into the benefits of low-grade heat use toward a fully electrified carbon capture plant which results in reducing energy consumptions to 1.2-1.4 GJ/ton (including CO2 compression power consumption and enhancing sustainability while maintaining high CO_2 capture efficiency.

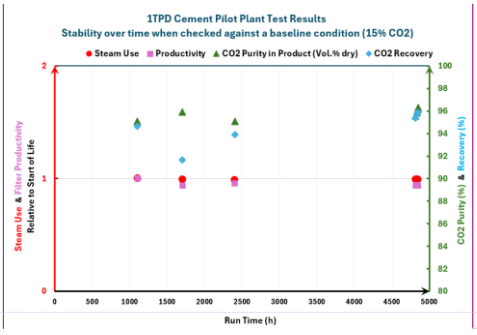


Performance data from a long-term test using a VeloxoTherm™ capture process at a 1 TPD scale at real cement kiln flue gas was collected in 2024. Results confirm CALF-20's long-term stability, maintaining CO_2 capture efficiency despite exposure to challenging industrial conditions. The data is summarized in Figure 1, below. These findings highlight the potential of CALF-20 and the Svante process to provide an energy-efficient and scalable solution for reducing CO_2 emissions in the cement industry, supporting the transition to a more sustainably built environment.

Commented [MN7]: @Bhurisa Thitakamol could you add an overal diagram on a cement application showing with Svante, that only electricity is provided. I will give you a call later to discuss.

Commented [BT8R7]: Added

Commented [PC9]: I made some edits in this paragraph



(a) Image of 1 TPD pilot plant at cement site *(b) KPI stability over time*

Figure 1. Svante's 1 TPD pilot plant hosted at a cement site

This paper will also cover Svante's technology advancements and discuss Svante's operational experience. Svante has made significant developments both in the fields of testing and filter and contactor manufacturing over the past few years, resulting in a technology maturation plan for commercial scale deployment which is well underway. Svante has built multiple test platforms, pilot plants and prototypes over the last 18 years, which have enabled progression and demonstration of technology readiness. Svante currently has a pilot plant capturing 365 tonnes per year (TPY) (1 TPD) CO_2 from cement flue gas (Lafarge) which to date has operated for more than 10,000 hours. Svante's second-of-a-kind (SOAK) 400 Series plant capturing 9125 TPY (25 TPD) has accumulated more than 4570 hours. Svante has two mobile process demonstration units (PDUs) with 0.1 TPD capacity, located at its R&D facility in Vancouver, Canada, and at Technology Centre Mongstad (TCM), the world's most advanced test arena for CO_2 capture technologies, under real refinery (Fluid Catalytic Cracker-FCC) conditions. PDUs are multi-filter bed test stations that simulate Svante's complete carbon capture process using real flue gas generated on-site. The test campaign at TCM is designed to validate filter stability by simulating high presence of contaminants (NOx, SOx, particulates, and aerosols) and to measure and validate the absence of secondary emissions in stack and product gases. The results gathered from the PDUs and the 1 TPD Lafarge Canada plant are used to confirm long term stability and process performance. One of the key elements of Svante's technology scale up is that the length of the filter beds at lab scale, pilot plant, and commercial scale are all the same length, which de-risks the scale-up of the overall process.

Commented [MN10]: Any other picture?

Commented [MN11]: Is steam use actually "normalized steam use", if yes I suggest to write it like that, same for productivity

Commented [MC12]: @Becky Gardiner I guess no additional data between the 3rd and the last data points ? If not no worries.

Commented [BG13R12]: @Peter Cave

Commented [PC14R12]: None that fit the 'same baseline condition' criteria. Of note for all, these data are with Synthetic gas, but intermixed with ~50% operating time running cement flue gas. At first I tried to caption this, but then felt it was ok as is.

Commented [MC15]: @Becky Gardiner It is it clear to people what we manufacture or do we need to say filters and Contactor ?

Commented [BG16R15]: Done

Commented [MC17]: @Becky Gardiner Would say 10,000 .....until this is published we will be there no ? Not sure how much 10,000hours is :)

Commented [BG18R17]: Done

Svante has constructed and is currently testing a full-scale prototype of its Ursa 1000 contactor, used for commercial scale applications, with current production of filter beds at equivalent dimensions to the modular production units used in full size Ursa 1000 filter beds. The Ursa 1000 contactor has been conceptualized, designed, fabricated, and was erected in January 2023. The contactor is now undergoing a series of mechanical testing and seal testing and optimization procedures to validate the sealing system, cost, and rotary drive system. The design incorporates scaling from a 4-meter diameter contactor to a 14-meter diameter contactor providing CO_2 capture capacity of up to 500 TPD. As of the end of 2024, this prototype had performed 4300 hours of mechanical and sealing testing, providing de-risking and a platform for sub-system design.

Over the last five years, Svante has completed its development phase, culminating in the completion and testing of the first-of-a-kind "400 Series" Pilot Plant, capturing up to 30 TPD of CO_2 from the Cenovus (formerly Husky Energy) oil & gas facility in Saskatchewan, and a 25 TPD plant at a Chevron oil & gas facility in California. To achieve its targets, Svante has been focusing its efforts on:

i) Scaling up and installing a commercial scale manufacturing line for its filter technology – at its 141,000 sq. ft / 13,100 m2 facility in Vancouver, Canada, with a filter throughput sufficient for 10 mmtpa CO_2 capture. Filter manufacturing line will start up in Q2 2025.
ii) Developing supply chain partnerships to support the manufacturing facility, as well as further growth over the next decade such as our commercial supply agreement with BASF,
iii) Completion of scaling up of the contactor design to large scales of 14m diameter (1000 Series) and 24m (2000 Series),
iv) Developing value chain and channel-to-market partnerships with EPC companies, balance of plant (BOP) equipment vendors, utilization companies, storage providers, project developers, and strategic customers, and
v) Development of scalable business systems, process, and maturation of the company's operating model to ensure commercial readiness by 2026.

Svante has developed a technology architecture for adsorption-based CO_2 capture that maximizes modularity and repeatability, facilitating the scale-up and technology maturation process.

Keywords: Carbon Capture; CCUS; Metal-Organic Framework (MOF); Solid sorbents; Carbon Management

Commented [MN19]: Could we add the buck picture here please

Commented [BG20R19]: no room

Commented [PC21R19]: Also, AFAIK, buck images have never been authorized for public facing publications. Correct/incorrect?

Commented [MN22]: Do we want to say the beds at the prototype is the same as the Ursa 1000?

Commented [AL23R22]: Yes

Commented [MC24]: @Becky Gardiner Do not fully understand this...does it refer to the overall capture system or the Buck ?

Commented [BG25R24]: clarified

Commented [MN26]: At the beginning of this paragraph we said we constructed the Ursa 1000, here in this line we said say it again, let's just keep this one and merge it with the 1st line at this paragraph

Commented [MN27]: Why we say early here?