

Regional roadmap on the way to a climate positive industrial region



Foto: Dag Jensen

Produced by SINTEF Industri in cooperation
with Periti og University of SouthEast Norway

Focus areas

Product- and process development

Bioenergy, CCU, electrification, reduced carbon footprint products, CO₂ capture, purification, other emission reduction (to air, water, sea), separation technology, use of hydrogen, green plastics, digitization, automation, autonomy

Industrial circular economy

Recycling, efficient use of resources, waste management

Logistics and infrastructure

Green transport, autonomy, sustainable mobility

Business conditions and regional attractivity

Regulations and policies, lobbying, attracting new business to the region

Cluster development

Collaborative culture, competence, network, sharing

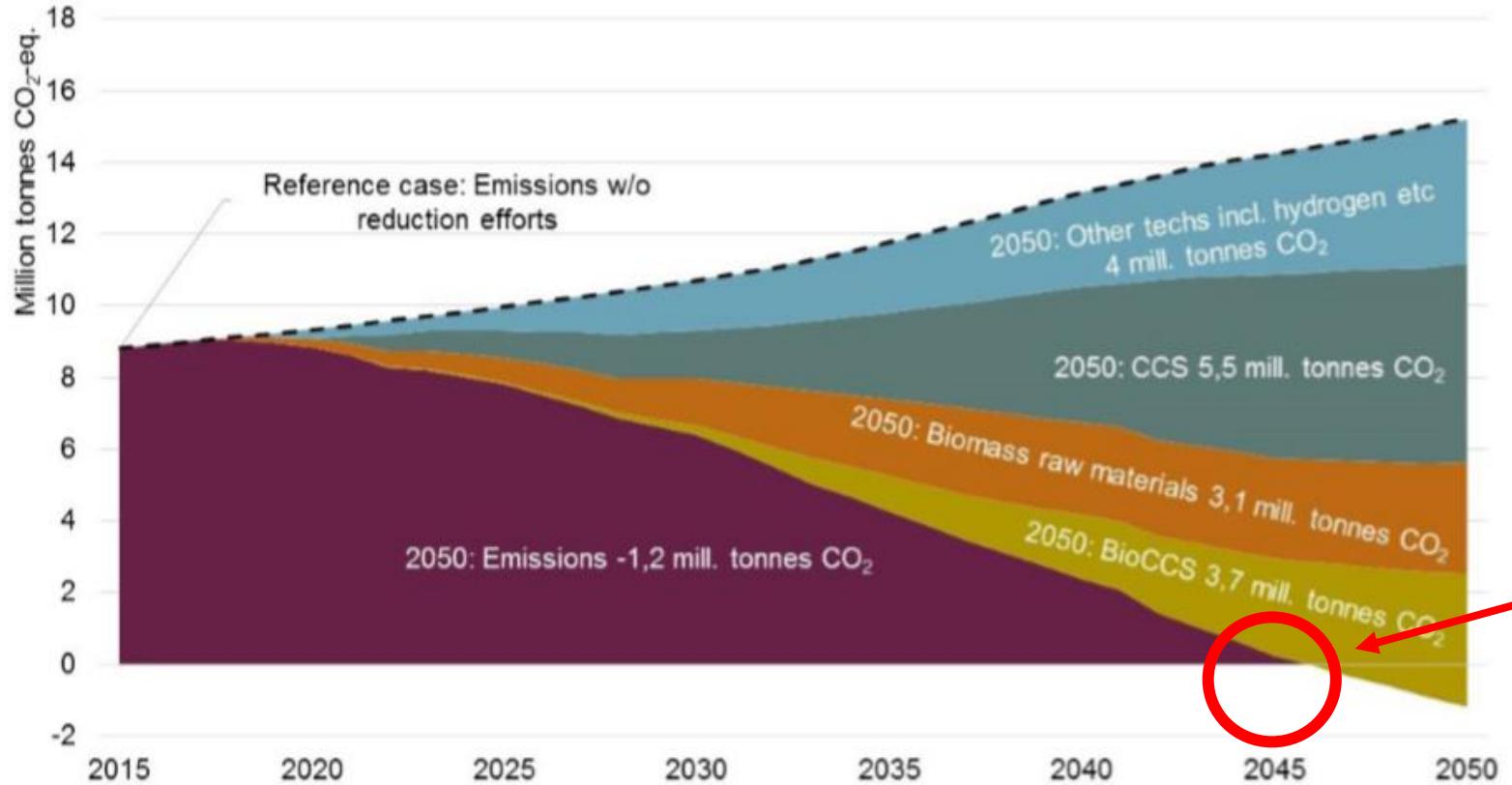


Grenland in Vestfold/Telemark aims to be the worlds first climate positive industry region, delivering green technology solutions to the global market



