

Techno-economic assesment of CO₂ transport

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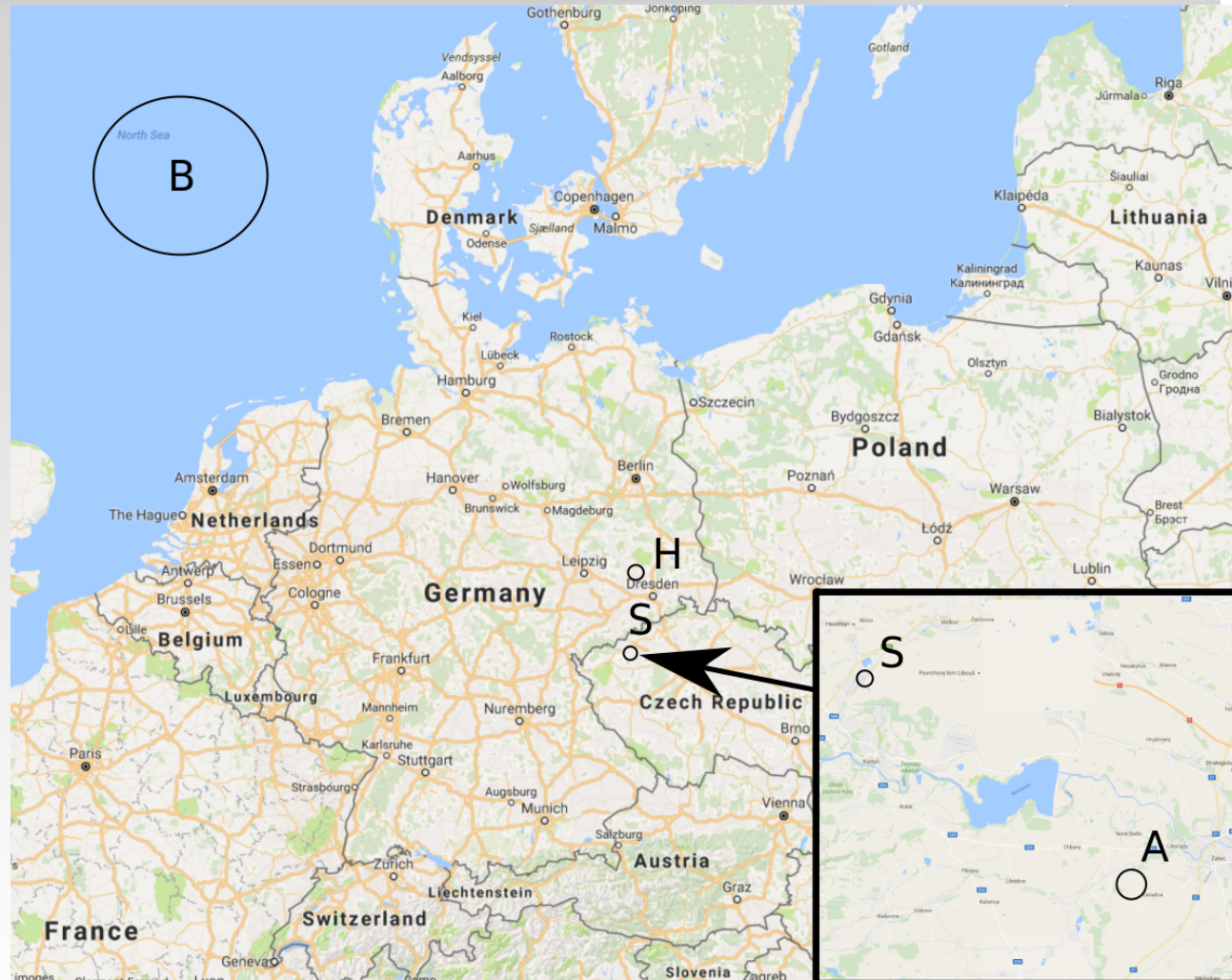
Outline

- Introduction
- Storage location
- Transport type
- Description of transport method
- Description of transport routes
 - On-shore
 - Off-shore
- Description of technical model
- Results



Storage location

- A – Onshore
- B – Offshore no.1
- S – Source
- H – Offshore no. 2
(hypothetical
HUB for EU CCS
continental pipe)

