Projects overview

CATO day 2025 | Juliana Monteiro

TNO innovation for life

Updates on 4 selected projects

EverLoNG – CO_2 capture on-board ships

DRIVE – deep removal and electrification of CO_2 capture

SCOPE – emissions mitigation and CO_2 quality

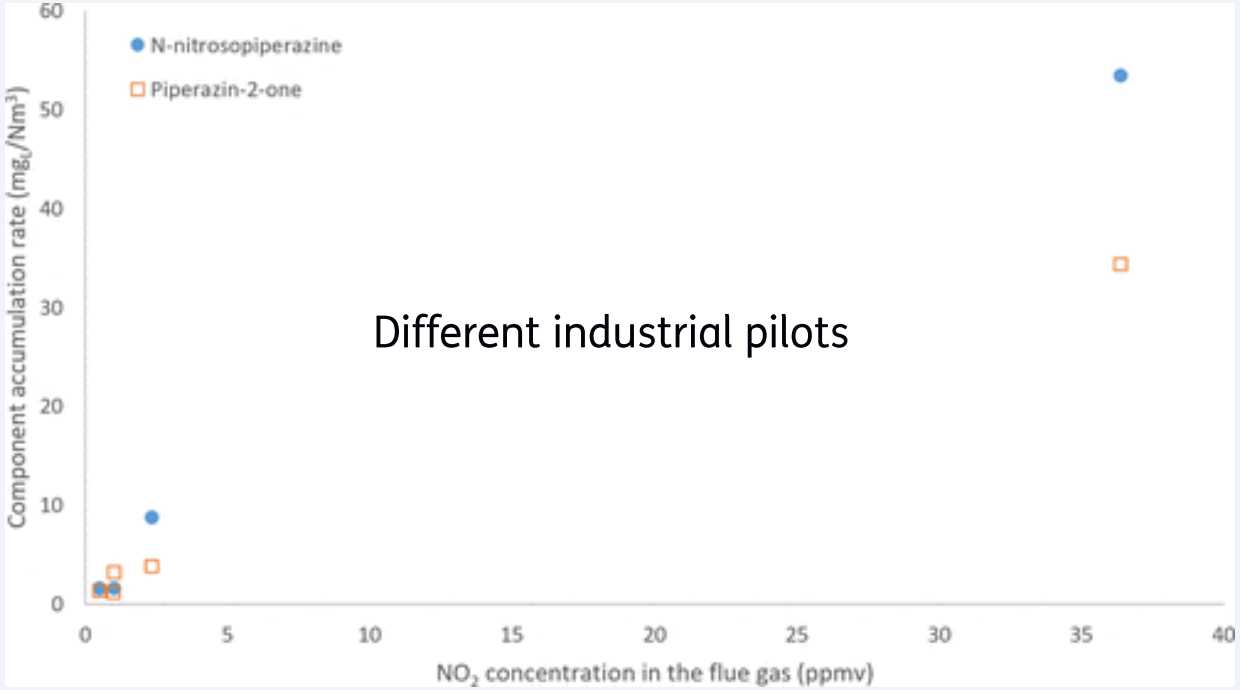
MeDORA – demonstration of DORA technology: mitigating solvent degradation and improving CO_2 quality

EverLoNG

CO_2 capture onboard ships

EverLoNG key take-away messages

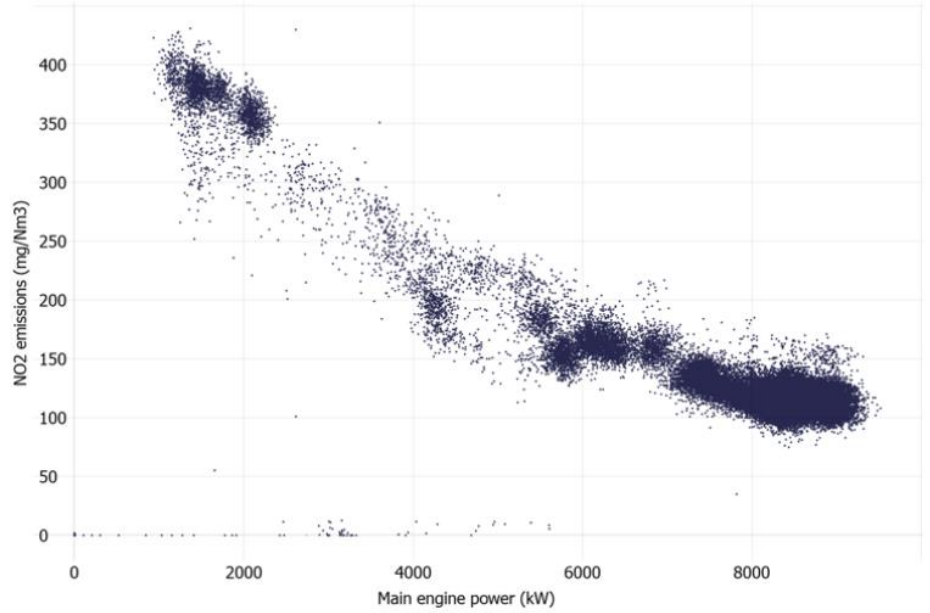
- CO_2 capture on-board technically feasible. However:
  - NO_2 will impact solvent lifetime



