

ROADMAP CCU and CCS

COULD CARBON CAPTURE AND USAGE INITIATIVES AT
WASTE TO ENERGY FACILITIES QUALIFY FOR SUPPORT
FROM THE EU INNOVATION FUND?

September 19, 2019



UNIQUE PARTNERSHIP BETWEEN TWO SECTORS



Dutch horticulture sector

Surface: 9.200 ha
Natural gas usage: 7,5 % of Dutch consumption (3,2 billion m3)
CO2 emission: 5,6 Mton (2016)
Employment: 2500 companies
400.000 FTE
Added value: 7,7 billion euro

Reduction target 2030: 1,0 Mton
[source: Glasstuinbouw Nederland, 2016 numbers]



Dutch Energy from Waste sector

Number of plants: 12
Capacity: 8 Mt
Energy production: 35 PJ (53% biogenic)
Share Dutch renewable production: 16%
CO2 emissions: 8 Mt (64% biogenic)

Reduction target 2030: 1,1 Mton fossil
3,0 Mton (total)

[source: VA]



AVR.



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PCC POST-COMBUSTION CAPTURE OF CO₂ FROM FLUE GAS (PILOT PLANT)



- Operator
RWE Power AG
- Location
Niederaußem/Germany

- Technology partners
RWE/BASF/Linde

- Process
BASF solvent

- Capacity
1 552 Nm³/h flue gas from lignite power plant
7.2 t/d CO₂

- Purity
> 99 vol % CO₂ dry

- Scope of work
Project management, basic engineering, detail engineering,
equipment supply, erection, start-up, test run

- Start-up
2009 (still in operation)



FROM DEMO TO FIRST LARGE PILOT PLANT



Pilot plant, by TNO, 2016



3D design CO₂ Plant Duiven, 2018



Construction CCU Plant AVR Duiven, 2019



Technical parameters.

- Capacity: 12 T/h
- Liquid storage: c. 1.000 Ton
- CO₂ application: greenhouse horticulture
- Operator: AVR
- Off-taker: Air Liquide
- Annual production: 60 – 80 kTon
- Transport to consumer: road / truck
- Start supply: Aug, 2019
- Main contractor: TPI (Italy)
- CAPEX: 20 M€
- CAPEX support: c. 20%, Dutch schemes DEI, HE, CCU(S),
- GHG avoidance: 50 – 100% per T/CO₂ (source CE)
- Operating time: growing season April – October
- Synergy: district heating supply and infrastructure

