# ALIGN CCUS







4<sup>th</sup> ACT Knowledge Sharing Workshop



Project no 271501, ACT – Accelerating CCS technology

# Peter van Os (TNO)

**Coordinator of ALIGN-CCUS** 

#### **Project Characteristics**

#### Accelerating Low Carbon Industrial Growth through CCUS 'ALIGN-CCUS'

- 29 partners from NL, UK, DE, NO, RO
- 1 associated partner from DE
- Total budget: € 21.270.975
- Total funding: € 14.141.278

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### Full Chain, well integrated







### **ALIGN-CCUS** Overall Objectives

- ALIGN addresses specific issues across the CCUS chain for industrial regions in ERA-NET ACT countries, enabling large scale, cost effective implementation of CCUS by 2025.
- ALIGN will combine the results from each of these objectives to deliver actionable blueprints in ERA-NET ACT countries: Teesside and Grangemouth (UK), Rotterdam (NL), North Rhine-Westphalia (DE), Grenland (NO) and Oltenia (RO)
- These blueprints should be usable for other industrial clusters.







#### ALIGN-CCUS

- Good cooperation with other ACT and H2020 projects ACORN, ELEGANCY, ECOBASE, PreACT and ENOS (especially on storage, clusters and society)
- Many dissemination activities, good branding.



CO2 recycling conference in Japan

Trondheim TCCS conference





#### **ALIGN-CCUS** Dissemination

What	Where	When	Who	Description	
0	GCCSI CCS Hubs and Clusters Forum, Rotterdam, Netherlands	26-10-2017	BGS	ALIGN-CCUS project table, dissemination and project flyers	
0	CATO, Utrecht, Netherlands	23-11-2017	TNO	General ALIGN-CCUS presentation at CATO day	
Web		30-11-2017	PMT	Accelerating low-carbon industrial growth through CCUS	
PR		1-12-2017	AUGN-CCUS	NL, NO, UK, DE, RO	
0	CSLF, Abu Dhabi, United Arab Emirates	3-12-2017	GeoEcomar	General ALIGN-CCUS presentation	
0	EERA-CCS, Brussels Belgium	14-12-2017	TNO	General ALIGN-CCUS presentation	
0	ZEP, Brussels, Belgium	22-2-2018	TNO	General ALIGN-CCUS presentation	
Po	UK CCS RC conference, Cambridge, UK	26-03-2018	BGS	ALIGN-CCUS project and collaboration between UK ERA-Net ACT projects	
Po	UK CCS RC conference, Cambridge, UK	26-3-2018	UEDIN	The role of 'place attachment' in CCUS acceptance	
1		28-3-2018	FZ Julich	AUGN innovation: can methanol-based synthetic fuels drive an energy revolution?	
0	All Energy, Glasgow	02-05-2018	BGS	ERA-Net ACT projects and ALIGN-CCUS Accelerating Low-Carbon Growth through CCUS	
8		14-5-2018	BGS	Pooling European learning and expertise to protect our atmosphere	
Web		5-6-2018	WP4 Team	CCUS as an element for large-scale energy storage and conversion	
v	University of Sheffield, United Kingdom	26-6-2018	NCCS at PACT	Preparing for large scale CO2 Capture - ALIGN-CCUS at the University of Sheffield.	
ws	Den Bosch, The Netherlands	28-6-2018	LU and TNO	Participation in the 'National Environmental Manager day' in Den Bosch, The Netherlands by LU and TNO to identify relevant practices, issues and stakeholders.	
Pa	Newsletter GEO Energy	1-7-2018	AUGN-CCUS	General information on ACT program	
0	IAPS 2018, Rome, Italy	11-7-2018	LU	Great green bribe or good practice? Community compensation in the context of Carbon Capture and Storage	

