Deutscher Verein des
Gas- und Wasserfaches e.V.

DVGW

www.dvgw.de

Energy Morning Lounge
Künftige Nutzung/Anwendung CCU/S

22.03.2023, Berlin

Björn Munko, Leiter Einheit Gastechnologien und Energiesysteme, DVGW e. V.

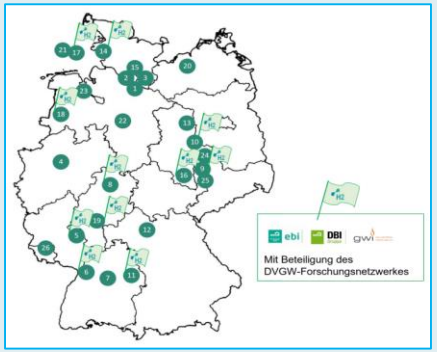
DVGW - Kurzvorstellung

Regelsetzer
nach. §§49, 113 EnWG

- Normen & Standards für CH4, H2 & CO2
- Anwendungsbezogene Richt- und Leitlinien

Unabhängige Forschungsstellen Testzentren

Beteiligung an 26 H_2-Demo Projekten in Deutschland



Non-profit Organisation

Ausbildung und Training von 40 000 Betreibern, Technikern, Ingenieuren und Handwerkern

