Supplementary Materials

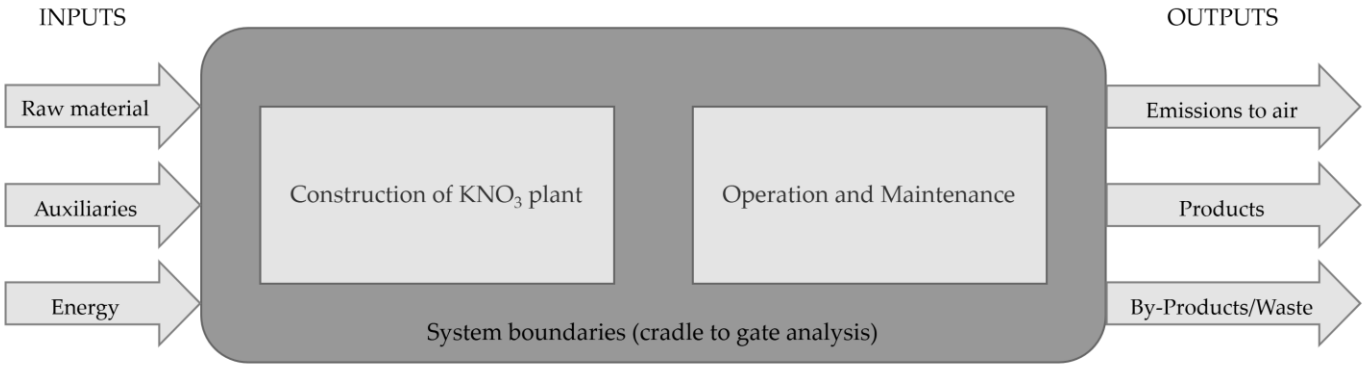


Figure S1. System boundaries applied for the LCA and LCC study

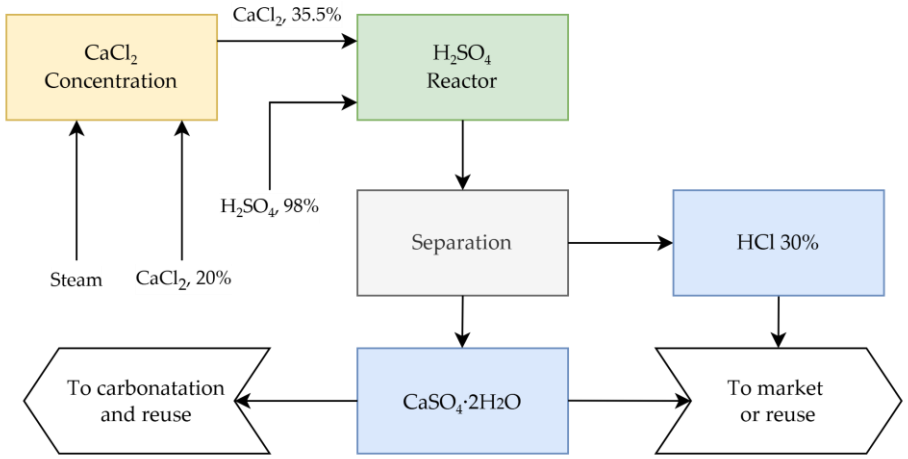


Figure S2. Block diagram of the HCl concentration process

Table S1. Inventory of baseline scenario per functional unit

Category	Input	Amount	Unit
Raw materials	Potassium chloride	0.5176	kg
	Ammonioum nitrate (%80)	0.6947	kg
Auxiliaries	Process water	26,43	kg
	Refrigeration water	276,51	kg
	Steam	5,97	kg
Energy	Electricity	4.20	kWh
	Natural gas	1.26	kWh
Emissions	Atmospheric emissions	0.00048	kg (proxy)
Infrastructure	Equipment use (normalized)	0.00492	kg
	Replacement (normalized)	0.00040	kg
Transport	Equipment transport	0.00422	tkm
	Equipment replacement	0.00034	tkm

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Table S2. Inventory of CORALIS scenario per functional unit