	What	Where	When	Who	Description
	OPa	GHGT14, Melbourne, Australia	25-10-2018	TNO, BGS, SINTEF IND, FZ Julich, GeoEcomar, Bellona	Targeted CCUS R&D activities in industrial clusters
	OPa	GHGT14, Melbourne, Australia	25-10-2018	TNO	De-oxygenation as countermeasure for the reduction of oxida degradation of CO2 capture solvents
	PoPa	GHGT14, Melbourne, Australia	25-10-2018	TNO	Lab scale investigation on the formation of aerosol nuclei by a Electrostatic Precipitator in the presence of SO2 in a gas stream
-	OPa	GHGT14, Melbourne, Australia	25-10-2018	TNO	In-situ experimental investigation on the growth of aerosols al the absorption column in PCCC
г	PoPa	GHGT14, Melbourne, Australia	25-10-2018	HWU, TNO, RWE	Impact of transient operation on amine emissions at Niederaussem capture plant.
	OPa	GHGT14, Melbourne, Australia	25-10-2018	RWE, MHPSE, AKAE, FZ Julich, RWTH, FEV, TNO	Demonstrating the CCU-Chain and Sector Coupling as Part of ALI CCUS - Dimethylether from CD2 as chemical Energy Storage, I and Feedstock for Industries
n	PoPa	GHGT14, Melbourne, Australia	25-10-2018	RWE, TNO, USN,HWU, SINTEF IND	MEA consumption – ALIGN-CCUS: Comparative long-term testin answer the open questions
•	PoPa	GHGT14, Melbourne, Australia	25-10-2018	NTNU, SINTEF IND	Aerosol growth in an absorber for a post combustion CO2 capt using the 2-Amino-2-methyl-1-propanol/ Piperazine (CESAR solvent
•	OPa	GHGT14, Melbourne, Australia	25-10-2018	USN	Electrochemical Corrosion Measurements of MEA aque solutions at elevated temperatures
t	ws	GHGT14, Melbourne, Australia	26-10-2018	ALIGN-CCUS, CSIRO,	Knowledge exchange workshop ALIGN-CCUS
	V	GHGT14, Melbourne, Australia	6-11-2018	BEIS	ALIGN-CCUS@GHGT-14 - interview with Brian Allison, BEIS
	v	GHGT14, Melbourne, Australia	6-11-2018	CSIRO	AUGN-CCUS@GHGT-14 - interview with Greeme Puxty, CSIRO
1	v	GHGT14, Melbourne, Australia	6-11-2018	TNO	ALIGN-CCUS@GHGT-14 - interview with Peter van Os, TNO
n	V	GHGT14, Melbourne, Australia	6-11-2018	TNO	AUGN-CCUS@GHGT-14 - interview with Tom Mikunda, TNO
	v	GHGT14, Melbourne, Australia	6-11-2018	BGS	AUGN-CCUS@GHGT-14 - interview with Maxine Akhurst, Bri

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offshore?	Po	Management workshop,
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	•	"Power-to-Gas" of the Energy A
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в		23-11-2018	TNO Coincidence or just excellent planning?			
Po	Accelerating CCUS: A Global Conference to Progress CCUS' IEA/BEIS. International ministerial conference. Edinburzh. UK	28-11-2018	BGS ALIGN-CCUS project			
v		28-11-2018	BGS	Storing CO2 in the subsurface		
WS	ENOS workshop, Oostvoorne, NL	13-12-2019	LU	LU expert contribution in ENOS data collection workshop		
0	Forschungsnetzwerk Energie Working Group 2 CD2-Technologies of the German Federal Ministry of Economic Affairs and Energy	12-02-2019	RWE Presentation about "Status of ALIGN-CCUS"			
Web		13-2-2019	WP2 Team	Preparing for large-scale transport for offshore CO2 storage		
Po	Decarbonisation and Resource Management workshop, BGS Keyworth, UK	21-02-2018	BGS ALIGN-CCUS project			
1	Leiden University website	15-03-2019	LU	Expert interview: Public perception of energy projects		
A	ICEP, Plymouth, UK	01-04-2019	LU, ECN part of The importance of community engagement for undergr TNO storage: Lessons and insights from the field			
Web	ENOS webingr	(TBD: April/May)	LU and/or ECN part of TNO	ALIGN WP6 contribution (presentation + discussion) to ENOS webinar		
•	12th Meeting of the expert group "Power-to-Gas" of the Energy Agency North-Rhine-Westphalia	27-05-2019	RWE, FZ Julich, AKEU	Presentation about status of ALIGN-CCUS and the work in WP4		
OPa	TCCS10, Trondheim, Norway	19-6-2019	LU	Is public debate around carbon capture and storage changing? Exploring statements and visual frames used in Dutch newspapers		
ора	TCCS10, Trondheim, Norwey	19-6-2019	TNO	De-oxygenation as countermeasure for the reduction of oxidative degradation of CO2 capture solvents		
OPa	TCCS10, Trondheim, Norwey	19-6-2019	TNO	Network design and flexibility for low-pressure depleted gas reservoirs: hot or cold CO2?		
OPa	TCCS10, Trondheim, Norway	19-6-2019	TNO	Planning CO2 transport and storage infrastructure in the		

