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Carbon Capture from Flue Gas of a Chemical Industrial Park

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Master Thesis, Chemical Engineering

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Introduction

In the chemical park Schweizerhalle, multiple incineration plants handle the hazardous waste generated by production processes. The ALV1 is the smaller one of the two waste solvent incinerators. Within the scope of this project, the feasibility to upgrade this plant with a carbon capture unit was assessed.

Carbon Capture

The none confidential part of the project was the literature research on carbon capture technologies. Figure 1 visualizes the four basic approaches to capture CO_2 emitted by a point source (like the ALV1). The focus was set on post-combustion (tail end) capture technologies, since the other three approaches are either less efficient (Direct Air Capture) or require a major modification of the existing incineration plant (Pre-Combustion and Oxyfuel Combustion).

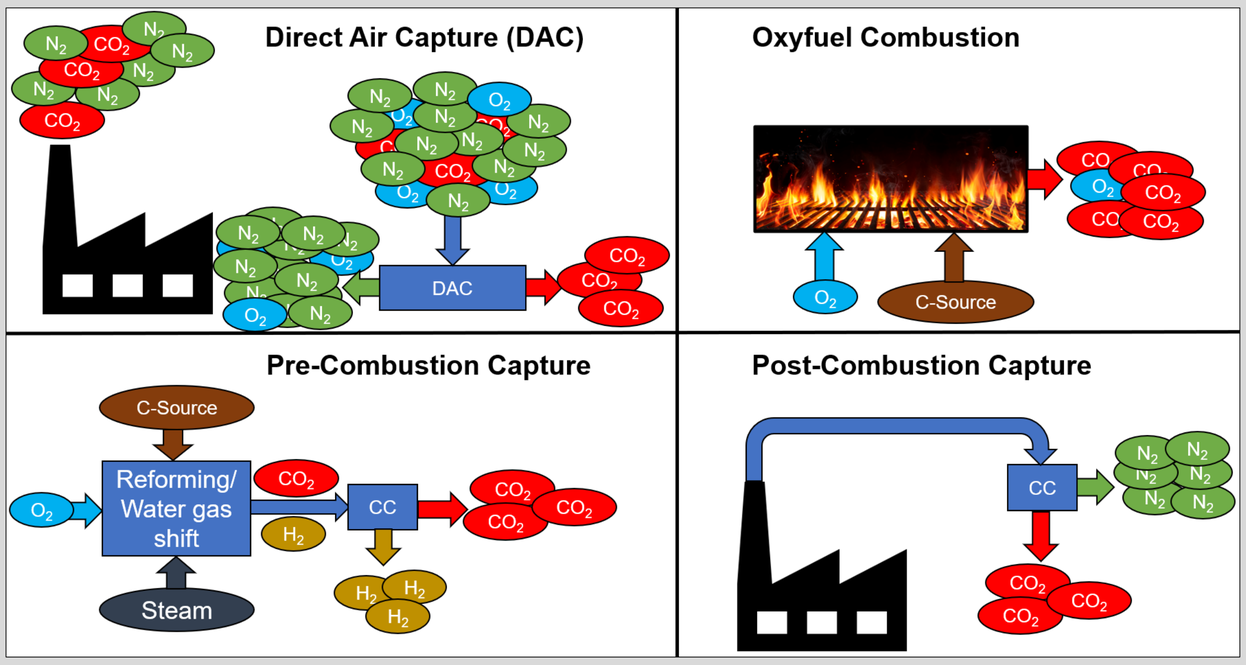

Fig. 1: Visualization of different carbon capture approaches.