Different industrial pilots

[CESAR1 Carbon Capture Pilot Campaigns at an Industrial Metal Recycling Site and Analysis of Solvent Degradation Behavior | Industrial & Engineering Chemistry Research]

NO_2 emissions as a function of engine load



[EverLoNG_Wenbinar2_Presentation_Slides.pdf]

EverLoNG key take-away messages

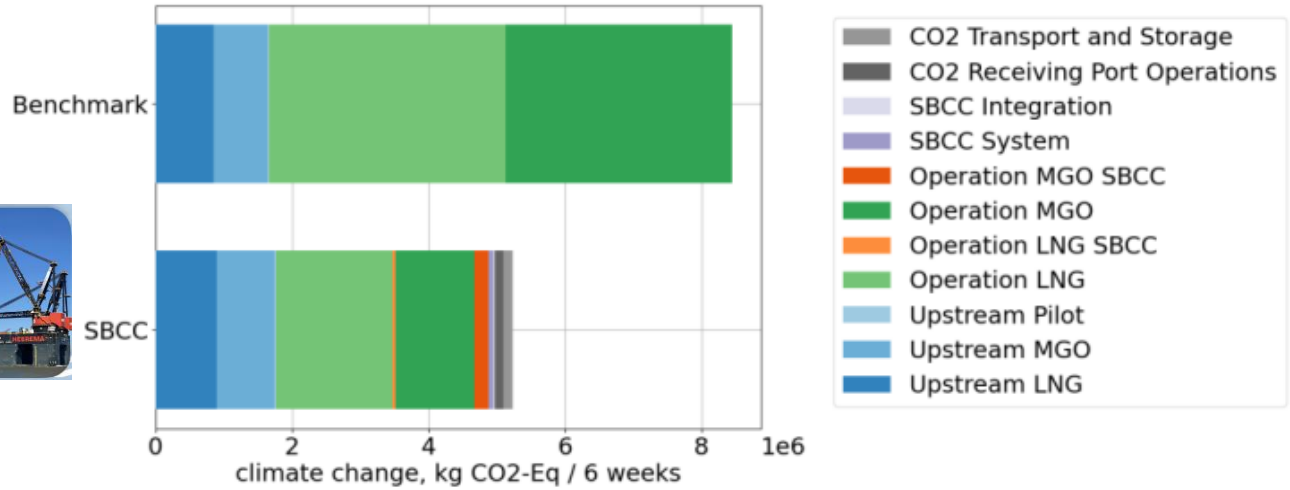


Fig. 3. EF3.1 climate change impacts of 6 weeks Sleipnir operation, with and without SBCC system.