What	Where	When	Who	Description
wnat	There	when	*10	Corrosivity of degraded MEA solvent and
OPa	TCCS10, Trondheim, Norway	19-6-2019	USN	fresh solvent added organic acids and salts
Po	TCCS10, Trondheim, Norway	19-6-2019	USN	Corrosivity of MEA solvent at stripper
				Beview of CO2 specifications and
Po	TCCS10, Trondheim, Norway	19-6-2019	IFE	experimental data used for verification
			EZ MAN DVE	Life Cycle Assessment of CCU-Chain
	ICCRU2019 Applyon Gar	25 C 2019	FZ Julion, HWE,	Demonstration in the ALIGN-CCUS project -
1°	CODOCOID, Machen, der	23-0-2013	BWTH TNO	Dimethyl Ether and Oxymethylen Ether from
				CO2many
WS	Leiden, the Netherlands	June 2019	LU, ECN part of TNO	6.2 stakeholder workshop on community
-				engagementroompensation
	VGB KONGRESS 2019 – Innovation in Power Generartion	5-9-2019	RVE,MHPSE, FZ	The project ALIGN-CCUS - A contribution to
0			Julich, AKEU, FEV,	energy and raw material supply through
			RVTH	recycling of carbon
				Analysis of flexible operation of CO2 capture
A	PCCC-5, Kuoto, Japan	18-9-2019	HVU, RVE, TNO	plants: Predicting Solvent Emissions from
				conventional and advanced amine systems
				ALIGN-CCUS: Results of the 18-month test
۵.	PCCC-5 Kiroto Japan	18.9.2019	BVE TNO HVU	with MEA at the pilot plant at Niederaussem -
<u> </u>	1 CCC-0, NgOLO, Oapan	10-3-2013	Hwe, Heo, Hwo	solvent management, emissions and dynamic
				behavior
Α	PCCC-5, Kyoto, Japan	18-9-2019	SINTEF IND	Dynamic model development in ALIGN-CCUS
A	CSM2019, Catania, Italy	15-10-2019	RVTH, FEV	Uptical spray investigations on UME3-5 in a
v	DVE Comment	Diseased	Marris by CCCC at	CONSTANT VOIUME NIGN pressure champer.
WS.	Sniikenisse The Netherlands	26.6.2019	THOME BY SUCS at	Work shop Public Percention at CATO event
WS	oppletnisse, the retrienance	Sentember	10	Participation in ECOBASE meeting
				Corrosion reactions in simulated CO2 ship
A	Corrosion 2020 Conference	March 15-19	IFE	transport conditions.
VEB		26-6-2019	RUG	Reuse of offshore hydrocarbon installations
				for CCS Legal issues stakeholder workshop op
VS	BGS, Edinburgh, UK	9-4-2019	RUG, BGS	infrastructure reuse in the UK
				Presentation of progress on storage and UK
0	CCUS leadership group, Scottish Government	25-4-209	Bus, SULS, SCOT	case study to Scottish Government
			Ent	representatives
			page enne soot	Conference presenation of ALIGN Storage
OPo	All Energy conference, Glasgow, UK	15-5-2019	Ent	Readiness Levels, ALIGN project poster and
				panelist at CCUS session
				Business case stakeholder meetings with
ws	Bus, Eanburgh, UK	12-6-2013	BUS, SDL, SCOTERT	Undrease & Eval Call Association Southish
				Pusipess, ease, stakeholder, meetings, with
∀S	Scottish Gas Network	12-6-2019	BGS, SDL	Scottish Bas Networks
-				Presentation of ALIGN WP3 for UK case
0	Lyell Centre GeoEnergy Symposium, Edinburgh, UK	2-10-2019	BGS	study to industry and researchers.
-		4 40 0040	000	study to industry and researchers.
<u> </u>	UK CCS HC conference, Edinburgh, UK	4-10-2019	BGS	
0	STEMM-CCS Storage Research Showcase, Brussels,	10.9.2019	BBS	Presentation of ALIGN WP3 for UK case
Ľ	Belgiium	10-0-2010	000	study to industry, researchers and EC
	PreAct project stakeholder meeting Brussels Belgijum	10-10-2019	BGS SINTEE THO	Presentations summarising ALIGN and VP3
0				for UK case study, transport and storage
1°	renor proport statemonate meeting, Didssets, Deigildin	10-10-2010	1000, 0101 EF, 1100	netoworks for The Netherlands and Norwary,
				to industry, research and EC stakeholders
			1	Developmentor Coz storage networks for
0.4	ALICAL COURSEALS	20.10.2010	BGS, SCCS, TNO,	Industrial clusers: storage readiness;
web	ALIGIN-CLUS WEDINARD	30-10-2019	SINTEF	Innascuccure re-use α network developemnt
				Inc. development or a mordal matrofffi storage