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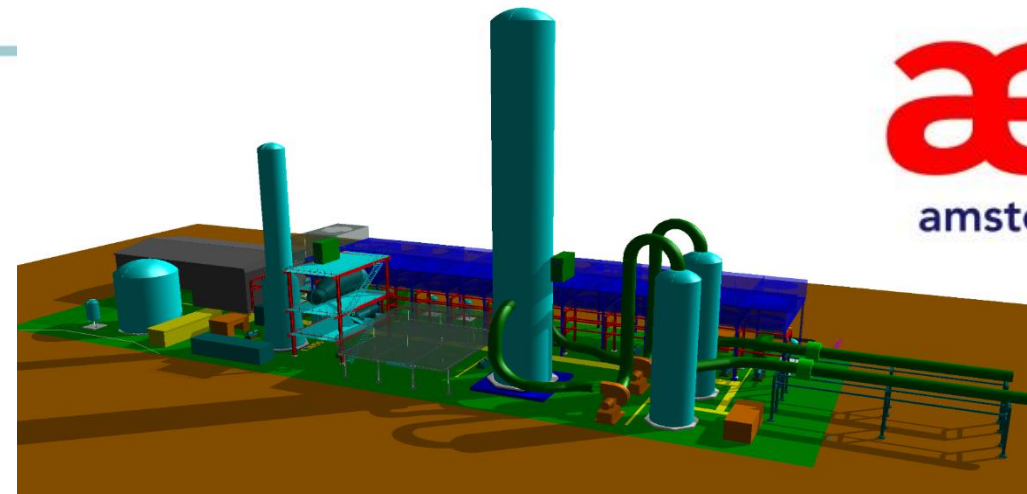
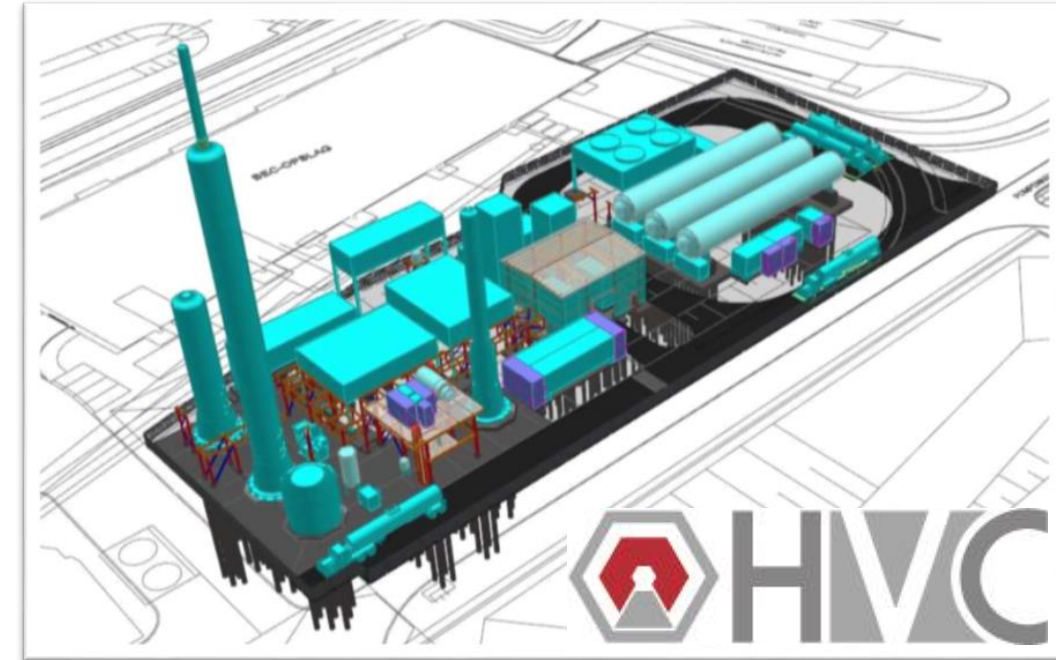
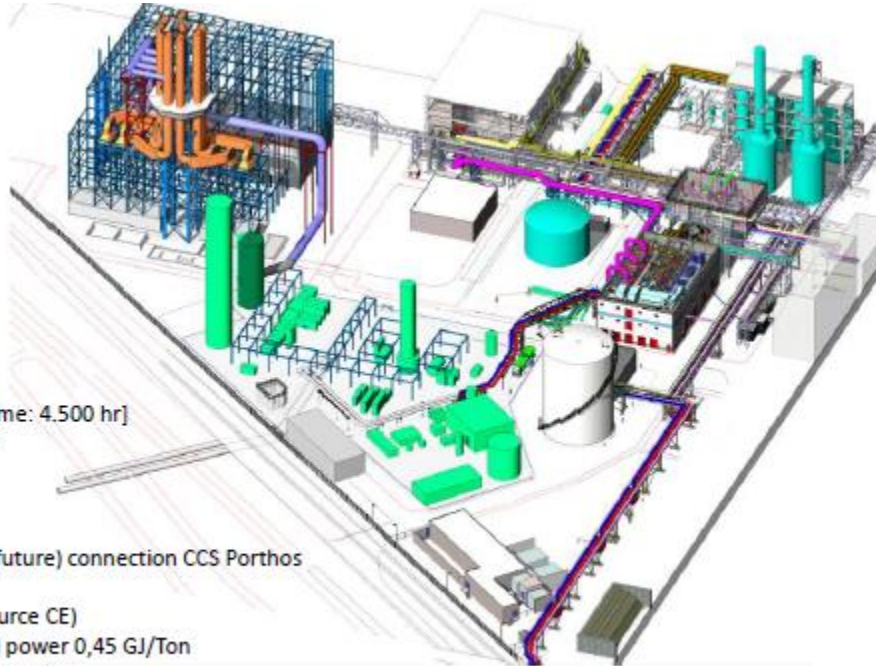
FEASIBILITY STUDIES CCU(S) AVR, AEB, & HVC



Preliminary outcome feasibility study.