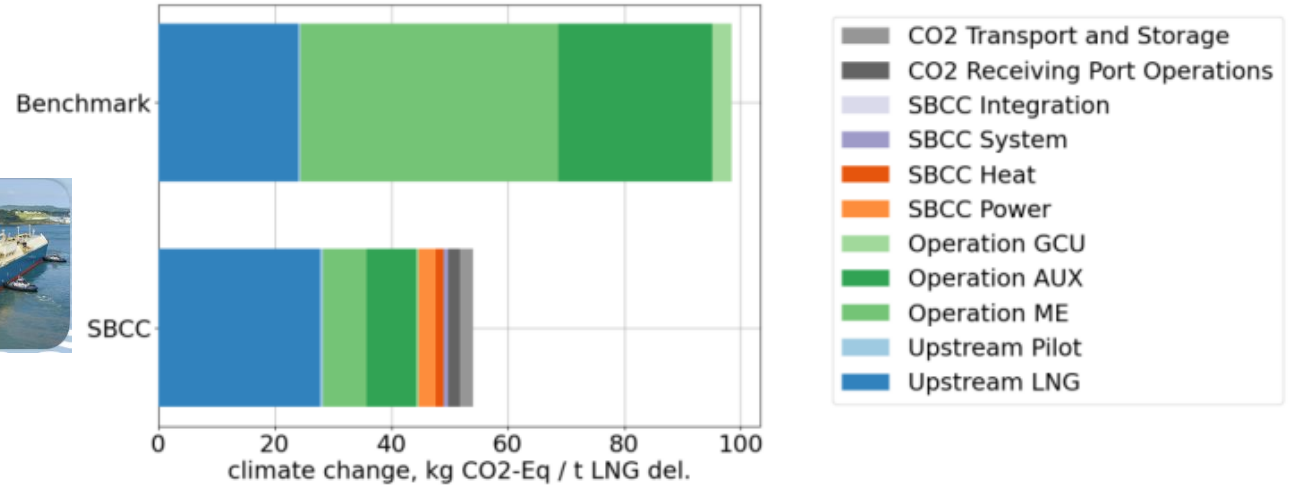


Fig. 4. EF3.1 climate change impacts of 1 t LNG delivered by the LNG tanker, with and without SBCC system.

- ***Tank-to-wake*** CO_2 emission reduction of 72% for the Sleipnir and 82% for the LNG tanker → EverLoNG target: 70%

- Considering methane slip and upstream emissions ***well-to-wake*** reduction are 42% and 50% for the Sleipnir and LNG tanker, respectively

Life Cycle Assessment of Ship-Based Carbon Capture: An Environmentally Sustainable Measure to Reduce CO2 Emissions in Shipping? by Lavinia Reitz, Jasper Ros, Anette Mathisen, Abhishek Subramani, Ragnhild Skagestad, Gabrielle Farrell, Megan Hellendall, Babul Patel, Prashant Sharan, Joan van den Akker, Petra Zapp :: SSRN

[Webinar 3 - Final Project Results | EverLoNG]

DRIVE

Deep removal and electrification of CO_2 capture

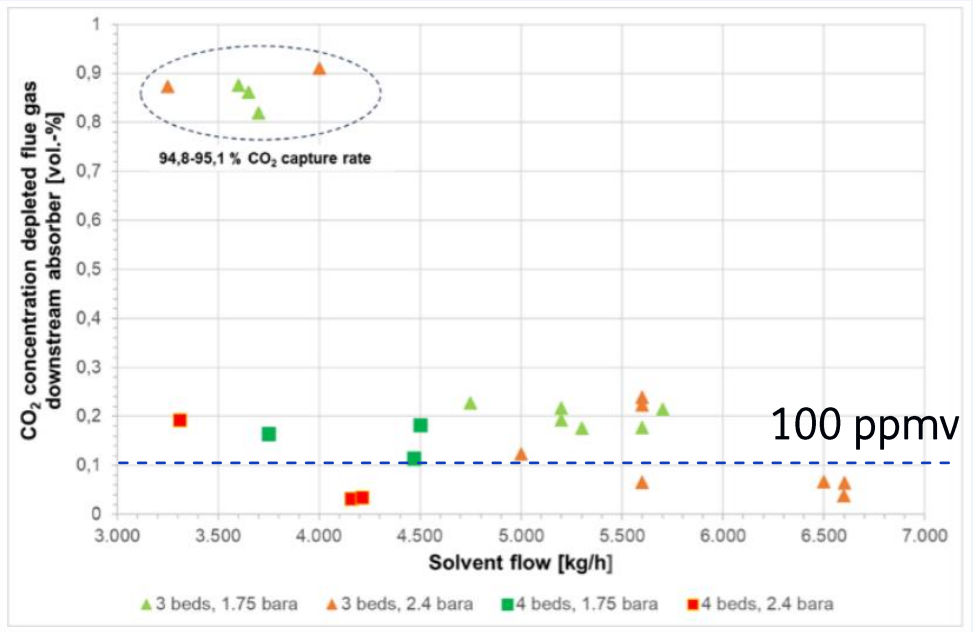
DRIVE: demonstration of deep removal

RWE CO_2 capture pilot, Niederaussem (DE)

[Demonstration of Highest Capture Rates for Deep Removal - Pilot Plant Test with CO2 Capture Rates from 98% to >99.9% with an AMP/PZ-Based Solvent by Peter Moser, Georg Wiechers, Peter van Os, Roberta Veronezi Figueiredo, Diego Pinto :: SSRN]