From the roadmap for Norwegian process industry

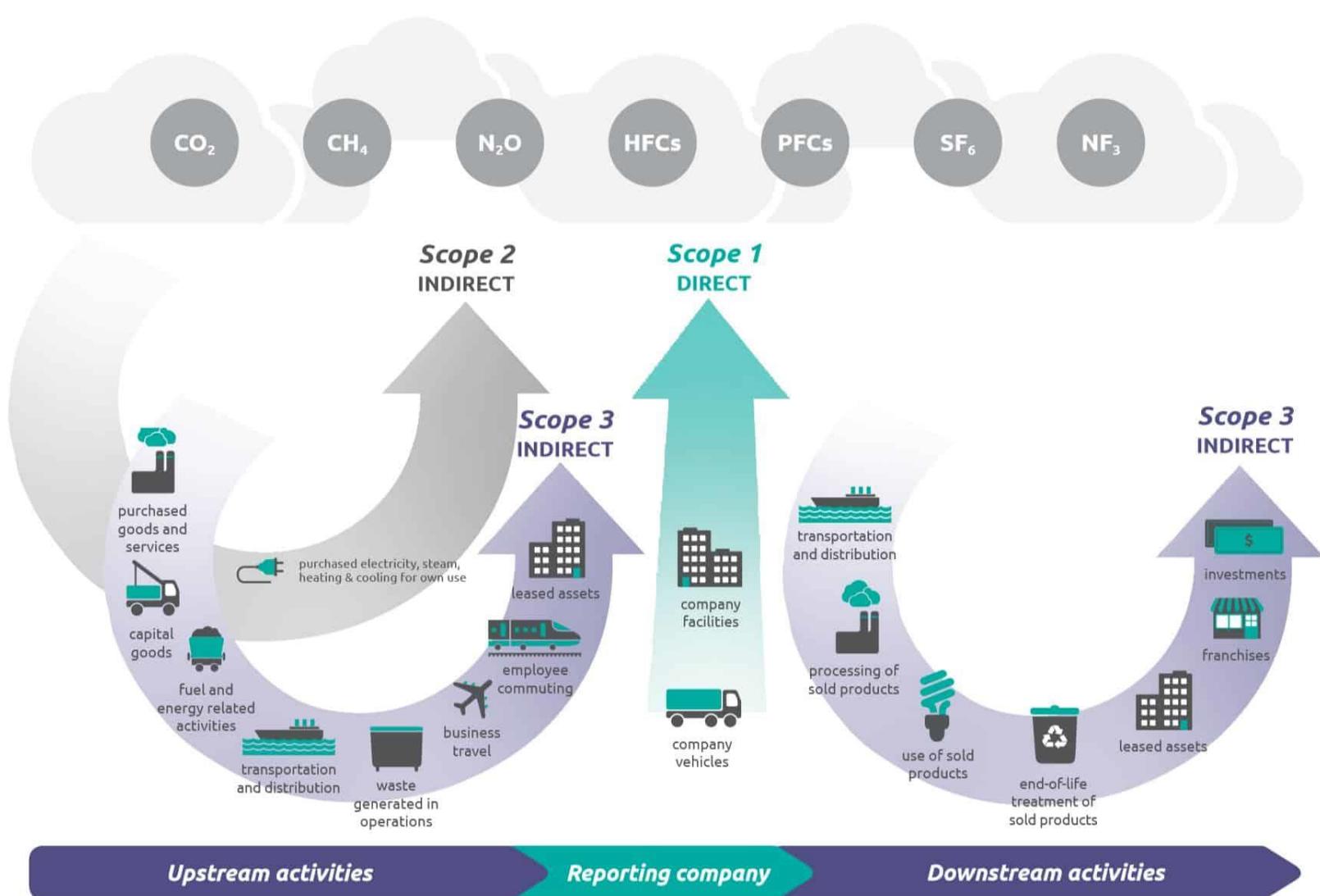
Emissions and possible reduction



**Business
opportunities in
reaching this point