- Capacity: 55 – 60 T/h [annual operating time: 4.500 hr]
- CCU application: greenhouse horticulture
- Operator: AVR
- Off-taker: OCAP / Linde
- Annual production: 250 kTon
- Transport to consumer: OCAP pipeline / (future) connection CCS Porthos
- CAPEX: c. 110 M€
- GHG avoidance: 50 – 100% per T/CO₂ (source CE)
- Energy consumption: heat 2.5 GJ/Ton and power 0,45 GJ/Ton
- Synergy: district heating supply and infrastructure
- Duration for FEED, FID and construction: >3 years

AVR.



aeb
amsterdam

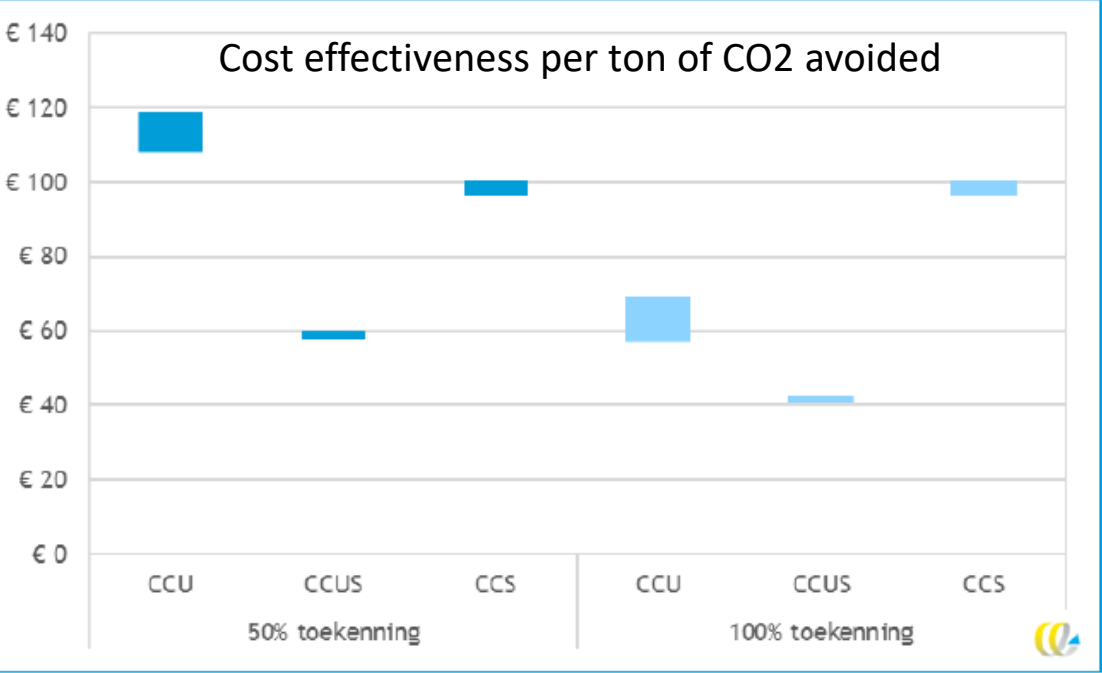
LCA Results - CO2 emission reduction per application (CCU/CCU+CCS/CCS)



	€/tCO ₂		Equivalent annual cost (€ mln.)	Meerkosten (€ mln. netto contante waarde)	Gemiddelde jaarlijkse CO ₂ - besparing (kton)		Looptijd
Toerekening (%)	50%	100%			50%	100%	
CCU	108-119	57-69	2,8-8,2	35-104	23-72	40-125	18
CCUS	58	41	10,3	131	179	255	18
CCS	96	96	28,9	366	300	300	18