Zertifizierung

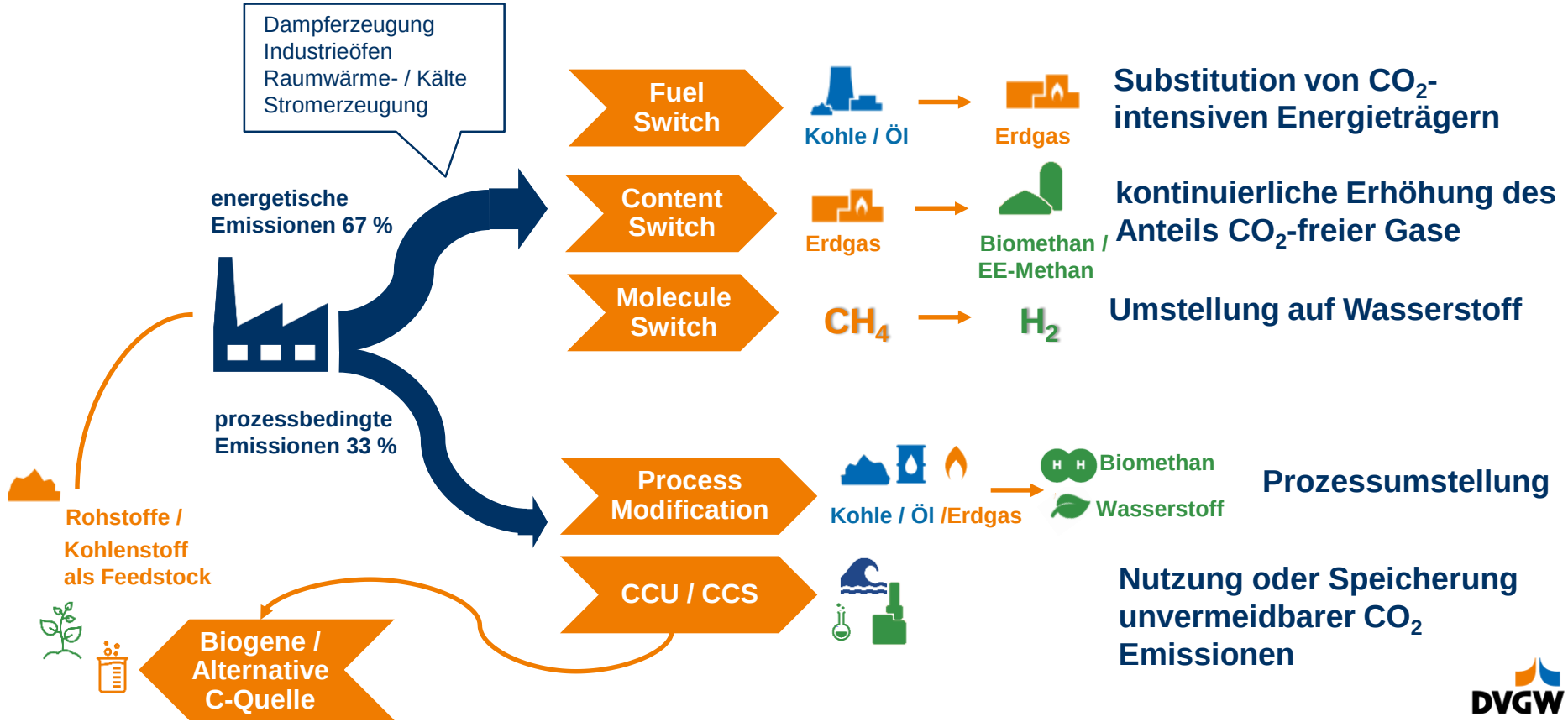
H2 DVGW CERT

DIN DVGW CERT

DVGW

Schematisch Darstellung möglicher Transformationspfade

Wasserstoff und CO_2-Abscheidung sind Schlüsselelemente für eine klimaneutrale Industrie



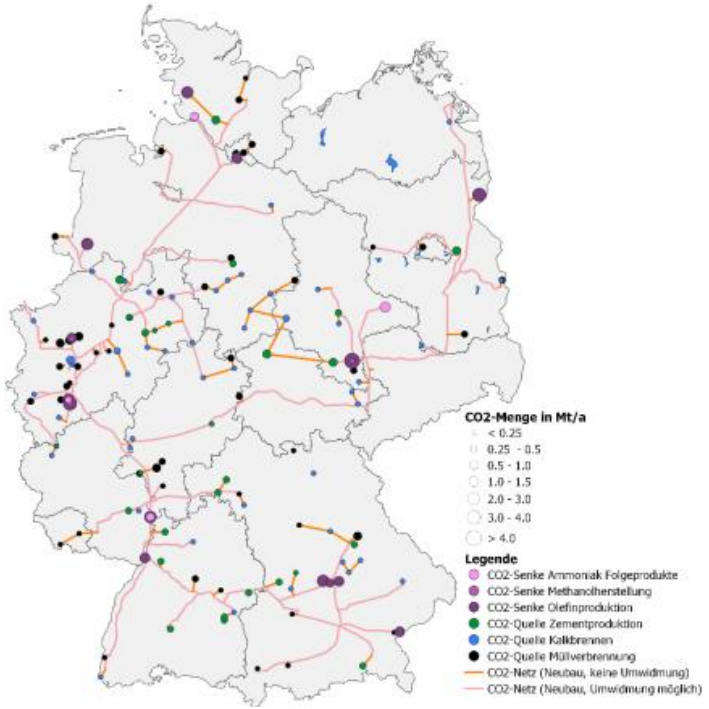
CO2 Kreislaufwirtschaft wird unverzichtbarerer Bestandteil eines klimaneutralen Wirtschaftssystems

CCU ermöglicht eine Verknüpfung lokaler Quellen und Senken von CO_2

- Reduzierte Transportwege
- Ressourcenschonung

Transport Optionen
- Pipeline
- Schiff
- Barge (Binnenschiff)
- LKW
- Schienentransport

Pipelines und Schiffe sind am leichtesten zu skalieren, mit den niedrigsten Transportkosten pro Tonne.



BMWK Langfristenszenarien Industrie

CC(S)S – Carbon Capture (Shipping) Storage Projekte

Northern Lights
- JV Shell, Equinor, Total Energies
- Injektion: Oygarden (Bergen)
- Abscheidung: Brevik, Oslo, weitere
- 1 – 2 mtpa
- Schiffe sind bestellt, Terminals in Bau
- 2 x 7,500 cbm CO2/LPG Schiffe
- www.northernlightsccs.com

Stella Maris
- JV Altera, Hoegh
- Injektion: Nordsee
- Quellen: Nothern Europe
- Studie Phase 3 gestartet
- ca. 10 mtpa
- www.alterainfra.com/what-we-do/ccs

Carbfix
- Injektion: Island
- Quellen: Umgebungsluft, Nordeuropa
- Verschiffung durch DanUnity CO2
- Terminal Investment Entscheigung Anfang 2021
- www.carbfix.com