early**

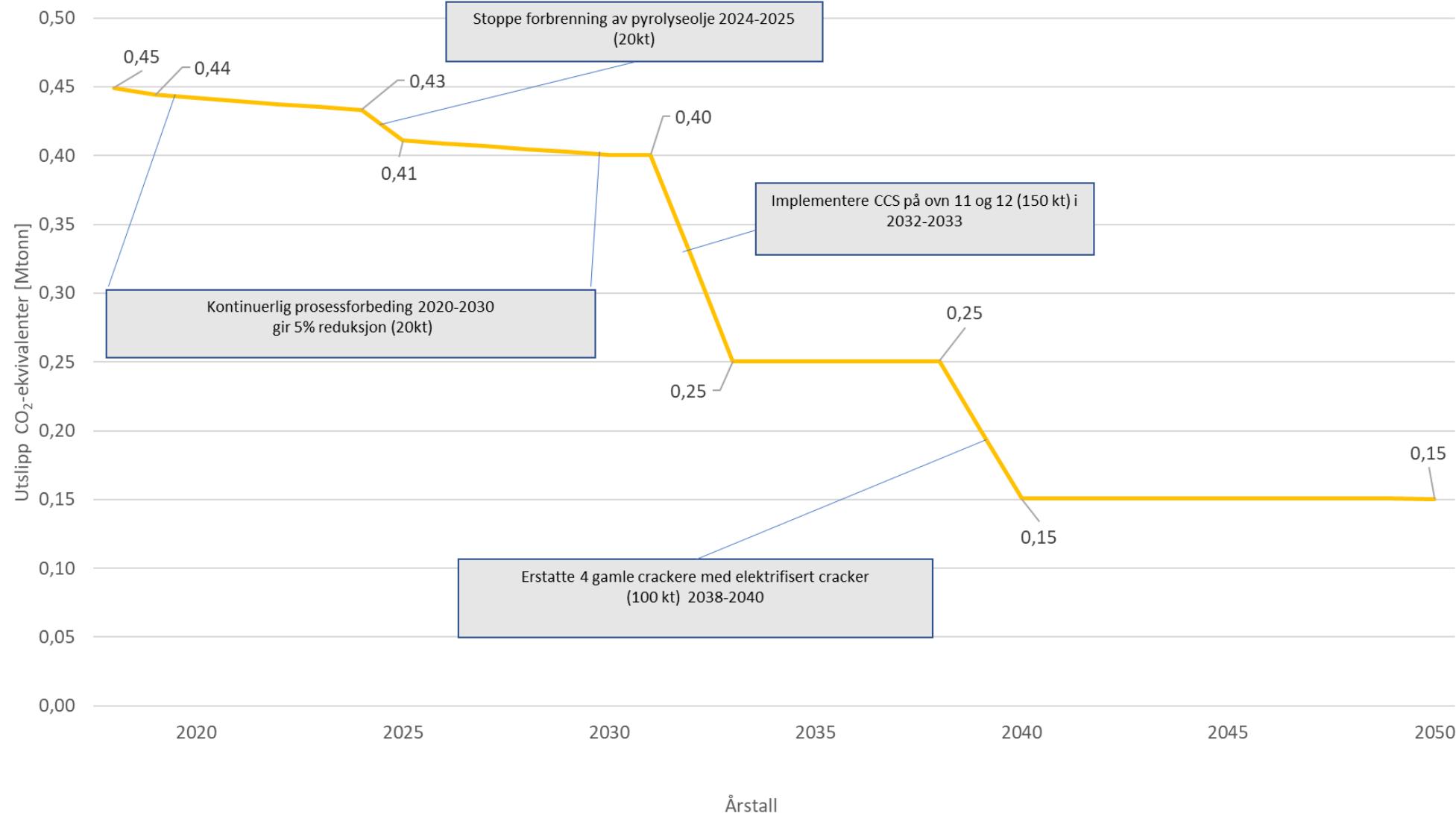
Figure 4: Emissions and emission reductions by technology, compared to reference case with robust industrial growth.