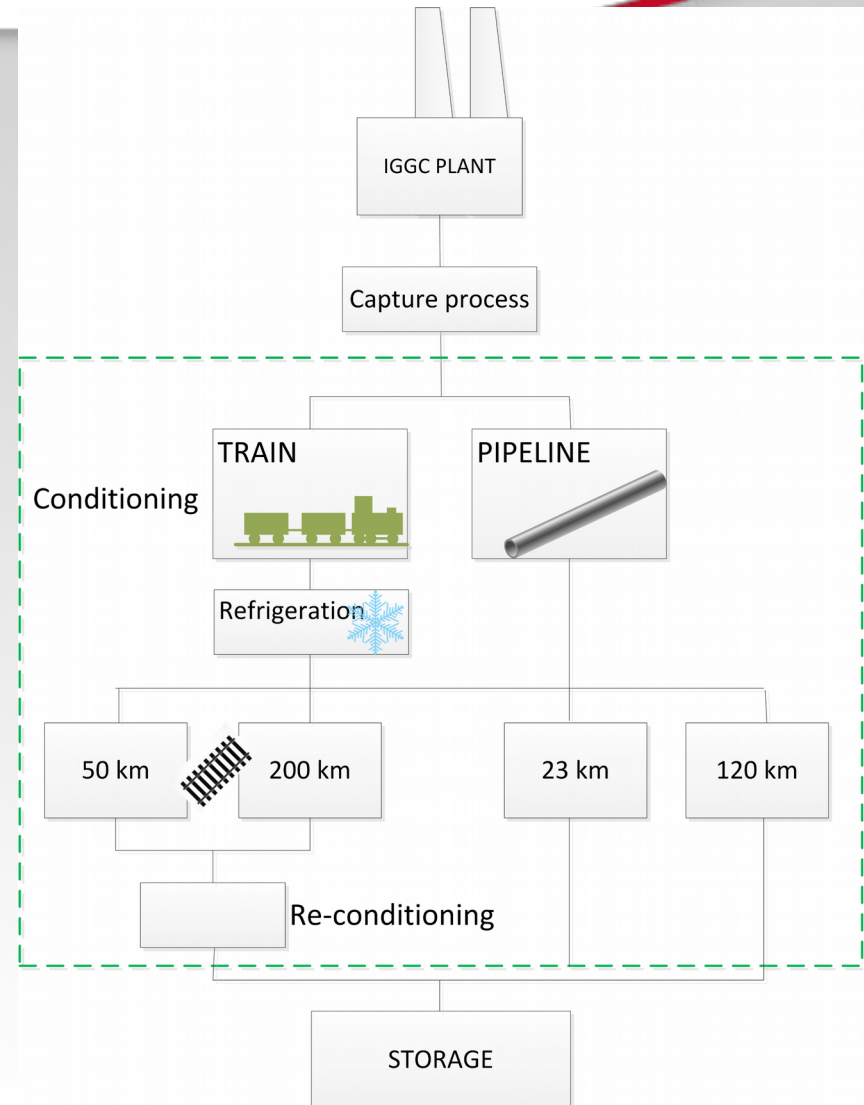


Transports type

- Transportation can be performed for the two phases of CO₂.
 - liquid phase
 - gas phase

Type of transport:

- Transport via pipelines
 - Gas phase
 - Liquid phase
- Transport of CO₂ in the pressurized container (Train)
 - Liquid phase





Description of transport method

Type of transport:

- Transport via pipelines
 - Transport of CO₂ in the gas phase in a region above the critical pressure.
 - » Operating pressure - 8.6 to 20 MPa
 - » Operating temperature - 4 °C to 38 °C
- Transport of CO₂ in the pressurized container – via railway
 - The transport pressure is in the range from 0.52 MPa up to 7.3 MPa and temperature is about -50 °C.
- Recommended composition of mixtures for the transport:

Component	H ₂ O	H ₂ S	CO	CH ₄	N ₂	O ₂	Ar	H ₂	CO ₂
	ppm	ppm	ppm	vol.%*	vol.%*		vol.%*	vol.%*	%
Pipeline	500	200	2000	< 4	< 4	Unknown	< 4	< 4	> 95.5
ship/railway	50	200	2000	< 0.3	< 0.3	Unknown	< 0.3	< 0.3	> 99.7