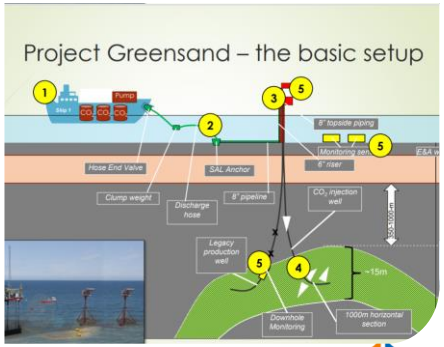
Greensand
- Ineos, Maersk (Drilling), Wintershall
- Injektion: Offshore Dänemark
- Verschiffung DanUnity CO_2
- www.projectgreensand.com

Acorn
- Storegga, Shell, Harbour Energy
- Injektion: Offshore Scotland
- Füörderung fragwürdig
- www.theacornproject.uk

DanUnity CO2
- JV Navigator & Evergas
- 1. reine CO2 Reederei
- Transport Partner Carbfix & Greensand
- AIP* für 12,5 Tm³ & 22 tm³ CO2 Schiffe


Northern Lights


Carbfix, Island

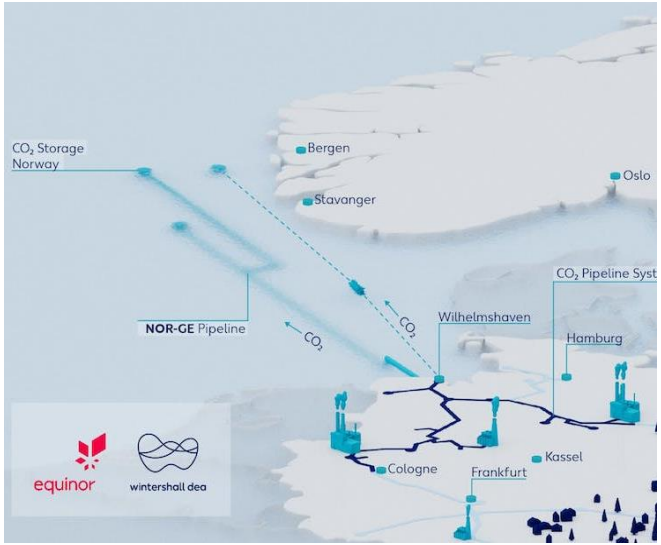


*AIP-Approval in Principle

Aktuelle Pipeline Projekte

Delta Corridor Shell – www.shell.nl

CO2 starter grid OGE/TES – www.oge.net

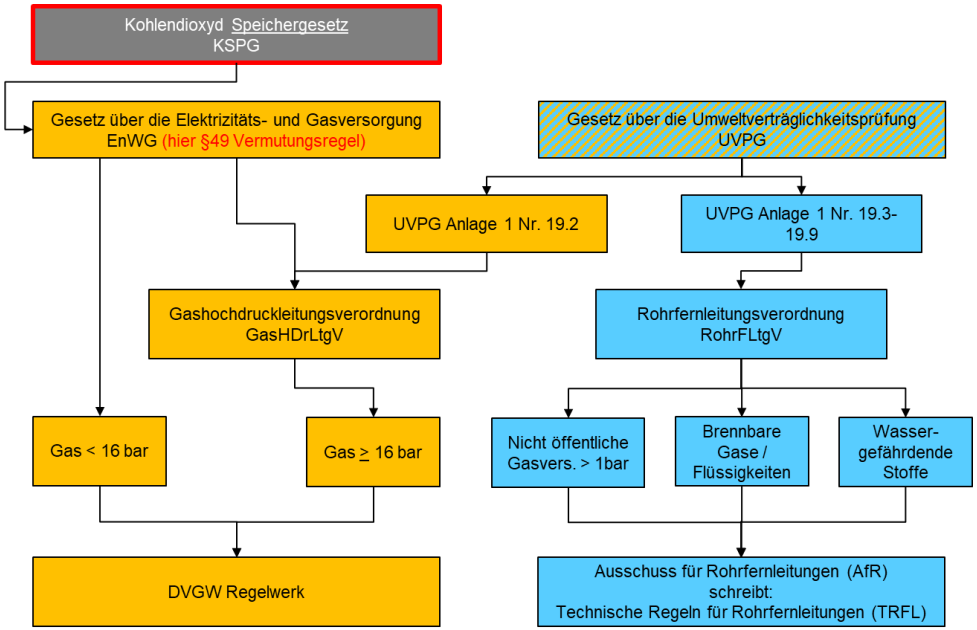


Equinor / Wintershall Dea – Quelle: Pressemitteilung

Weiterentwicklung des Rechtsrahmens für CO_2-Transportleitungen und - Netze erforderlich