GHG protocol: Scope 1, 2 and 3



- **Scope 1 All Direct Emissions** from the activities of an organisation or under their control
- **Scope 2 Indirect Emissions** from electricity purchased and used by the organisation.
- **Scope 3 All Other Indirect Emissions** from activities of the organisation, occurring from sources that they do not own or control.

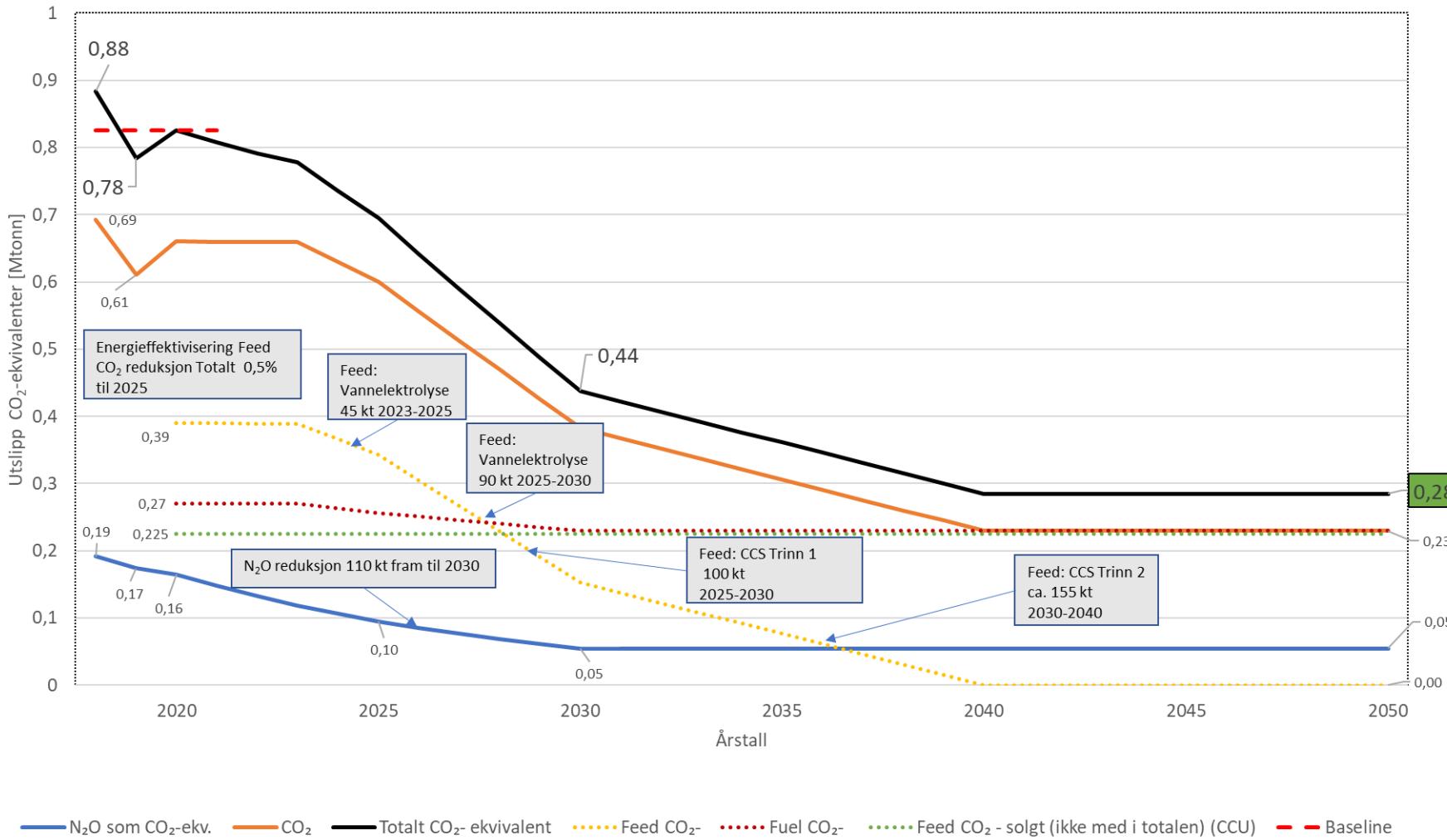
Mulig utvikling av klimagassutslipp INEOS Rafnes i perioden 2020 - 2050
[CO₂-ekvivalenter, Mtonn/år]



Possible development of emissions from INEOS Rafnes.