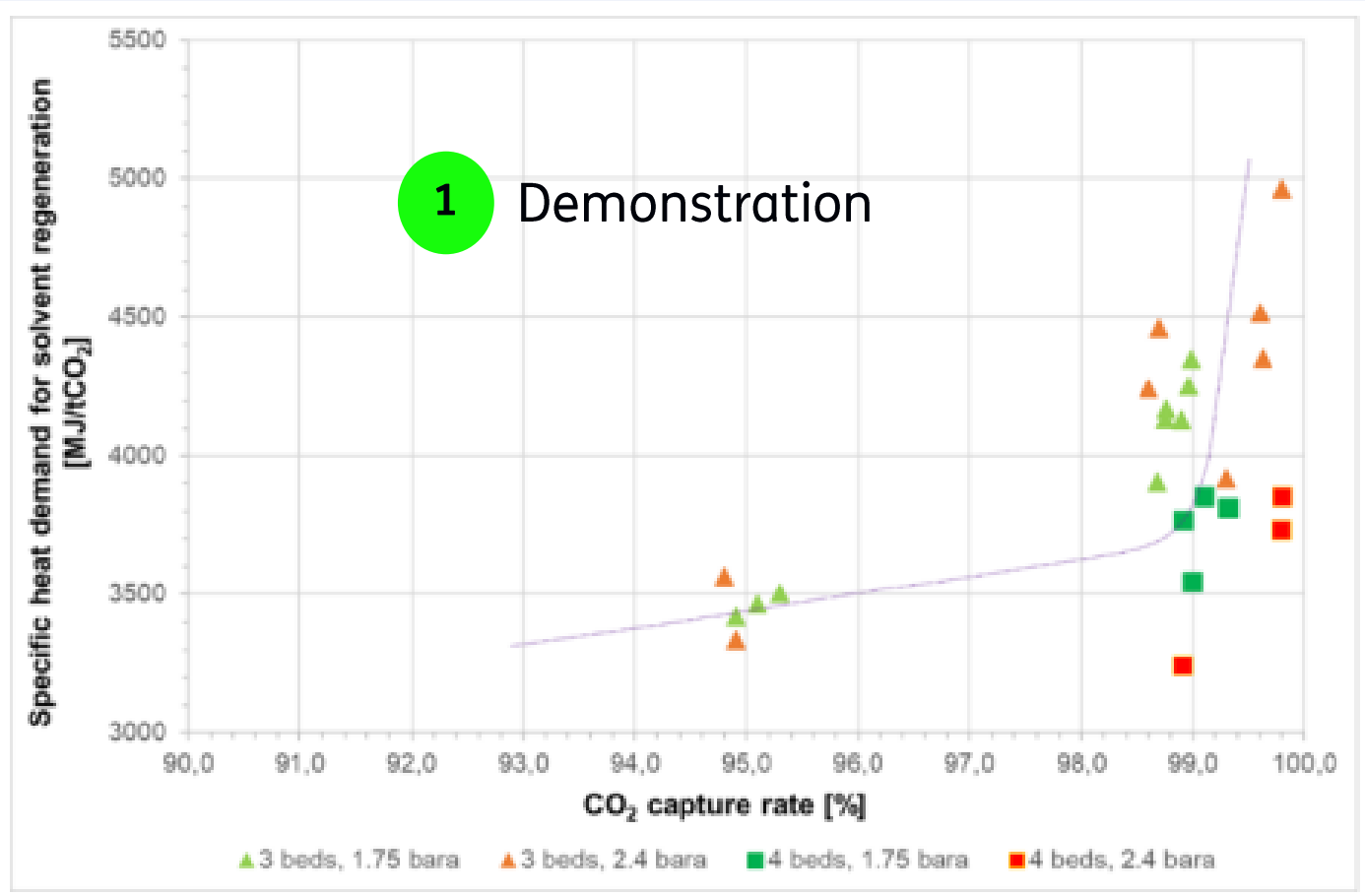
Previous campaigns with CESAR1:
capture rates of 90% and 95%

DRIVE deep removal results:



DRIVE: capture rates up to 99.8%

1 Demonstration



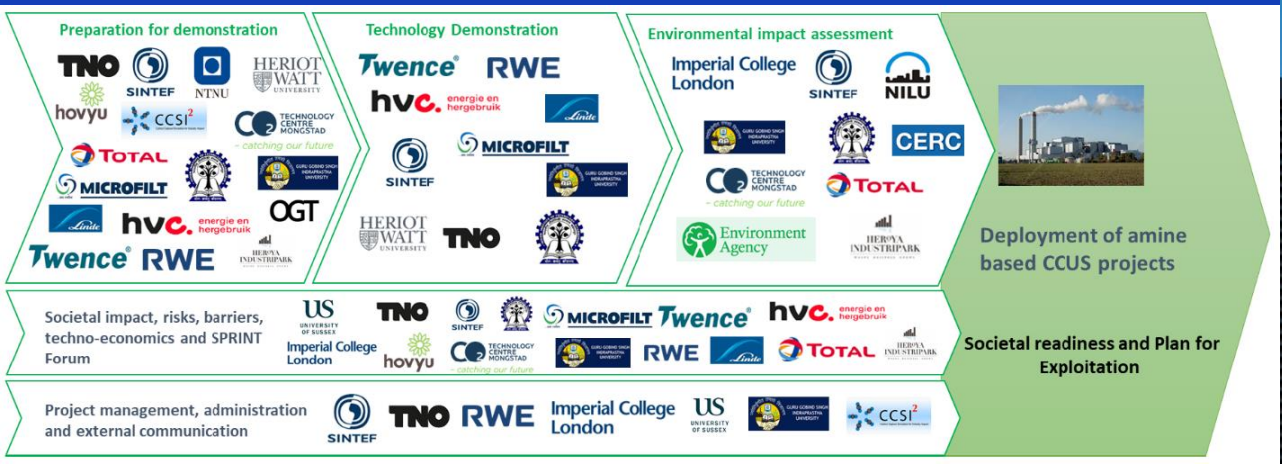
2 Model validation

3 Techno-economic assessment (on-going, not yet published)

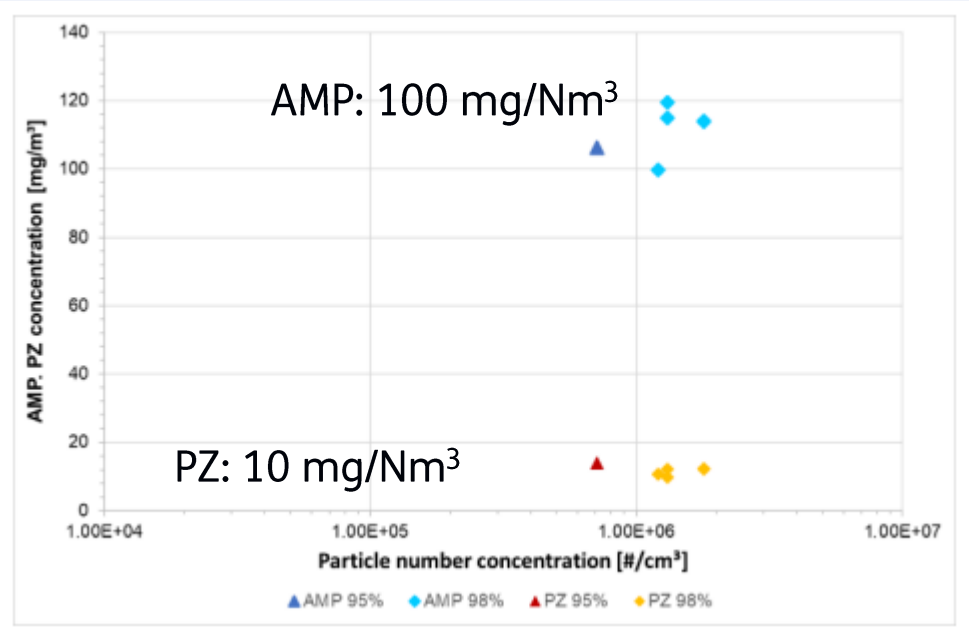
[Demonstration of Highest Capture Rates for Deep Removal - Pilot Plant Test with CO2 Capture Rates from 98% to >99.9% with an AMP/PZ-Based Solvent by Peter Moser, Georg Wiechers, Peter van Os, Roberta Veronezi Figueiredo, Diego Pinto :: SSRN]