Erforderlicher Rechtsrahmen

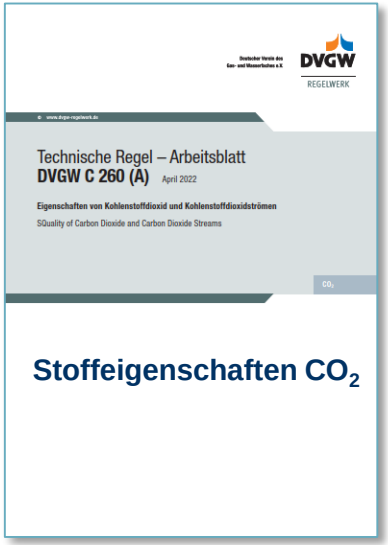
- Kohlendioxyd Speichergesetz ist heute für CCS und CCU nicht anwendbar
- Notwendiger Anwendungsbereich:
  - Transportleitungen zu Endlagern – CCS über die nationalen Grenzen
  - Transportleitungen zu Nutzern von CO_2 – CCU
  - Zwischenspeicher
- Themen:
  - Anzuwendendes Regelwerk → EnWG
  - Genehmigungsrecht → EnWG
  - Regulatorische Fragen



DVGW-Regelwerk zum CO_2-Transport

Veröffentlichtes Regelwerk

DVGW C 260 (A)
April 2022



Stoffeigenschaften CO_2

DVGW C 463 (A)
April 2022

CO_2-Transportleitungen Errichtung

Aktuelle Projekte

- **ISO/CD 27913**, Carbon dioxide capture, transportation and geological storage — Pipeline transportation systems
  → **ISO/DIS in Vorbereitung**
- Weiterentwicklung **DVGW C 260 (A)**
  → weitere Grenzwerte aus Betriebserfahrungen
- Weiterentwicklung **DVGW C 463 (A)**
  → weitere Aspekte aus ISO 27913; Umstellung
- **DVGW C 466 (A)**, CO2-Transportleitungen – Betrieb und Instandhaltung
  → **Entwurf in Vorbereitung**
- **DVGW C 491 (A)**, Anlagen in CO_2-Transportsystemen
  → **Entwurf in Vorbereitung**

Danke für Ihre Aufmerksamkeit!

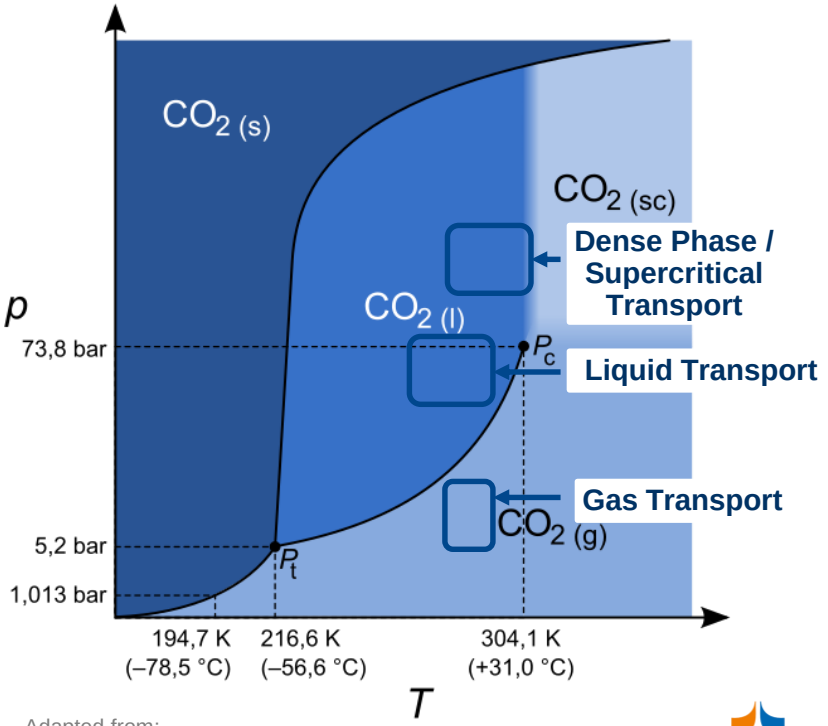
Björn Munko, Leiter Einheit Gastechnologien und Energiesysteme, DVGW e. V.