— Totalt CO₂- ekvivalent [Mtonn]

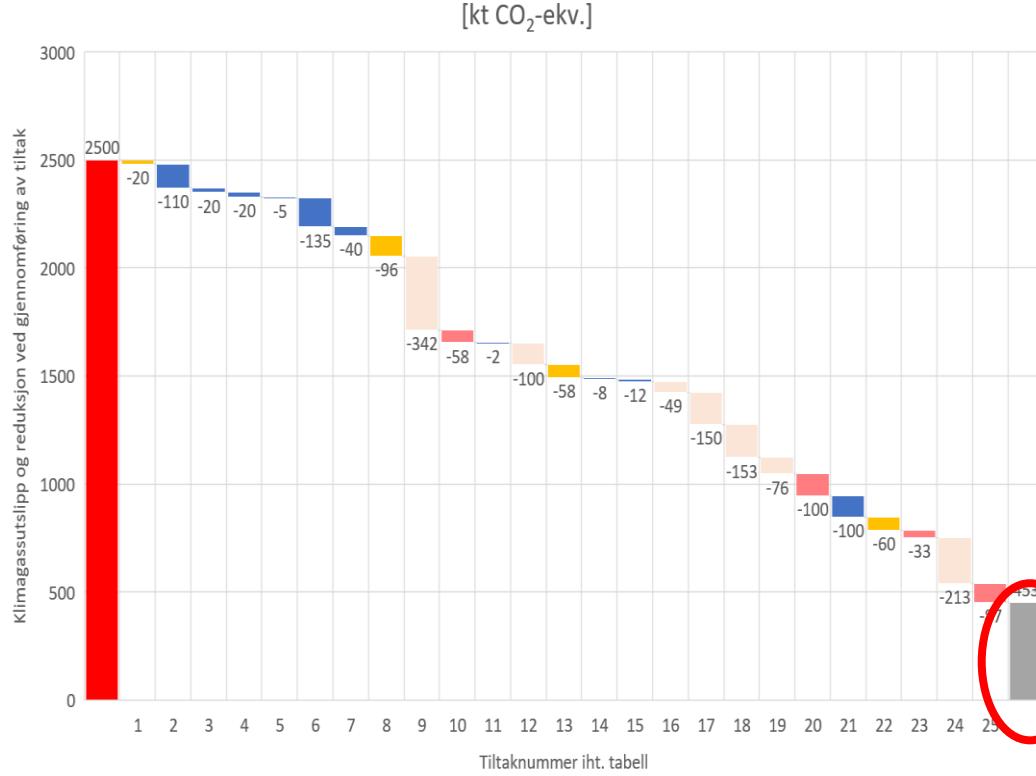
Mulig utvikling av klimagass-utslipp YARA Porsgrunn 2020 - 2050 CO₂- ekvivalenter, [Mtonn/år]



Possible development of emissions from Yara Porsgrunn.