SCOPE

Emissions mitigation and CO_2 quality



SCOPE: amine and ammonia emission mitigation



Single water wash + high particle number

Demonstration of emission mitigation technologies

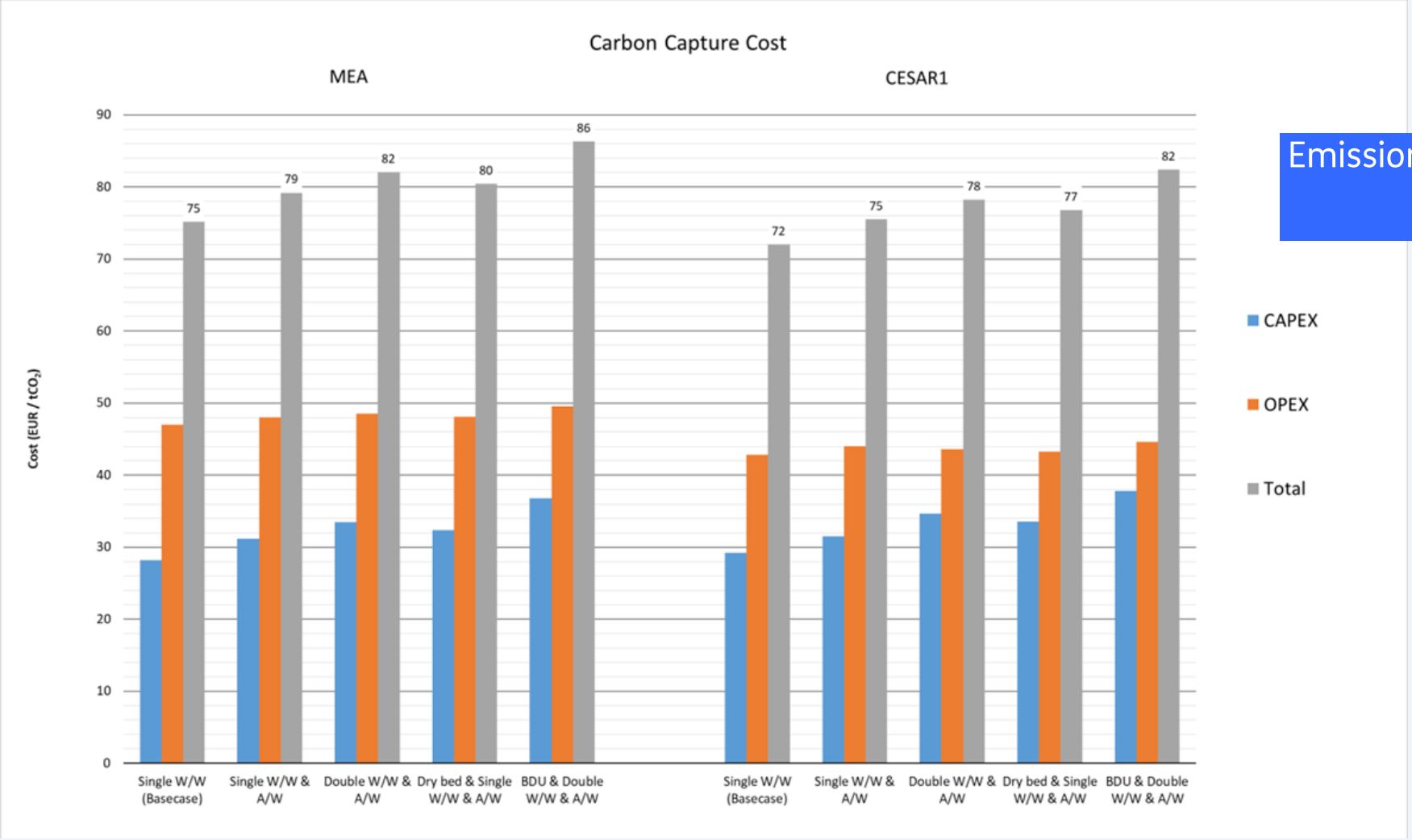
Configuration	CO_2 capture rate	AMP	PZ	NH_3	CH_3CHO	Total particle number concentration
	[%]	[mg/m³]	[mg/m³]	[mg/m³]	[mg/m³]	[#/cm³]
Double water wash drain in first WW (WESP off)	93.1	0.2	0.0	5.7	0.007	-
Double water wash drain in first WW (WESP off)	95.9	0.3	0.1	4.6	0.008	-
Double water wash drain in first WW (WESP off)	98.2	0.5	0,0	5.6	0.000	1.87E+04
Dry bed (WESP off)	96.9	0.0	0.0	4.5	0.000	1.62E+04
Dry bed (WESP off)	97.0	0.4	0.0	4.6	0.000	1.33E+04
Double water wash drain in first WW, dry bed, (WESP off)	95.3	0.0	0.0	5.6	0.002	-
Double water wash drain in first WW, dry bed, (WESP off)	97.3	0.0	0.0	5.2	0.030	1.46E+04
Acid wash, pH value 5, (WESP off)	95.0	0	0.3	2.5	0.000	1.63E+04
Dry bed (WESP on)	95.8	1.3	1.8	4.8	0.000	1.47E+06
Acid wash, ph value 4 (WESP on)	98.6	0.0	2.3	0.6	0,000	1.71E+06
Dry bed and acid wash, pH value 5 (WESP on)	97.2	0.0	0.3	2.5	0.003	1.77E+06

AMP < 1.3 mg/Nm³

PZ < 2.3 mg/Nm³

[Demonstrating Emission Mitigation for an AMP/PZ-Based Solvent at CO2 Capture Rates from 90 to 98% by Peter Moser, Georg Wiechers, Sandra Schmidt, Hallvard F Svendsen, Maxime François, Hanna K. Knuutila, Susana Garcia, Laura Herraiz, Juliana Garcia Moretz-Sohn Monteiro, Eirini Skylogianni :: SSRN]