E-Mail: bjoern.munko@dvgw.de

CO2 Pipelines Design

Technical Options

- low-pressure CO2 gas pipeline, e.g. operating at a maximum pressure of 4.8 mpa
- high-pressure CO2 gas pipeline operating at a minimum pressure of e.g. 9.6 mpa, supercritical or dense phase state
- (refrigerated) liquid CO2 pipeline



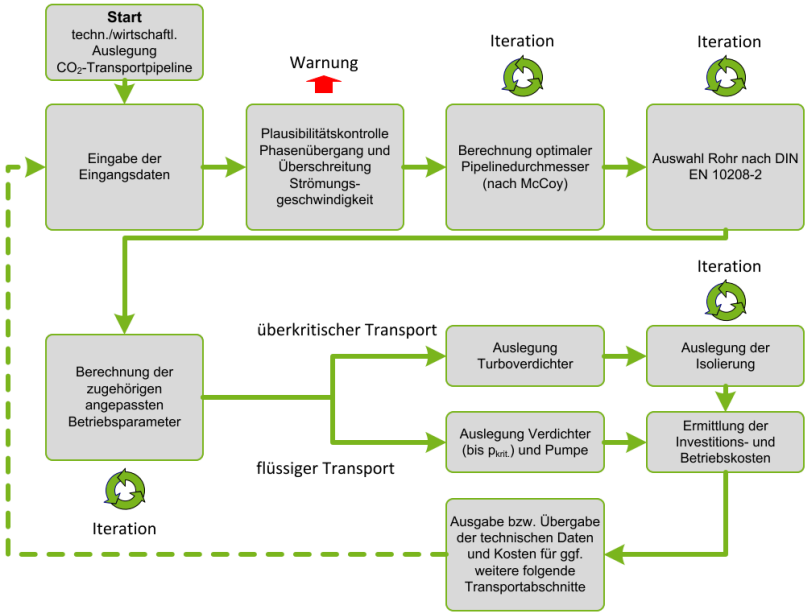
Adapted from: https://commons.wikimedia.org/wiki/File:Carbon_dioxide_p-T_phase_diagram.svg

Existing CO2 Pipelines

• Canyon Reef (US)	352 km onshore	4.4 mt/a	gas processing	1970
• Bravo Dome (US)	350 km onshore	7.3 mt/a	EOR	1980‘ (20“)
• Cortez (US)	803 km onshore	20 mt/a	EOR	1984 (30“)
• Sheep Mountain (US)	660 km onshore	9.5 mt/a	EOR	
• Val Verde (US)	130 km onshore	2.5 mt/a	EOR	1998
• Bati Raman (TUR)	90 km onshore	1.1 mt/a	EOR	1982
• Sleipner (NOR)	12.5 km offshore	1 mt/a	gas processing	1996
• In Salah (Algeria)	14 km onshore	1.15 mt/a	gas processing	2005
• Snoevit (NOR)	153 km offshore	0.7 mt/a	LNG processing	2008
• Weyburn (CAN)	330 km onshore	4.6 mt/a	EOR	2000
• Decatur (Illinois)	2 km onshore	0.33 mt/a	gasification	2011

Scope of the COORAL Project

- Evaluation of optimal design for CO2 pipelines
  - technical & economical
- Influence of CO2 impurities
- Design and Operation
  - Compression
  - Materials
  - Safety Measures
  - CAPEX
  - OPEX
- Point to point pipeline
- Calculation tool