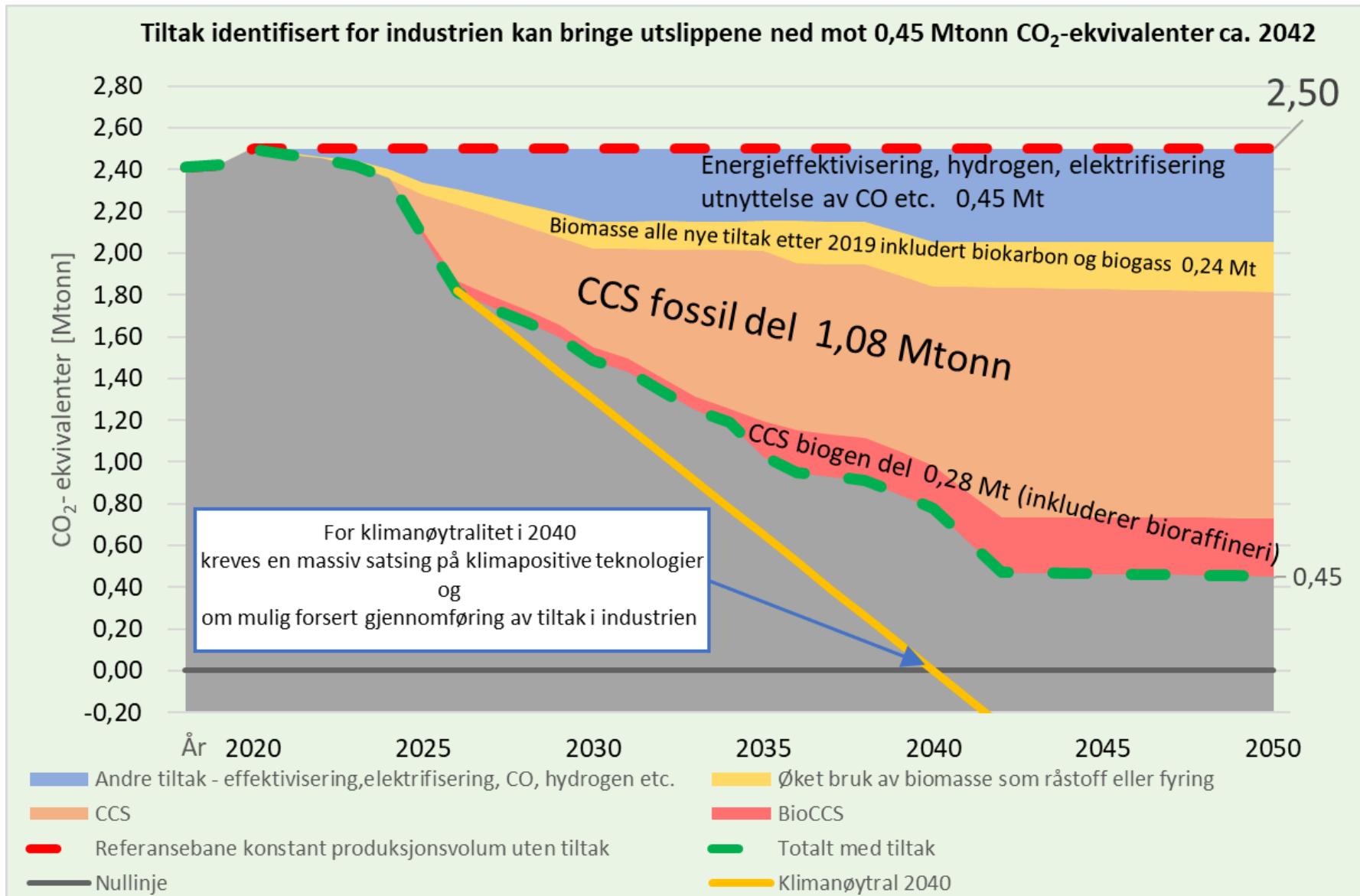
Possible measures and their effect

Effekt av mulige tiltak lagt inn for referansebanen



Tiltaknr.	Tiltak	Bedrift	Når	Effekt i kt (reduksjon av CO ₂ eq)		Forankret i scenario for bedrift
				2020	2500	
1	Øket mengde biobasert brensel (ca. 4% per år)	Norcem Brevik	Biomasse	2020-2025	20	Ja
2	Fortsatt reduksjon av lystgassutslipp	Yara Porsgrunn	Reduksjon	2020-2030	110	Ja
3	Kontinuerlig forbedring - øket energieffektivitet	Ineos Rafnes	Reduksjon	2020-2030	20	Ja
4	Stans i forbrenning av pyrolyseolje	Ineos Rafnes	Reduksjon	2020-2030	20	Ja
5	Kontinuerlig forbedring - øket energieffektivitet	Inovyn Norge	Reduksjon	2022-2030	5	Ja
6	Produksjon av hydrogen ved vannelektrolyse	Yara Porsgrunn	Elektrifisering	2023-2030	135	Ja
7	Redusert fossil fyring pga. vannelektrolyse	Yara Porsgrunn	Elektrifisering	2023-2030	40	Ja
8	Innføre biokarbon	Eramet Porsgrunn	Biomasse	2023-2030	96	Ja
9	Karbonfangst og lagring (fossil del)	Norcem Brevik	CCS	2024-2026	342	Ja
10	Karbonfangst og lagring (biogen del)	Norcem Brevik	BioCCS	2024-2026	58	Ja
11	Energieffektivisering	Yara Porsgrunn	Reduksjon	2025-2030	2	Ja
12	Karbonfangst og lagring (fossil)	Yara Porsgrunn	CCS	2025-2030	100	Ja
13	Øket mengde biobasert brensel (ca. 1% per år)	Norcem Brevik	Biomasse	2025-2050	58	Ja
14	Mindre karbonatiske råvarer	Eramet Porsgrunn	Reduksjon	2027-2030	8	Ja
15	Forredusjon ved bruk av CO	Eramet Porsgrunn	Reduksjon	2028-2030	12	Ja
16	Karbonfangst og lagring (fossil)	RHI Normag	CCS	2029-2031	49* (70)	Ja
17	Karbonfangst og lagring (fossil)	Ineos Rafnes	CCS	2030-2035	150	Ja
18	Karbonfangst og lagring (fossil)	Yara Porsgrunn	CCS	2030-2040	153	Ja
19	Karbonfangst og lagring (fossil)	Inovyn Norge	CCS	2034-2036	76* (88)	Ja
20	Karbonfangst og lagring (biogen del)	Bioraffineri	BioCCS	2035-	100	Ny bedrift - beskrevet i scenario
21	Erstatte fire gamle crackerovner med elektrisk cracker	Ineos Rafnes	Elektrifisering	2035-2045	100	Ja
22	Overgang til biobrensel (biogass fra raffineri)	RHI/INOVYN	Biomasse	2036-	60	Nei
23	Karbonfangst og lagring (biogen del)	RHI Normag/Inovyn	BioCCS	2036-	33* (0)	Biogen del avhenger av nr.22