Category	Input	Amount	Unit
Raw materials	Calcium sulfate dihydrate	0.0945	kg
	Sulfuric acid 98%	0.0677	kg
	Nitric acid	0.3903	kg
	Potassium chloride	0.2914	kg
	Potassium hydroxide	0.0110	kg
Auxiliaries	Process water	0.9809	kg
	Process water	0.8418	kg
	Refrigeration water	1.5572	kg
	Steam (low pressure)	0.0688	kg
	Steam (medium pressure)	0.2275	kg
Energy	Electricity – Reaction and recovery section	0.076	kWh
	Electricity - Concentrator section	0.243	kWh
Infrastructure	Equipment – Reaction and recovery section	0.00168	kg
	Equipment – Replacements	0.000034	kg
	Equipment - Concentrator	0.000012	kg
Transport	Initial equipment	0.00144	tkm
	Replacement equipment	0.000029	tkm
	HCl concentrator	0.000010	tkm

Table S3. Category impacts for the study under ReCiPe environmental method

Impact Categories	Abbr.	Unit
Global warming	GWP	kg CO_2 eq
Stratospheric ozone depletion	ODP	kg CFC11 eq
Ionizing radiation	IRP	kBq Co-60 eq
Ozone formation, Human health	HOFP	kg NO_x eq
Fine particulate matter formation	PMFP	kg $PM_{2.5}$ eq
Ozone formation, Terrestrial ecosystems	EOFP	kg NO eq
Terrestrial acidification	TAP	kg SO_2 eq
Freshwater eutrophication	FEP	kg P eq
Marine eutrophication	MEP	kg N eq
Terrestrial ecotoxicity	TETP	kg 1,4-DCB
Freshwater ecotoxicity	FETP	kg 1,4-DCB
Marine ecotoxicity	METP	kg 1,4-DCB
Human carcinogenic toxicity	HTPc	kg 1,4-DCB
Human non-carcinogenic toxicity	HTPnc	kg 1,4-DCB
Land use	LOP	m^2a crop eq
Mineral resource scarcity	SOP	kg Cu eq
Fossil resource scarcity	FFP	kg oil eq
Water consumption	WCP	m^3

Table S4. Environmental cost factors used in eLCC assessment

Impact Category	Unit	Cost (€)

Climate change	€/kg CO_2-eq.	€0.13
Ozone depletion	€/kg CFC-11-eq.	€29.1
Ionizing radiation	€/kBq Co-60-eq.	€0.00422
Oxidant formation, human health	€/kg NO_x-eq.	€2.17
Oxidant formation, terrestrial ecosystems	€/kg NO_x-eq.	€0.416
Particulate matter formation	€/kg $PM_{2.5}$-eq.	€99.2
Acidification	€/kg SO_2-eq.	€5.27
Freshwater eutrophication	€/kg P-eq.	€7.94
Marine eutrophication	€/kg N-eq.	€14.25
Terrestrial ecotoxicity	€/kg 1,4-DCB-eq.	€0.00064
Freshwater ecotoxicity	€/kg 1,4-DCB-eq.	€2.70
Marine ecotoxicity	€/kg 1,4-DCB-eq.	€0.0032
Human toxicity, cancer-related	€/kg 1,4-DCB-eq.	€3.99
Human toxicity, non-cancer related	€/kg 1,4-DCB-eq.	€0.071
Land use	€/m^2·crop-eq.	€0.099
Mineral extraction	€/kg Cu-eq.	€0.0826
Fossil extraction	€/kg oil-eq.	€0.028
Water consumption	€/m^3	€0.407
NO_2-mortality*	€/kg NO_x-eq.	€6.37

Table S5. Detailed results of life cycle impact assessment across all categories for Baseline scenario

Impact category	Unit	Raw materials	Energy	Auxiliaries	Equipment	Transport
Global warming	kg CO2 eq	4,11E-01	1,45E-01	5,87E-04	1,23E-03	1,11E-05
Stratospheric ozone depletion	kg CFC11 eq	2,35E-06	5,37E-08	2,92E-10	1,15E-08	5,91E-12
Ionizing radiation	kBq Co-60 eq	1,11E-03	3,94E-03	1,97E-05	9,98E-06	7,86E-08
Ozone formation, Human health	kg NOx eq	7,28E-04	3,20E-04	1,11E-06	2,12E-06	8,86E-08
Fine particulate matter formation	kg PM2.5 eq	5,24E-04	2,20E-04	9,27E-07	1,42E-06	2,15E-08
Ozone formation, Terrestrial ecosys-tems	kg NOx eq	7,42E-04	3,23E-04	1,12E-06	2,21E-06	8,94E-08
Terrestrial acidifica-tion	kg SO2 eq	2,45E-03	6,00E-04	2,39E-06	3,21E-06	5,65E-08
Freshwater eutroph-ication	kg P eq	1,06E-05	7,32E-06	6,31E-08	1,16E-07	1,21E-09
Marine eutrophica-tion	kg N eq	4,29E-07	3,05E-07	2,85E-09	1,10E-08	1,01E-10