Coral Algorithm: Source DBI

Cluster

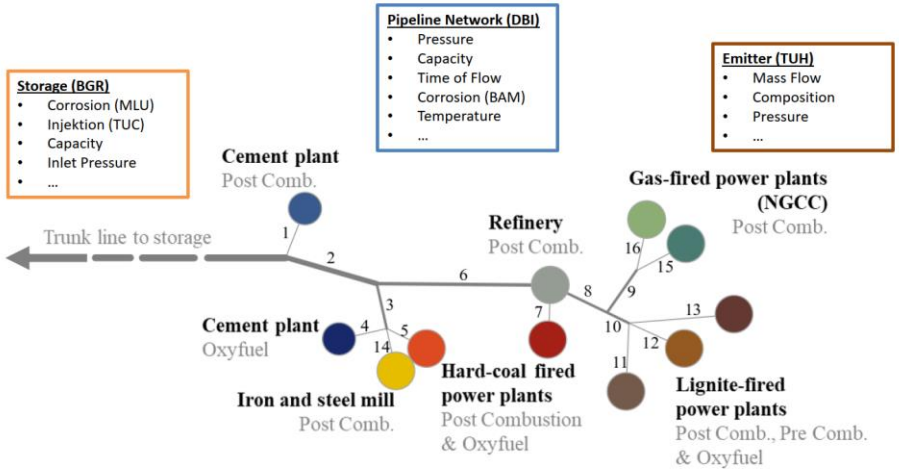
Development of a whole chain model

Data Input:
Mass Flow, Composition, Temperature

Data Output:
Combined mass flow, composition, thermodynamic properties, minimal inflow pressure, emitter power demand, design parameters pipeline, temperature gradients

Partners: BAM, BGR, DBI, Eurotechnica, Martin-Luther-Universität-Halle-Wittenberg, TU Clausthal, Technische Universität Hamburg

Sponsored by: the German Federal Ministry of Economic Affairs and Energy

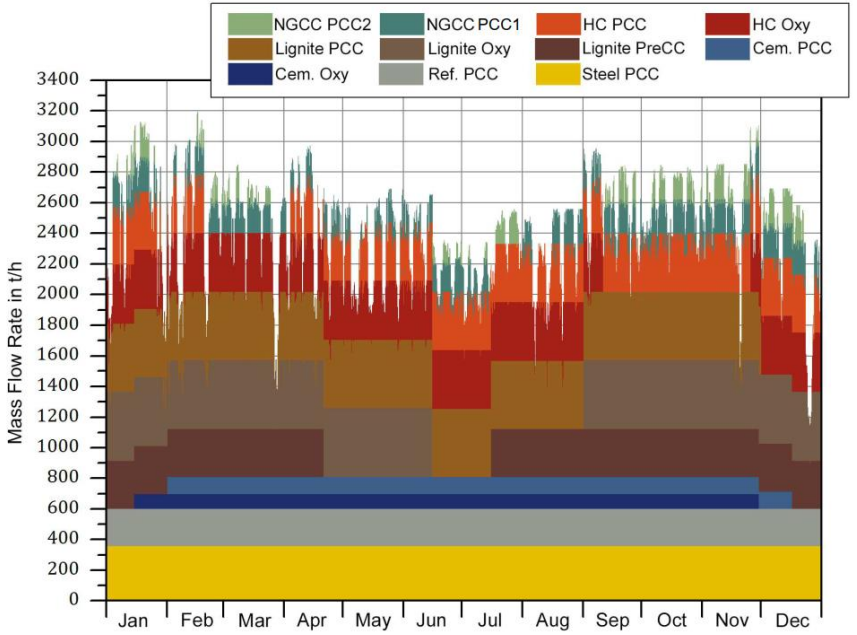


Source: DBI

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Results

- Cost are driven by maximum mass flow
- Impurities have an impact to thermodynamic properties
- however no significant impact on pipline diameter
- only a minor impact on wall thickness, which should be covered by standard pipe wall thickness
- degradation may have an impact based on material selection
- impurities should be defined as minimum composition thresholds for shared transport importstructure