O = Oral Presentation, Veb = Vebinar, VS = VorkShop, V = Video, A = Abstract, B = Bloc OPa = Oral presentation and paper, PoPa = Poster and Paper, PR = Press Relea











### Work Packages in ALIGN-CCUS



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#### Work Package 1: Capture



#### WP-leader: Hanne Kvamsdal (SINTEF)

**Partners:** 

- SINTEF
- TNO
- NTNU
- HWU
- RWE
- NORCEM
- UoSheffield
- UoSouthEastNorway
- TCM







Long-term testing of MEA at RWE in Niederaussem > 13000 hours



Very low emissions of MEA: < 3-10 mg/Nm<sup>3</sup>

Particle measurements  $\rightarrow$  aerosol-based emissions are negligible for the flue gas of a lignite-fired power plant with state-of-the-art gas treatment technologies



Most extensive solvent management dataset for MEA

- Confirmation of the non-linear degradation behavior
- Very low degradation rate for the first 6 months
- Opens-up for new modelling approaches







Solvent management strategy – dissolved oxygen removal (DORA)



Initial tests with MEA degradaded solvent from RWE positive.

Tests at PACT are ongoing.









### WP1 Impact - Status

#### • Aerosol-based emission:

 Results from RWE campaign indicate that aerosol-based emissions are irrelevant for the flue gas of a lignite-fired power plant with state-of-theart gas treatment technologies

#### Solvent consumption:

- Results from RWE campaign indicate that solvent consumption of less than 0,3 kg per tonne of CO<sub>2</sub> captured is possible
- Still three major campaigns to conduct before the solvent management strategy is set

#### Guidelines for reliable and cost-efficient operation

 Campaign at Tiller pilot shows promising effect of advanced control (NMPC) during some flexible operation scenarios

Solvent management and process control technologies are being utilized in new ACT and EU initiatives, including demonstration in commercial plants (refinery, waste incinerator)





#### WP1 Preparing for large-scale capture demonstration

### WP1 Ongoing work

- Conduct 3 campaigns:
  - CESAR1 at RWE (long-term) and TCM (3 months)
  - MEA 40wt% at PACT (10 weeks)
- Further develop
  - models for emission and degradation (understanding)
  - technologies for the control of emission and degradation (mitigating)
- Cost estimation of efficient integration of capture plants into power and industrial plants (cement and waste incineration)
- Links with WP5 on cost drivers for integration of capture plants in CCS networks





#### Work Package 2: Transport



WP-leader: Hans Aksel Haugen (SINTEF)