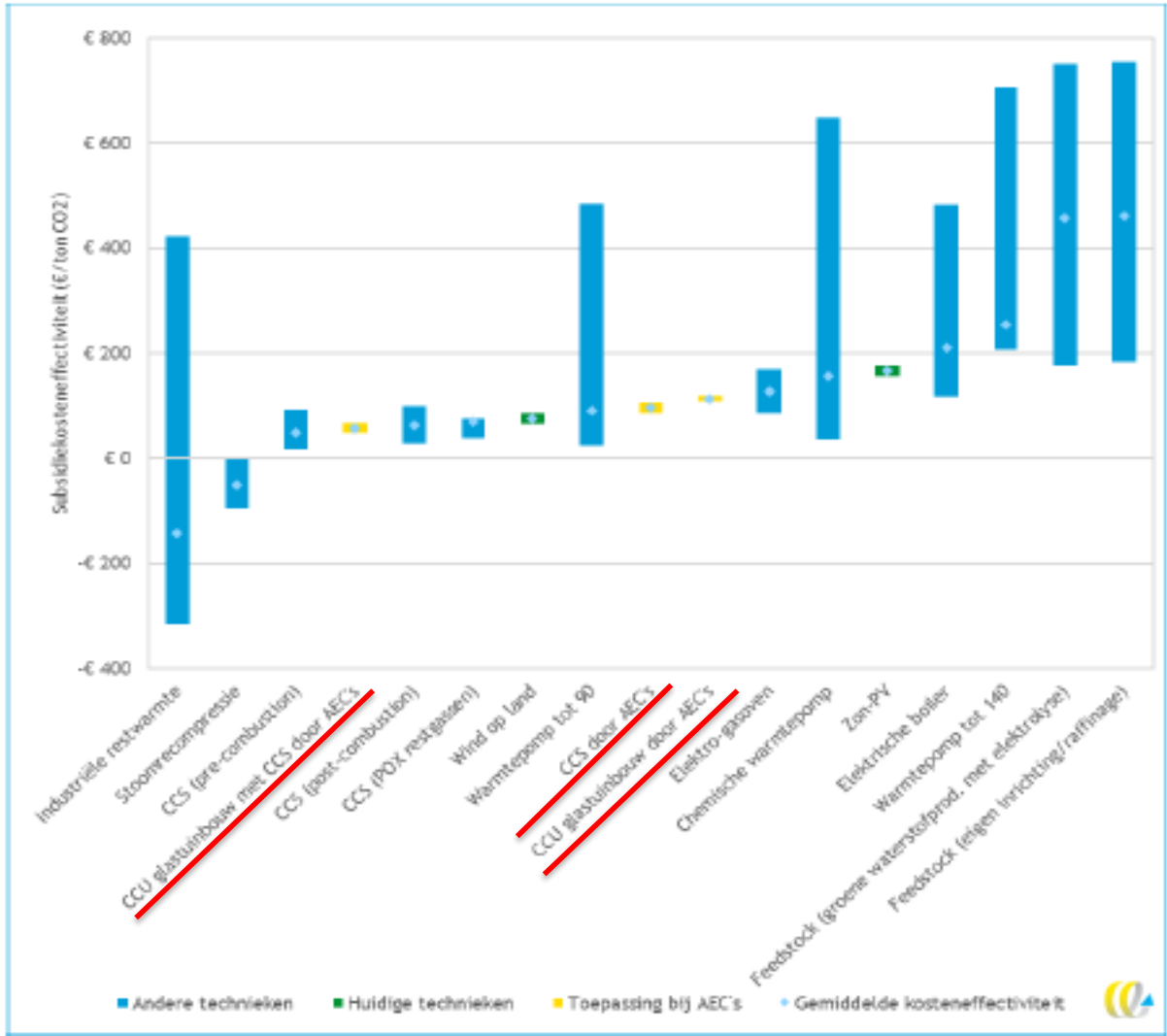
Projectalternatief	2024 (kg CO ₂ -eq./ton afgevangen CO ₂)			2030 (kg CO ₂ -eq./ton afgevangen CO ₂)		
	0%	50%	100%	0%	50%	100%
% toerekening						
AEB CCU	75	366	658	9	281	553
AEB CCU+CCS	357	535	713	369	483	701
AEB CCS	800	800	800	800	800	800
AVR CCU	140	431	722	73	345	617
HVC CCU	121	413	704	53	327	599