Source: DBI / Cluster Abschlusssynthese

CapTrans CO2

Feasibility for a climate neutral industry in central Germany by use of CCU/CCS and with an interconnected transport infrastructure

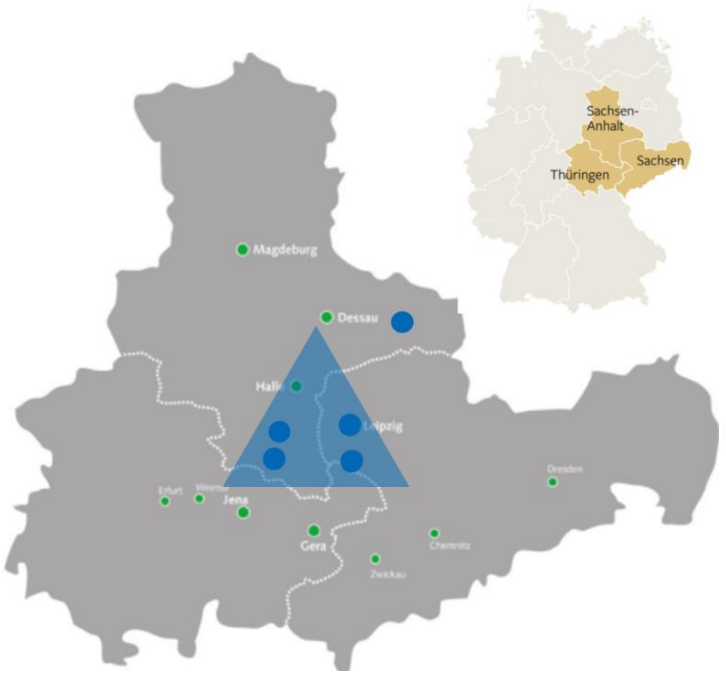
Projekt Partners:

- Total Energies
  - Partial Oxidation
  - Refinery
- VNG
  - Intermediate Storage
  - Pipelines
- DBI
  - Scientific evaluation

Associated Partners:

- Ammonia
- Carbamite
- Cement
- Plastics
- Chemicals

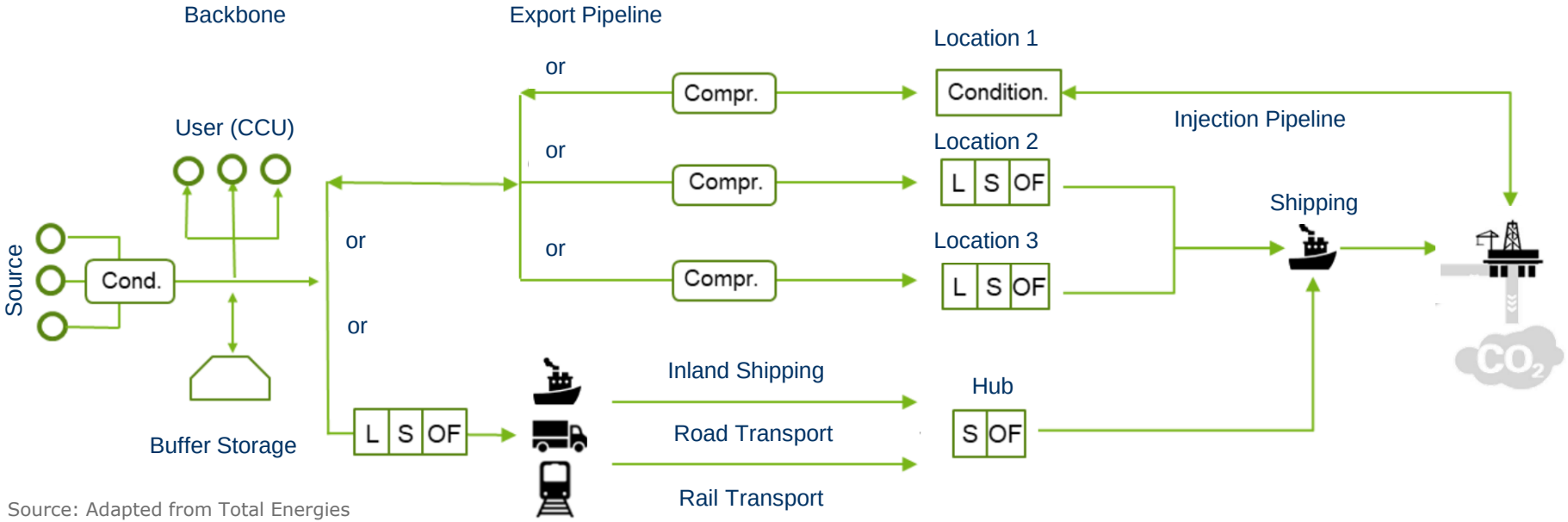
Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages
ptj Projektträger Jülich Forschungszentrum Jülich