**Partners:** 

- SINTEF
- IFE
- Imperial College
- TNO
- TAQA







 Focusing on ship transportation of CO<sub>2</sub>, pressure and temperature ranges feasible for ships and CO<sub>2</sub>injection have been suggested









 To avoid batchwise injection, CO2 may be offloaded to a FPSO or other systems for intermediate offshore storage









- Injection of cold CO<sub>2</sub> may introduce risk of hydrate formation in the reservoir and stress on well cement due to thermal contraction of steel casing
  - Suggested solutions:
    - Avoid injection of  $CO_2$  colder than 10 15 °C at the bottom hole
    - Include contraction loads due to cooling in the design of new injection wells and in assessments of well integrity risks in existing wells to be re-used for CO<sub>2</sub>-injection







- There is a need to define a safe operation window with regard to varying compositions of CO2. WP2 looks at finding such window before process plants are designed and built.
  - Experiments performed
  - Focus on impurities like water, oxygen, NOx, SOx etc.









- ALIGN-CCUS is connecting to the ongoing Norwegian full scale CCS infrastructure initiative by comparing the pressure/temperature conditions recommended in this project with other possible p/t combinations
- Also, the ALIGN-CCUS work on CO2-specification is strongly connected to the Norwegian full-scale initiative.
- Parallel project established between SINTEF and an industry consortium including a Norwegian ship building company from May 2019 to look into implications of ALIGN-CCUS recommended p/t conditions for design of ships for CO2 transport.





Preparing for large-scale transport networks for offshore storage of CO<sub>2</sub>

- Final recommendation on strategies for resolving identified technical challenges within shipping and offshore unloading of CO2, and for monitoring of storage integrity and performance
- CO2 specification, recommended for ALIGN-CCUS partners
- Development of techno-economic assessment tool for transport and storage, followed by guidelines for the development of flexible transport and storage networks





#### Work Package 3: Storage



WP-leader: Maxine Akhurst (BGS)

**Partners:** 

- BGS
- SINTEF
- TNO
- TVCA
- Groningen University







Reduce uncertainty in the provision of large-scale storage networks by:

- Establishing a unique CO<sub>2</sub> storage readiness assessment protocol to accelerate the definition of CO<sub>2</sub> storage capacity
- Better characterized potential storage locations in the North Sea to support decision-making for near- and mid-term infrastructure planning for CO<sub>2</sub> clusters
- Assess existing offshore oil and gas assets for suitability of re-use for CO<sub>2</sub> transport and storage





# - Highligh

Accelerating CS Technologies Athens, Greece, November 6<sup>th</sup> – 7<sup>th</sup> 2019

# WP3 Highlight

- Nine levels from first recognition to operation, with increased assurance
- Based on experience and practise, and expert, industry and regulator input
- Each level has detail on characterisation, permitting & project planning
- Consistent with published industry work
- Mapped onto UK, NO & NL storage sites
- Communicates 'readiness' & informs of the technical appraisal, permitting and planning achieved
- Highlights what remains for operation







#### WP3 Highlight

Better characterized stores, conceptual storage networks for ALIGN-CCUS clusters Teesside & Grangemouth, UK



Multi-store sites with proposed storage networks for scenarios of initial, growth & mature CCS projects deployment. Network modelling, including economic factors, in progress within ALIGN WP5. Stores with higher SRLs assessed. Input from NL appraisal of batch-wise injection for Teesside selection.





#### Better characterised stores NL & NO









#### WP3 Highlight

Re-use of oil and gas assets for CO<sub>2</sub> transport and storageMethodology to assess infrastructure re-use based on published criteria.