* all condensable gases



Criteria of transport routes

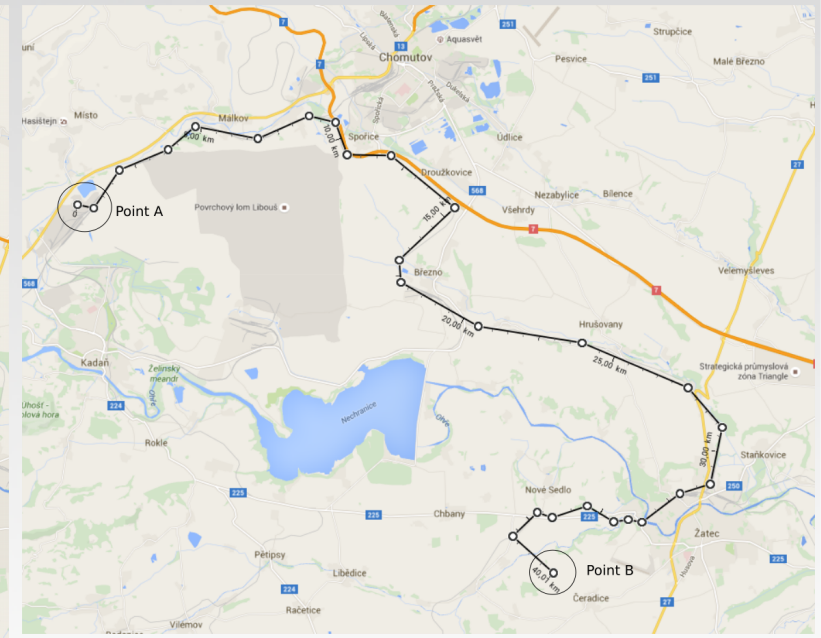
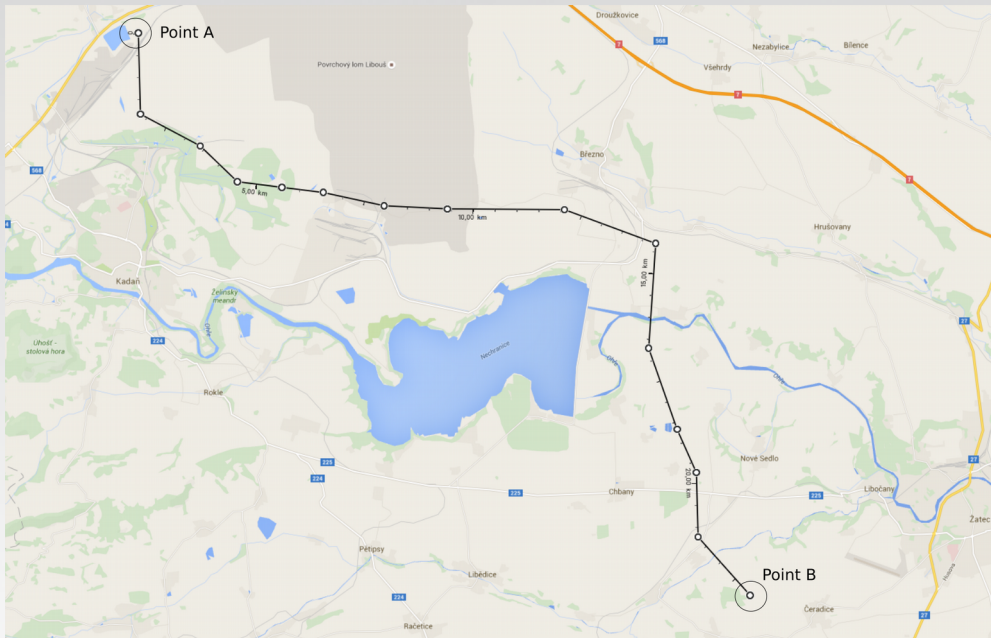
Assessment of transport type for conditions in the Czech republic:

	Pipeline	railway
Impact on landscape	Yes	No
Impact on Residents	Yes	Yes
Investment demands	Big	Small
New built up area	Big	Small
Infrastructure	No	Yes
Load factor of transport corridors	Very low	High