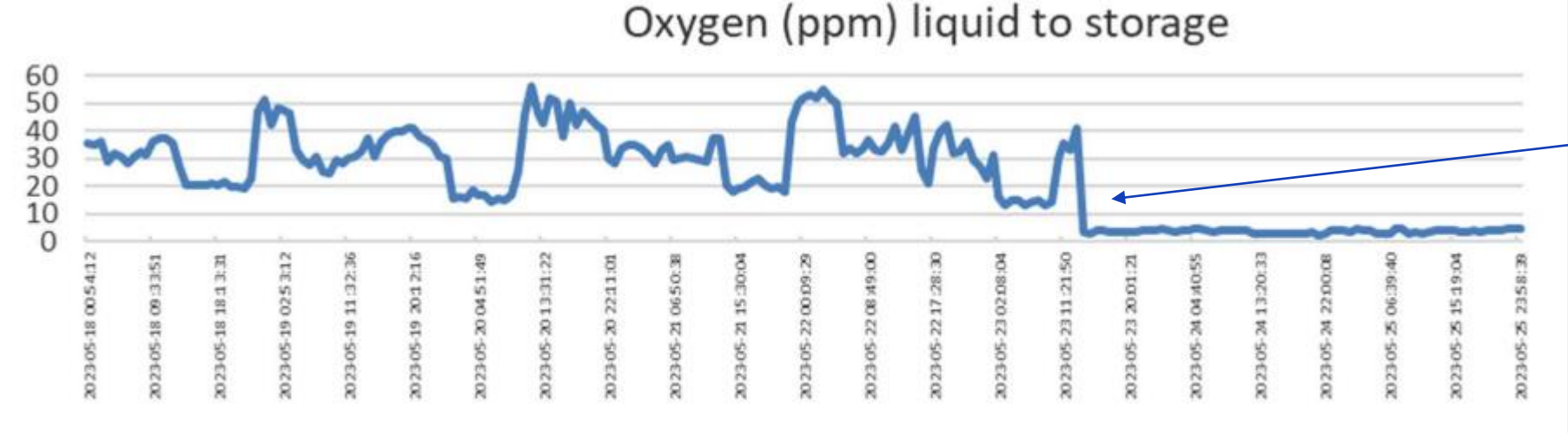
SCOPE: amine and ammonia emission mitigation



Emission mitigation technologies

3 to 7 EUR/ton

SCOPE: CO_2 quality



Increased boil-up ratio in CO_2 liquefaction plant

Twence CO_2 capture and liquefaction pilot (MEA)

[New Public Report on CO2 Purity Released — SCOPE]

Oxygen content in raw CO_2 as high as 50 ppmv, even with an amine that degrades fast (MEA)