SOCIAL COSTS-BENEFITS ANALYSIS / LCA

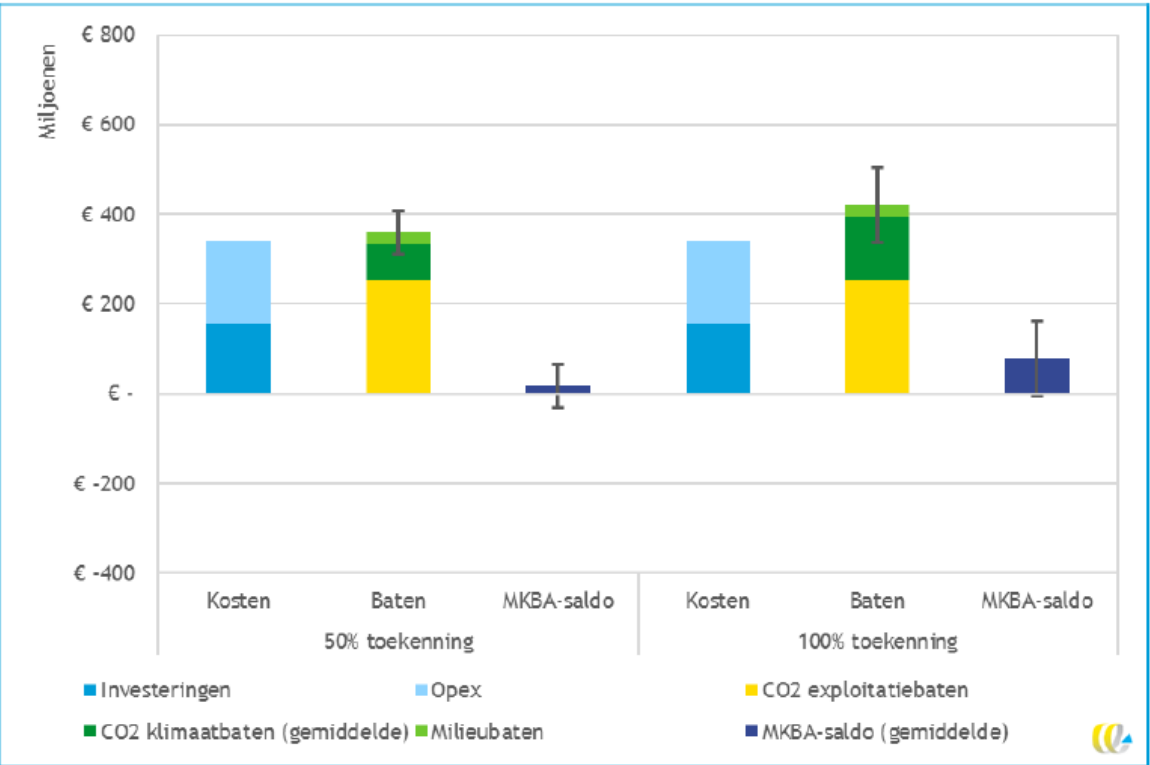


For the transition to a climate neutral operation of the Dutch greenhouse sector both renewable heat sources and the supply of external CO2 are required. In the LCA, CE allocates 50% of the climate benefit of a reduction in natural gas use to the CO2 captured at the Waste to Energy facilities. The sensitivity analysis also includes 100% if the CO2 replaces the summer use of natural gas at greenhouses (only CO2 production).

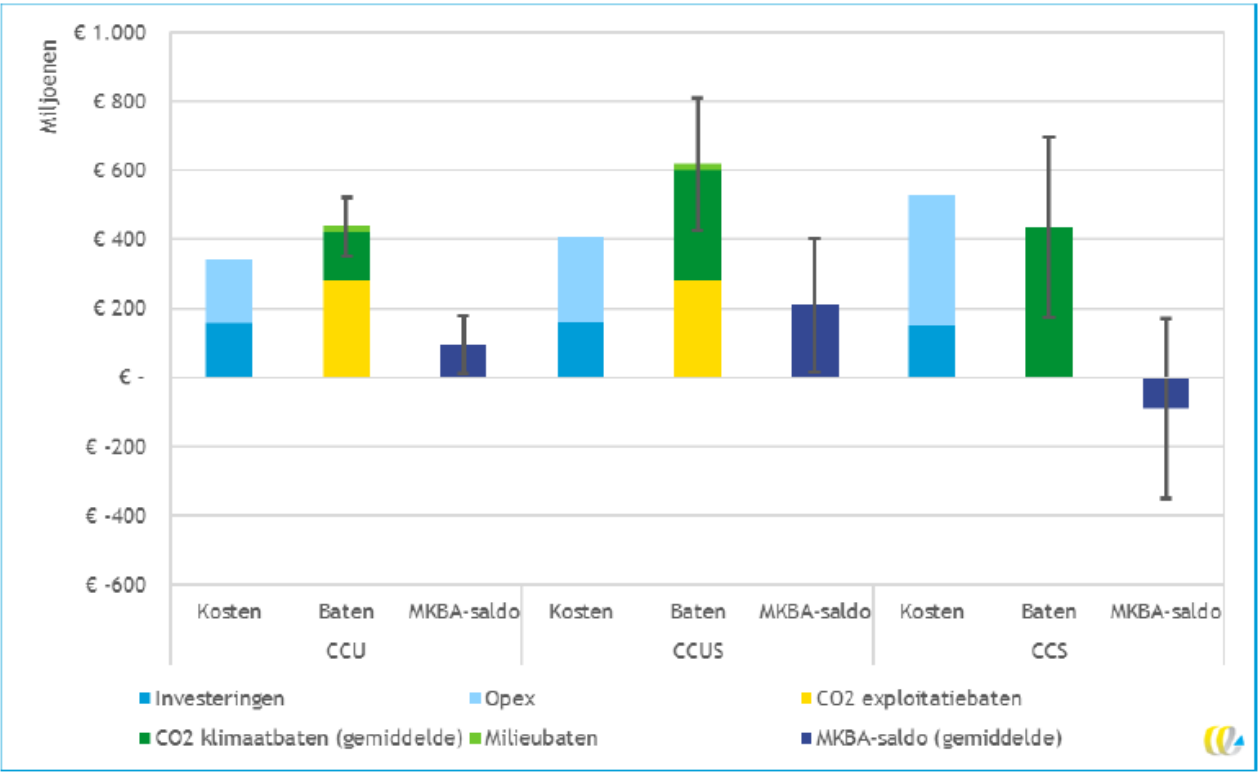
Benchmark cost-effectiveness of project alternatives AECs (50% allocation)



