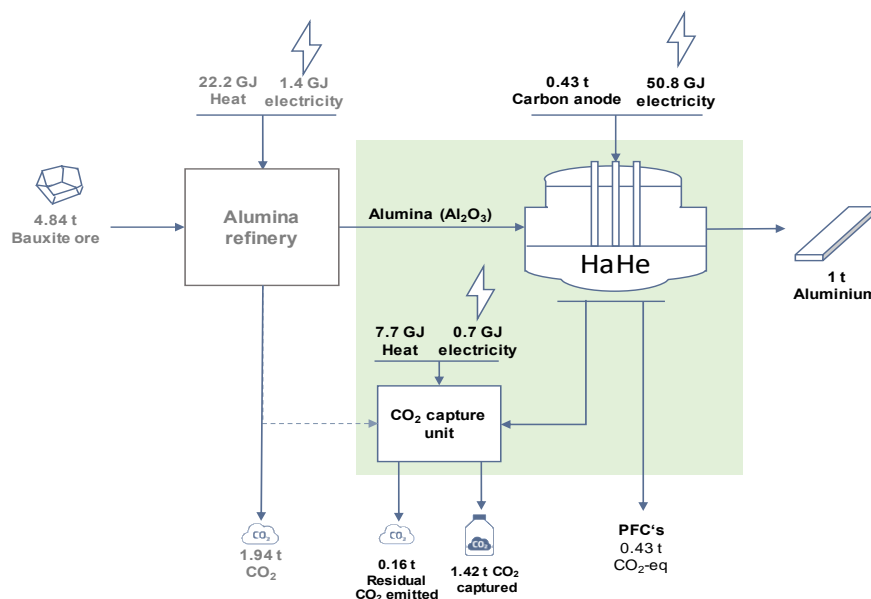


Aluminium Smelter equipped with carbon capture and Storage (HaHe-CCS)

Description | Carbon Capture and Storage (CCS) includes the capture of CO₂ at the plant and its subsequent transport to an underground storage site such as exploited oil and gas fields or saline aquifers in which the captured CO₂ will be permanently stored underground. For this the aluminium smelter (Hall–Héroult process; HaHe) is retrofitted with post-combustion CO₂ capture technology with a capture rate of 90%. However CCS technology can only capture CO₂ emissions but no PFC¹ emissions.



Process inputs and outputs per t of aluminium

	Unit	Value
Electricity demand	GJ	52.2
Heat demand	GJ	29.9
Bauxite ore	t	4.84
Carbon anode	t	0.43
GHG emissions (scope-1) ²	t CO ₂ -eq	0.59
GHG emissions (scope-2) [*]	t CO ₂	7.28
CO ₂ captured	t CO ₂	1.42

^{*}Assumed emission intensity of electricity: 516 g CO₂/kWh_{el}

¹ PFC (perfluorocarbons) emissions are mainly CF₄ and C₂F₆, whose global warming potentials (GWP) are a multi-fold of that of CO₂
² of the aluminium smelter (HaHe process) including PFC emissions in CO₂-eq, excluding alumina refinery

Key characteristics:³

- Retrofit to existing plants possible
- Low concentration of CO₂ in off-gases (~ 1%)
- Low Technology Readiness Level (TRL)
- Does not capture PFC emissions
- Green house gas (GHG) emission reduction compared to conventional aluminium smelting: ~70% (scope-1)⁴

Key requirements:

- Access to CO₂ infrastructure

Applicability to the Kazakh context:

- Promising CO₂ storage sites have distance of several hundred up to two thousand km from current aluminium smelters. Currently no transport infrastructure exists
- Application of CCS must be assessed in the context of a broader CCS-strategy

³ More information and assumptions are provided in the final report of the DeKaMe project (<https://epub.wuppertalinst.org/frontdoor/index/index/docId/8779>)

⁴ The system boundary for the calculations is the aluminium smelter (HaHe process), not including the alumina refinery