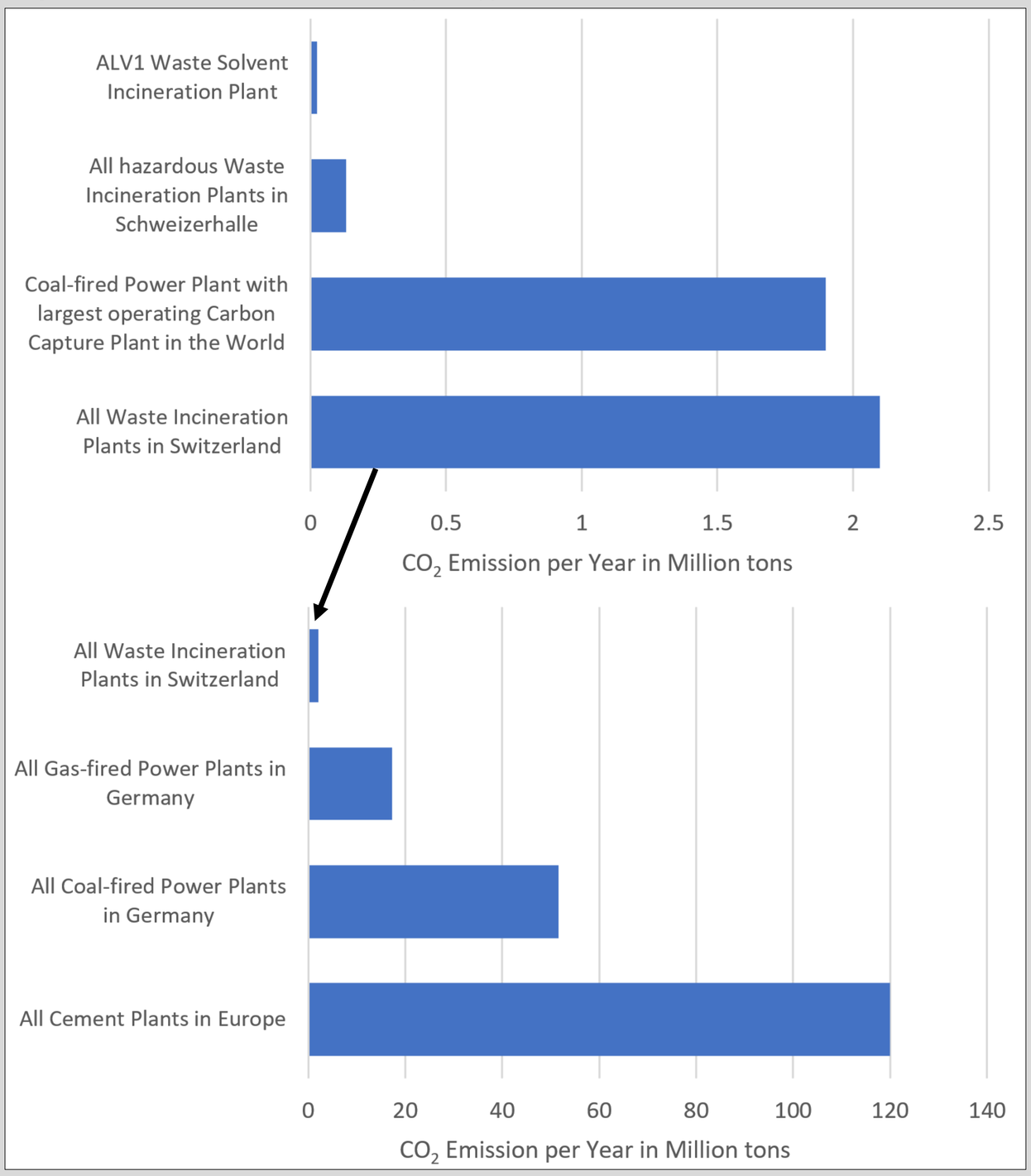

Fig. 2: Comparison of CO_2 emissions of ALV1 to other CO_2 point sources.

Amine Scrubbing

It was concluded that reactive absorption with amine solvents (amine scrubbing) is currently the state-of-the-art technology that is being built in large-scale all over the world (also for waste incineration plants). Other less popular technologies (e.g. ammonia based absorption, cryogenic, membrane, adsorption) promise lower energy consumption and costs, but are currently not technologically ready for large-scale. As a next step, potential technology providers were contacted to get an operational and investment cost quotation for an amine scrubbing plant that can capture CO_2 from the full ALV1 flue gas stream.

Comparison of ALV1 to other CO_2 Point Sources

In the upper part of Figure 2, the yearly CO_2 emission of the ALV1 and the incineration plants in Schweizerhalle are compared to the CO_2 emission of the point-source with the largest operating capture plant (Petra Nova, Texas) and the summarized emissions of all waste incineration plants in Switzerland. In the lower part of Figure 2, the summarized CO_2 emissions of all waste incineration plants in Switzerland are compared to the CO_2 emissions of all coal- and gas-fired power plants in Germany and all European cement plants. This shows on one hand the huge amount of CO_2 that is emitted and on the other hand, how tiny the still large ALV1 CO_2 stream is compared to other emitters. This fact did reflect in the contact with potential technology providers and sequestration (permanent storage of CO_2) companies. The focus for those is set on the large emitters with huge CO_2 streams.