SCBA CCU AVR Rozenburg with 50 and 100% allocation avoided GHG



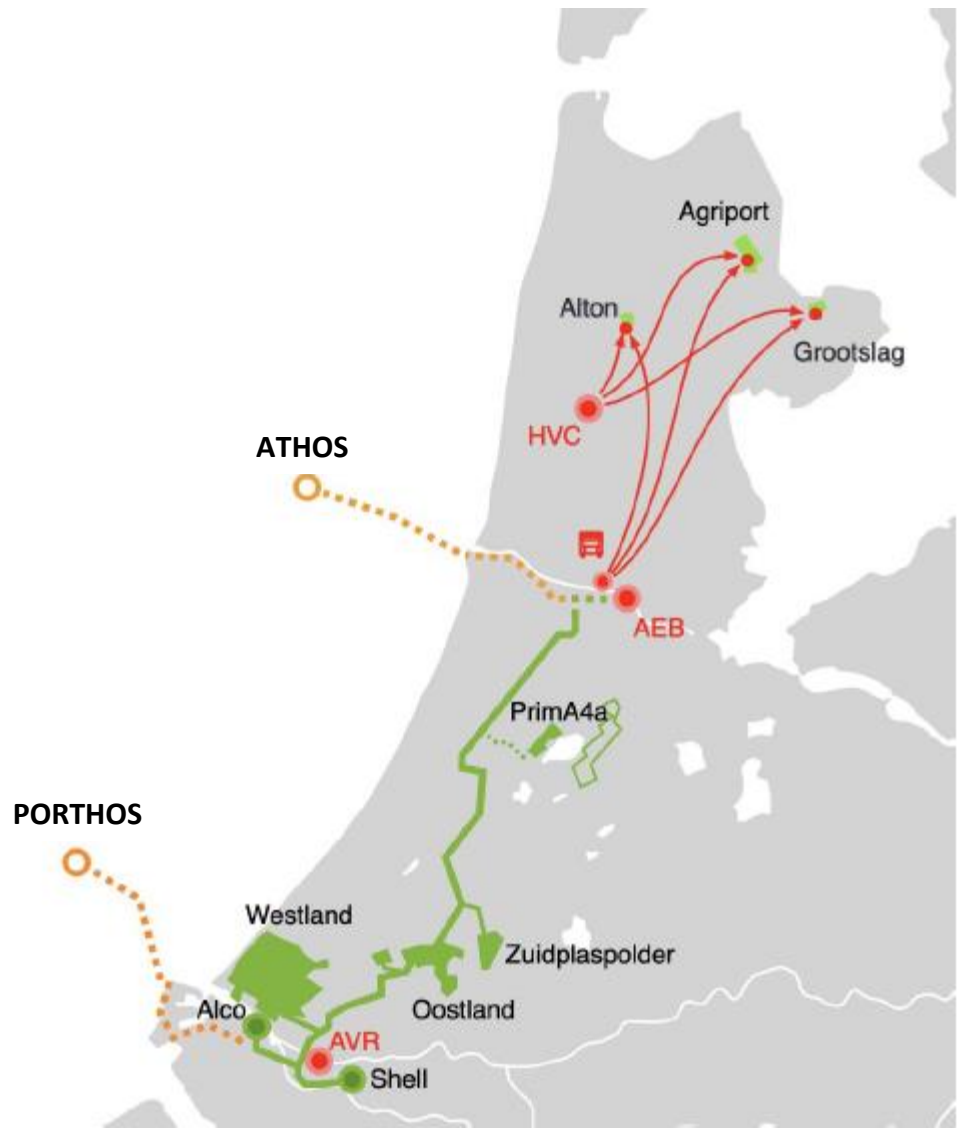
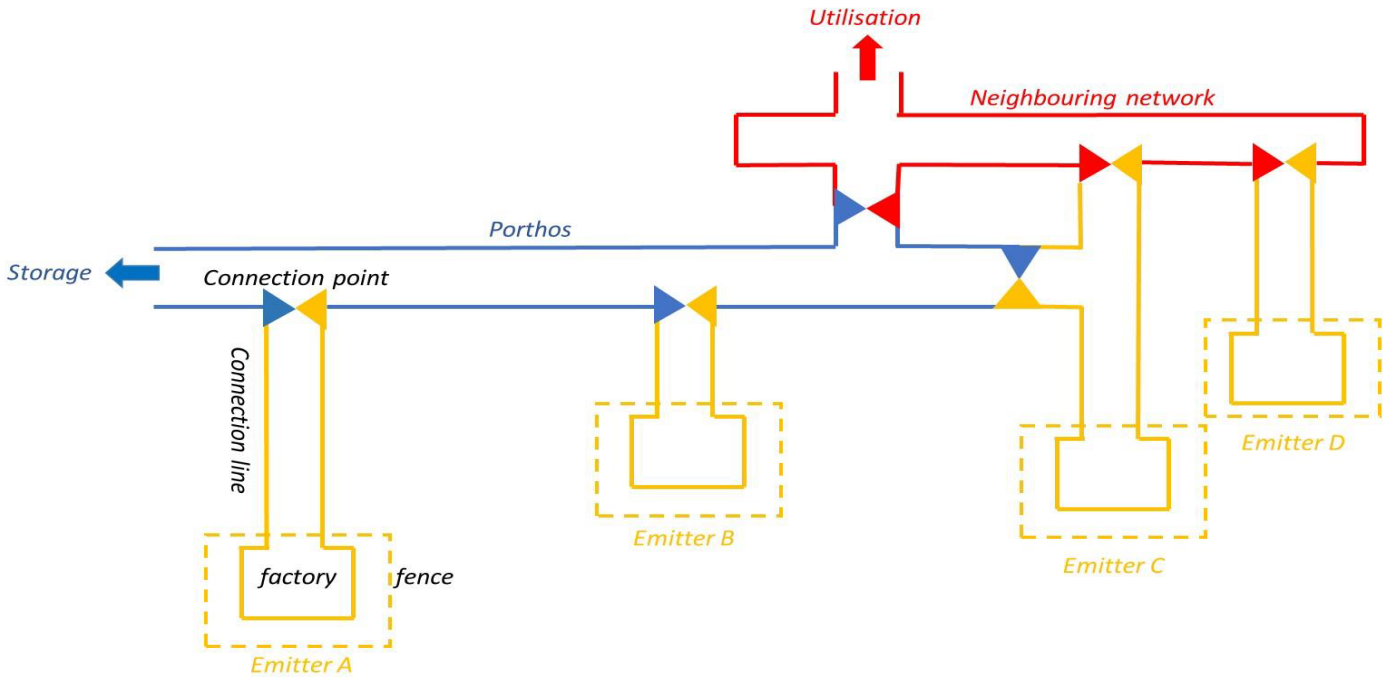
SCBA CCU(S) AEB Amsterdam with 100% allocation avoided GHG



Target 2025



Building blocks	CAPEX gross	On-stream
Compression OCAP-Porthos	125 tph	2023
Capture AEB	55 tph	2023
Capture/liquefier HVC	15/15 tph	2023
Capture AVR	55 tph	2023
	125 tph	€ 300 mio



PORTHOS OPEN BACKBONE SYSTEM