Impact category	Unit	Raw materials	Energy	Auxiliaries	Equipment	Transport
Terrestrial ecotoxicity	kg 1,4-DCB	1,16E+00	1,41E-01	5,42E-04	5,48E-03	1,83E-04
Freshwater ecotoxicity	kg 1,4-DCB	2,82E-04	2,90E-05	2,80E-07	5,43E-06	2,74E-08
Marine ecotoxicity	kg 1,4-DCB	1,01E-03	1,15E-04	7,06E-07	1,03E-05	1,30E-07
Human carcinogenic toxicity	kg 1,4-DCB	2,62E-04	2,94E-04	5,97E-06	3,83E-04	1,54E-08
Human non-carcinogenic toxicity	kg 1,4-DCB	3,40E-02	2,09E-02	1,48E-04	5,65E-04	2,85E-06
Land use	m2a crop eq	3,37E-04	1,96E-03	1,27E-05	1,64E-05	1,45E-07
Mineral resource scarcity	kg Cu eq	4,79E-04	4,83E-05	1,53E-06	9,56E-06	1,40E-09
Fossil resource scarcity	kg oil eq	1,27E-01	4,38E-02	1,59E-04	3,21E-04	3,51E-06
Water consumption	m3	6,90E-03	8,08E-04	2,77E-03	1,15E-05	7,55E-09

Table S6. Detailed results of life cycle impact assessment across all categories for CORALIS scenario

Impact category	Unit	Raw materials	Energy	Auxiliaries	Equipment	Transport
Global warming	kg CO2 eq	4,11E-01	1,45E-01	5,87E-04	1,23E-03	1,11E-05
Stratospheric ozone depletion	kg CFC11 eq	2,35E-06	5,37E-08	2,92E-10	1,15E-08	5,91E-12
Ionizing radiation	kBq Co-60 eq	1,11E-03	3,94E-03	1,97E-05	9,98E-06	7,86E-08
Ozone formation, Human health	kg NOx eq	7,28E-04	3,20E-04	1,11E-06	2,12E-06	8,86E-08
Fine particulate matter formation	kg PM2.5 eq	5,24E-04	2,20E-04	9,27E-07	1,42E-06	2,15E-08

Impact category	Unit	Raw materials	Energy	Auxiliaries	Equipment	Transport
Ozone formation, Terrestrial ecosystems	kg NOx eq	7,42E-04	3,23E-04	1,12E-06	2,21E-06	8,94E-08
Terrestrial acidification	kg SO2 eq	2,45E-03	6,00E-04	2,39E-06	3,21E-06	5,65E-08
Freshwater eutrophication	kg P eq	1,06E-05	7,32E-06	6,31E-08	1,16E-07	1,21E-09
Marine eutrophication	kg N eq	4,29E-07	3,05E-07	2,85E-09	1,10E-08	1,01E-10
Terrestrial ecotoxicity	kg 1,4-DCB	1,16E+00	1,41E-01	5,42E-04	5,48E-03	1,83E-04
Freshwater ecotoxicity	kg 1,4-DCB	2,82E-04	2,90E-05	2,80E-07	5,43E-06	2,74E-08
Marine ecotoxicity	kg 1,4-DCB	1,01E-03	1,15E-04	7,06E-07	1,03E-05	1,30E-07
Human carcinogenic toxicity	kg 1,4-DCB	2,62E-04	2,94E-04	5,97E-06	3,83E-04	1,54E-08
Human non-carcinogenic toxicity	kg 1,4-DCB	3,40E-02	2,09E-02	1,48E-04	5,65E-04	2,85E-06
Land use	m2a crop eq	3,37E-04	1,96E-03	1,27E-05	1,64E-05	1,45E-07
Mineral resource scarcity	kg Cu eq	4,79E-04	4,83E-05	1,53E-06	9,56E-06	1,40E-09
Fossil resource scarcity	kg oil eq	1,27E-01	4,38E-02	1,59E-04	3,21E-04	3,51E-06
Water consumption	m3	6,90E-03	8,08E-04	2,77E-03	1,15E-05	7,55E-09