- Application for ALIGN stores in national case studies tested
- Criteria are ranked for each country based on data availability and effectiveness of screening.
- Legal issues on infrastructure re-use, three national workshops, differing audiences and key points
- Temporal gap between hydrocarbon operations and CCS implementation
- Intermediary 'operator of last resort' to span temporal gap







#### WP3 – Impact - Status



- Lot of attention for SRL. Paper in preparation.
- Connection made with national projects:
  - Porthos
  - Northern Light
  - Activities at Teesside & Grangemouth







- Completion of deliverables (all under review)
- Dissemination & learning: ALIGN-CCUS WP3 webinar was on 30 October, papers for external publication
- Accelerate impact by presentation to industry bodies and national authorities of research findings to support implementation of national emissions reduction strategies
  - Infrastructure re-use assessment
  - Strategic site appraisal activities
  - Planning long-term storage site development





#### Work Package 4: CO<sub>2</sub> re-use.



WP-leader: Peter Moser (RWE)

**Partners:** 

- RWE
- MHPSE
- RWTH
- FEV
- Asahi Kasai
- FZ Jülich
- TNO

#### **Associated Partner:**

• Bosch





#### WP4 Objectives



Demonstration, evaluation, optimisation and scale-up of a full CCU chain - a blue print for sector coupling









#### WP4 Highlight



• Equipment being installed!





### WP4 Highlights

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- Treatment of purge gas by innovative catalytic burner system to meet German regulation for air protection and to avoid a flare at the power plant site.
- Online and offline analysis concept for DME synthesis finalised (sampling points and intervals, methods, investigated compounds).
- Optical Investigations in High-Pressure Chamber are nearly finished for the first set of injectors. Reference measurements with diesel fuel and also measurements with OME<sub>3-5</sub> and DME have been carried out.







### WP4 Highlight

Life Cycle Assessment (Cradle-to-Grave approach, special attention on reduction of

 $SO_x$ ,  $NO_x$ ,  $CO_z$ , particulates/soot emissions) for the full CCU chain is ongoing. First results for the Global Warming Potential of the DME and OME synthesis and

the impact of the electricity source of the electrolyser have been calculated and

indicate a superiority of DME over OME.

- Patent application options for waste heat utilisation and flue gas/carbon recycling from peak-power engines in the power plant with PCC.
- A continuous exchange between WP4 and WP5 "Industrial Cluster" and WP6 "Society" has been established. Important aspects have been jointly identified which have impact on the design of a future CCU system (e.g. avoidance of  $CO_2$ -pipelines).









### WP4 Impact

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- High interest exists especially at German stakeholders and politics regarding the status of the ALIGN-CCUS project and sector coupling on basis of energy carriers produced by CCU.
- In Germany the next step in the development of CCU is under preparation: a large-scale CCU demonstration-scale plant to produce e-fuels using "green" hydrogen based on renewable sources in the Rhenish mining area.

RWE Power has joined forces with project partners to participate in the national call "Real laboratories for the energy transition". A preproposal has been submitted: "Sustainable PowerFuel" .

Up to now three of the partners from ALIGN-CCUS are participating. The project idea has been considered as a key project in the final report of the German commission "Growth, structural change and employment".









### WP Ongoing work

 Erection and commissioning of the demonstrator at Niederaussem; inauguration ceremony at second half of November 2019



- Finalisation of the engine adaption to DME and start of testing of the peak power generator beginning of 2020 at Niederaussem
- Finalisation of the engine adaption to OME and start of testing of the personal car late 2019/start 2020.
- Techno-economic-environmental evaluation based on operating data, CCU chain optimisation and scale-up using the joint work of WP1/2/4/5/6





Large-scale energy storage and conversion

### Work Package 5: Clusters



**WP-leader:** Tom Mikunda (TNO)

**Partners:** 

- TNO
- BGS
- TVCA
- Imperial College
- Scottisch Enterprise
- Bellona
- FZ Jülich
- Yara
- NORCEM
- GeoEcoMar
- PicOil
- CO2Club







- Kick-starting, or advancing the development of CCUS in six industrial regions
- Identified specific development and research needs per cluster
- Use modelling tool developed in WP2 for consistent assessment







Blueprints for low



#### WP5 – integration is key









#### Recent events in industrial clusters

- March 2019 4<sup>th</sup> Projects of Common Interest list CO<sub>2</sub> transport infrastructure:
  - ERVIA Cork Ireland (relevant for T5.4)
  - CO<sub>2</sub> Sapling UK (relevant to T5.1)
  - Northern lights Norway (relevant for T5.4)
  - ATHOS The Netherlands (relevant for T5.2)
  - CO<sub>2</sub>TransPorts The Netherlands (relevant for T5.2)
- Shipping, buffering, CO<sub>2</sub> quality standards and storage portfolios remain key issues







#### Teesside

- 3 interconnecting sites covering chemicals, H<sub>2</sub> production, steel, gas processing, energy from waste, biomass power, and biofuels
- ~6 MtCO<sub>2</sub>/yr, 6% UK industrial emissions
- €12 billion/yr / 25,000 jobs.