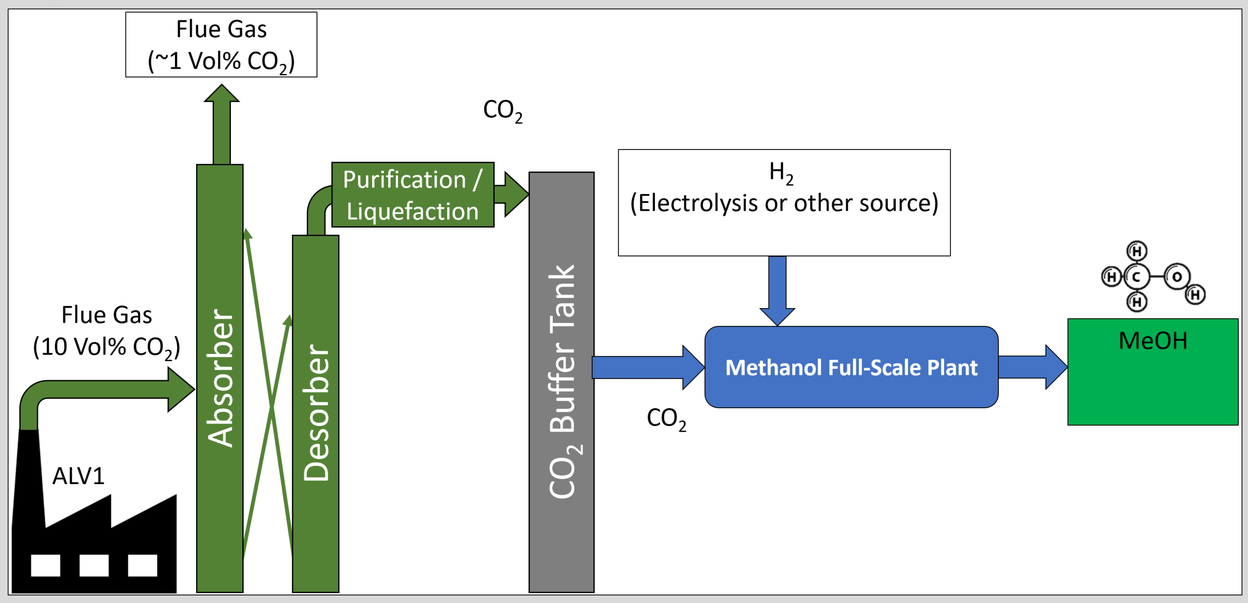

Fig. 3: Site concept including capturing CO_2 from the ALV1 flue gas and converting it to methanol.

Site Concept (Carbon Capture and Utilization)

One main issue with carbon capture is the fact that one needs to take care of the captured CO_2. The technical and food-grade CO_2 market is quickly saturated as soon as a few point source capture plants are built. Sequestration of the CO_2 is currently the path many future carbon capture plant operators have chosen. However, emitters in the size of the ALV1 are not interesting for sequestration companies. The only possibility would be if such smaller emitters could cooperate with many smaller or a larger emitter.

A sustainable approach to take care of the CO2 is the direct conversion of it into a higher priced substance with higher demand (utilization). The production of methanol could be a great opportunity for the chemical park Schweizerhalle. The methanol could be used internally or by other regional chemical companies. For the fine chemical production cluster in the Basel area, the combination of incineration, CO_2 capture, methanol synthesis and reusing methanol for the production processes would be a circular and sustainable approach to handle waste carbon atoms from production processes. Figure 3 shows a simple site concept of such a carbon capture and methanol production combination for the ALV1. Before directly scaling up the process, it could also be an opportunity to build a launch platform (pilot / demonstration) for this process, to prove it and win potential customers and supporters. As a part of this launch platform, an innovative carbon capture technology (e.g. ammonia based absorption, cryo-genic, membrane, adsorption) could be piloted.

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