Central German Chemistry Triangle

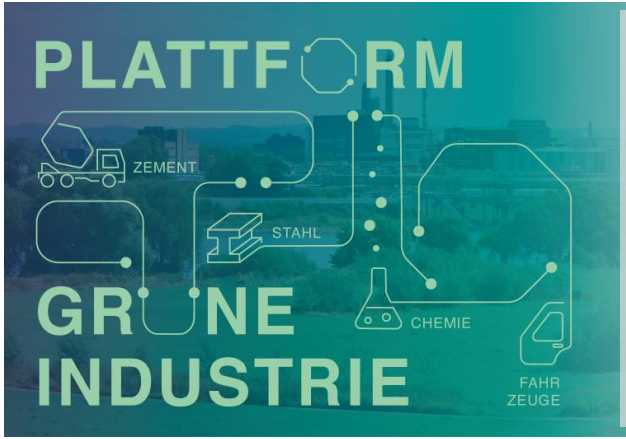
DBI Gruppe DVGW

Transport Options CapTrans CO2



Source: Adapted from Total Energies

Platform Green Industries
Accelerating the Industrial Transformation



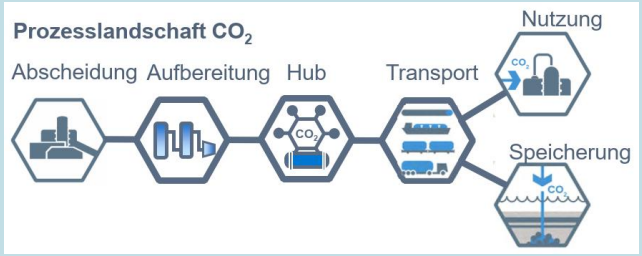
Industry Stakeholder
Vehicle Production, Logistics, Steel, Cement, Glas, etc.

Stakeholder Gas Supply
Infrastructure, Gas supply, Grid Operators, Production, Equipment Suppliers

Key questions

- ✓ Role of hydrogen within the transformation
- ✓ Future of energy and efficiency
- ✓ Future of fossile energy carriers
- ✓ CO_2-use and carbon sources
- ✓ Accounting for future energy requirements and energy mix
- ✓ Role of alternative energy vectors such as NH3, DME, …
- ✓ Change to pipeline based H2 supply
- ✓ Interfaces and common topics across different industries
- ✓ Development of a wholistic solution to net zero

Focus group „Cement and Gasinfrastructure“



DVGW
ROHRDORFER
Dyckerhoff
vdz
Holcim
OGE
OPTERRA
A CRH COMPANY
ontras
Gastransport GmbH
SCHWENK
Baustoff leben
VNG
spenner
terranets bw
CEMEX
DBI
HEIDELBERGCEMENT

First Milestones

Working Groups

Work program

CO_2 Quality	Collection of data and comparison of specifications (capture, transport, requirements for utilization and storage)
Rules, Standards and Legislation	Rules and regulations, political legislation, GAP analysis
CO_2 Handling in Germany	Case studies of regional processes and infrastructure from capture to storage or utilization under consideration of different parameters (energy, technology, economy, …)

DVGW

Conclusion

- Due to offshore storage significant distances have to be considered between CO2 emitters and storage sites
- CO2 transport by pipeline is feasible for small and large quantities of CO2
- Abt. 8000 km of CO2 piplines are in operation worldwide
- Grids can be based on clusters and collect the CO2 from several emitters
- Several projects for clusters and trunk lines to storages or hubs have been proposed and are under development