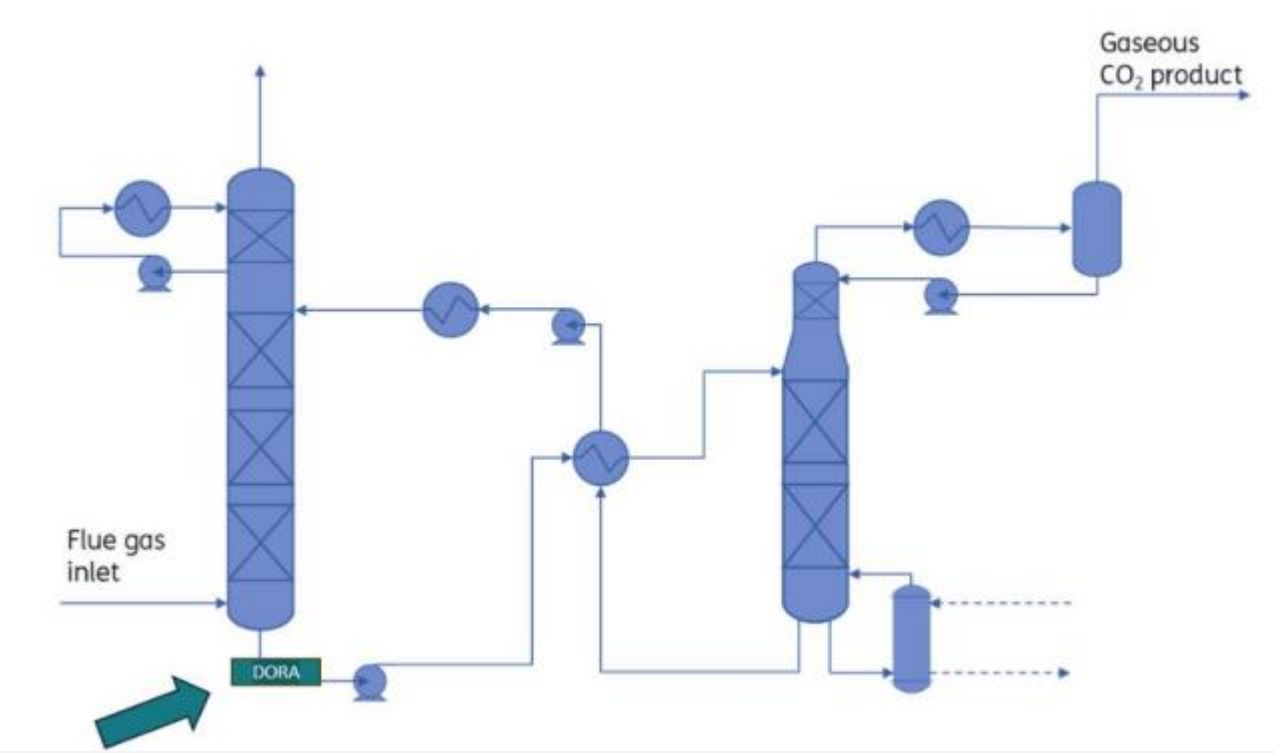
MeDORA

Degradation mitigation and CO_2 quality

TNO hvc. RWE AKER CARBON CAPTURE

NTNU SINTEF

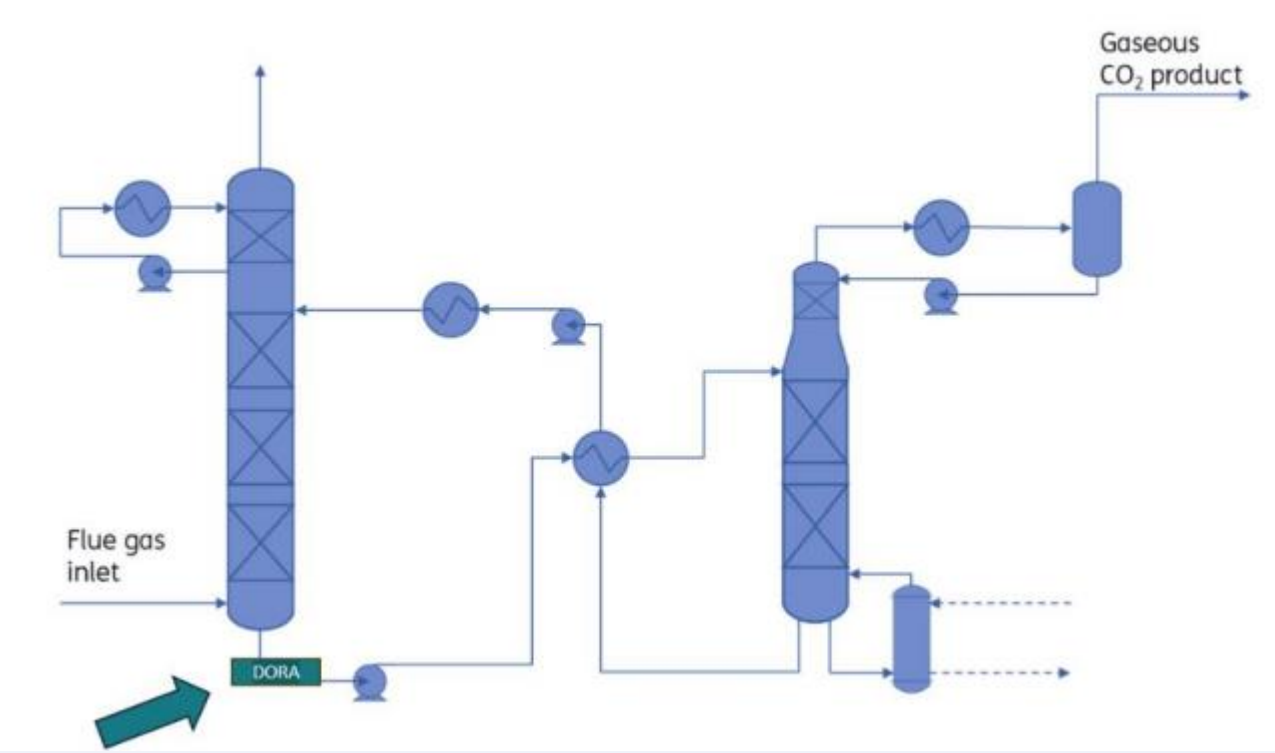
MeDORA: degradation mitigation



DORA skid at HVC pilot: 500h of operation and counting

ACT4 + HER+

MeDORA: CO_2 quality control



DORA skid at HVC pilot: 500h of operation and counting

Thank you

Juliana.Monteiro@tno.nl