#### Objectives

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- Cost reduction in capture and transport
- Optimise storage options under different CO<sub>2</sub> supply scenarios
- Business case development





Blueprints for low carbon industrial clusters through CCUS

### CO<sub>2</sub> profiling to match storage



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#### Teesside storage options

- UK CO<sub>2</sub> supply scenario used in WP3 to select potential storage options for Teesside cluster
- Initial modelling of selected stores in progress to establish boundary conditions and pressure response for growth & mature scenarios
- Conceptual storage network to be tested for least-cost options

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### North Rhine Westphalia

- Heavily industrialised state, one-third of total German CO<sub>2</sub> emissions (~300 Mt/yr)
- No CO<sub>2</sub> storage permitted in many states
- CCU for low-carbon transport fuels

#### Objectives

- Identification of CCU pathways
  - CO<sub>2</sub> and H<sub>2</sub> availability
  - Methanol-based fuel demand (Transport sector / stationary power)
  - Sub-cluster identification
  - Source-sink matching











### Identification of clusters









#### Sub-cluster identification



• 16 out 118 sources, 13.5 MtCO<sub>2</sub>/yr

Accelerating CS Technologies • Existing hydrogen grid, waterway infrastructure



WP5 Blueprints for low carbon industrial clusters through CCUS

#### Dürener Bus Fleet Diesel Consumption







Different Operating Cycles Consumption Depending on Age Rough Estimation results in ∼ 800 t Diesel / year → 1.72 kt OME







#### Impact

- Provide a set of actionable development plans for targeted CCUS activities in 6 key industrial clusters across the EU
- Supports industry, national and regional governments in decision-making for industrial decarbonisation strategies
- Work continues to be executed alongside current cluster initiatives and Projects of Common Interest





#### Work Package 6: Society



WP-leader: Emma ter Mors (LU)

**Partners:** 

- Leiden University
- UEDIN
- TNO
- Bellona
- FZ Jülich
- SNSPA







Reduction of **non-technical risk** for CCUS implementation by

- Assessing public and stakeholder perception about CCUS, specifically towards industrial CCUS and CO<sub>2</sub> utilisation projects.
- Developing theory-based, evidence-based communication and compensation strategies that instigate trust and have a positive effect on societal acceptance of CCUS.







Insights in narratives, arguments and visuals used in the **media**, relevant **stakeholders** and their perceptions, and determinants of **public** opinion – this will help in making site selection decisions and developing effective public engagement strategies









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Mixed method approach to understand do's and don'ts in community compensation and engagement both from theory and practice and close knowledge gaps – this work is focused on learning from, and sharing knowledge and findings with, stakeholders in the field







# WP6 Highlights: Social Science Network









#### WP-6 Impact - Status

- Collaboration and knowledge sharing with other ALIGN work packages.
- WP6 is connecting with CCUS initiatives (Porthos, Athos, waste incinerators) and CCUS stakeholders through bilateral meetings, WP6 interviews, the July 2019 WP6 workshop, and by participating in (inter)national CCUS networks/events (e.g. CATO meetings).
- ALIGN-CCUS, ACORN, ELEGANCY, ECO-BASE, ENOS social science network.
- Broad range of dissemination activities: e.g. scientific conference presentations, journal articles in preparation, blogs, interviews, workshop, seminars, bilateral meetings, a film.







 Finalizing data collection, data analysis, dissemination & integration of results.

 Providing concrete, evidence-based recommendations for designing effective compensation, engagement and communication strategies.





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