24	Karbonfangst og lagring (fossil del)	Norcem Brevik	CCS	2040-	213	Nei
25	Karbonfangst og lagring (biogen del)	Norcem Brevik	BioCCS	2040-	87	Nei
Resterende utslipp					453	

Reduction of emissions in Grenland



Source: Regional roadmap for Grenland by Sintef Industri, Periti and USN

In order to reach Zero in 2040 things will need to speed up, new technology must become available and more measures will need to be implemented

How to reach zero emissions in 2040, and thereafter become climate positive?

Further reduction of industrial emissions:

- Energy efficiency and process optimalization
(better/newer process equipment, better process control for stable operation with high load and regularity, more effective digitalization)
- Carry out CCS in large scale, transfer tech from Norcem to others
- CCU, including CO₂ as feedstock for the petrochemical industry
- Electrification of thermal processes, including production and use of hydrogen
- Large scale development of biobased and circular processes
- Measures entered along the value chain (scope 3)
- Measures for the transport sector as part of the total picture

Early and powerful focus on climate positive technologies:

- DAC (Direct Air Capture) (e.g Norsk E-fuel)
- Bio-CCS

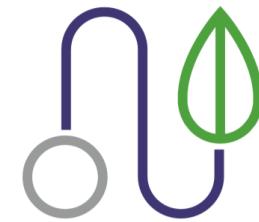
Climate neutral and climate positive technologies

Climate neutral (ex):

- Energyefficiency
- Switch of fuel (ex from coal to natural gas)
- CCS and CCUS
- Hydrogen, both «green» (from water electrolysis by renewable energy) and «blue» (from reforming of natural gas combined with CCS)
- Electrification of industrial prosesses
- Swithch of feedstock from fossile to biobased

Climate positive (ex):

- Use of biomass (landbased and offshore) for absorbing and storing CO₂
- Minerals that can bind CO₂ in nature (magnesium- and calcium-carbonates)
- Biotechnology – storage - more eficent production of biomass
- Artificial photosynthesis
- Storage of biocoal in soil
- DAC (Direct Air Capture)
- Biomass combustion combined with CCS (BECCS - Bio-Energy with CCS).



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