Transport routes - onshore

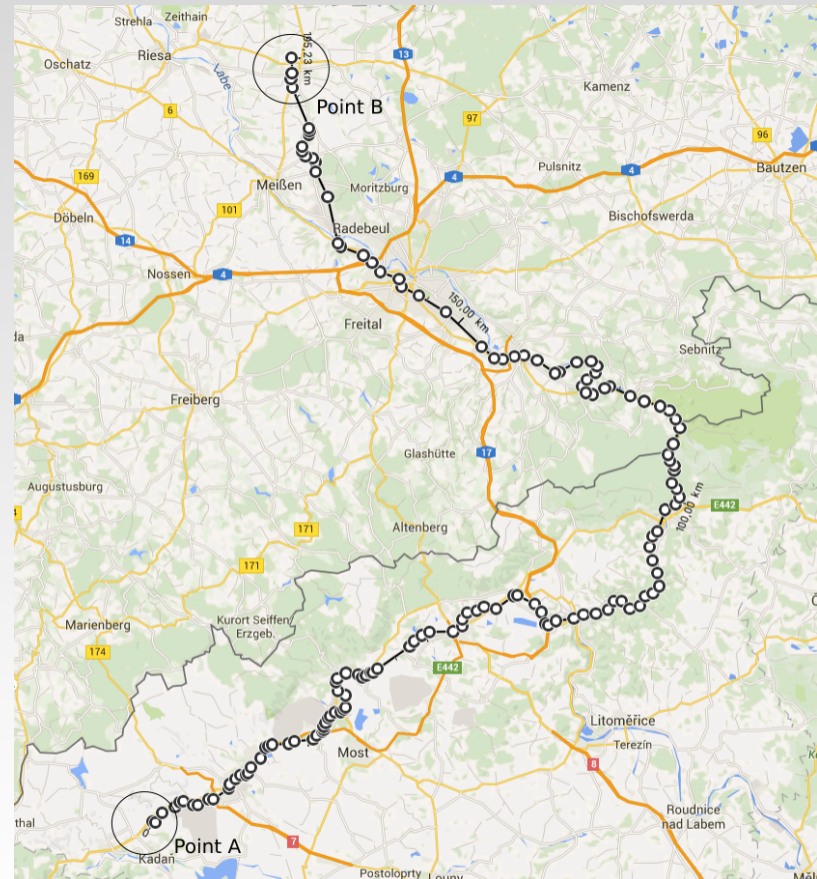
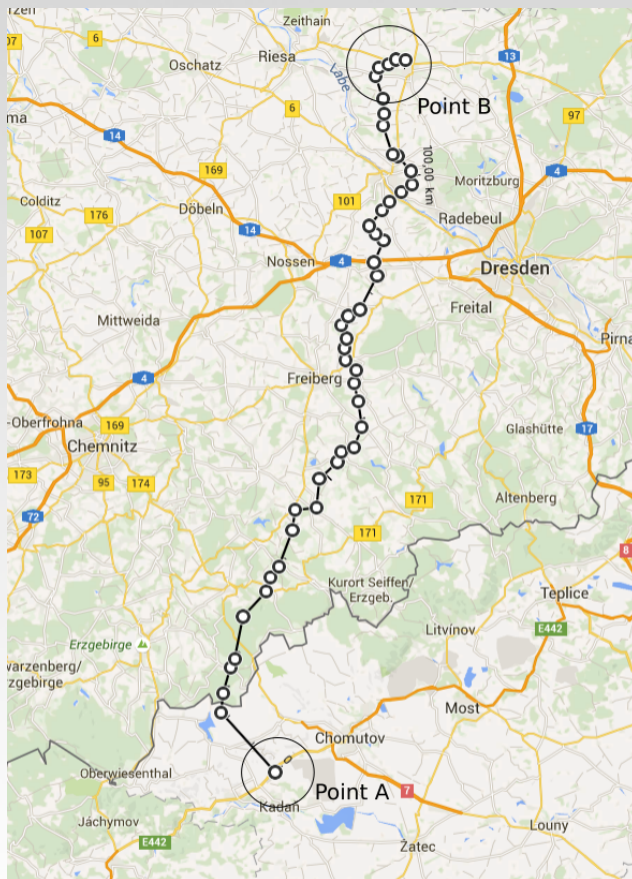
- The length of the transport route via pipeline is about 23 km.
- The length of the transport routes is via railway about 50 km.





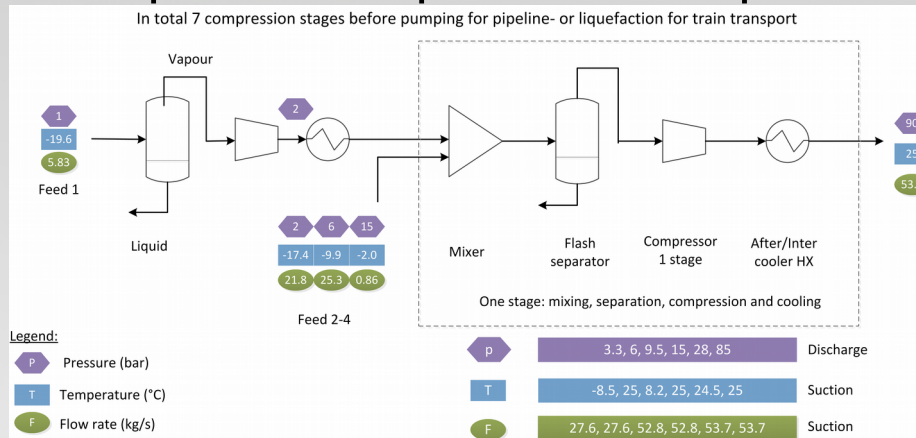
Transport routes - offshore

- The length of the transport route via pipeline is about 120 km.
- The length of the transport routes via railway is about 200 km.



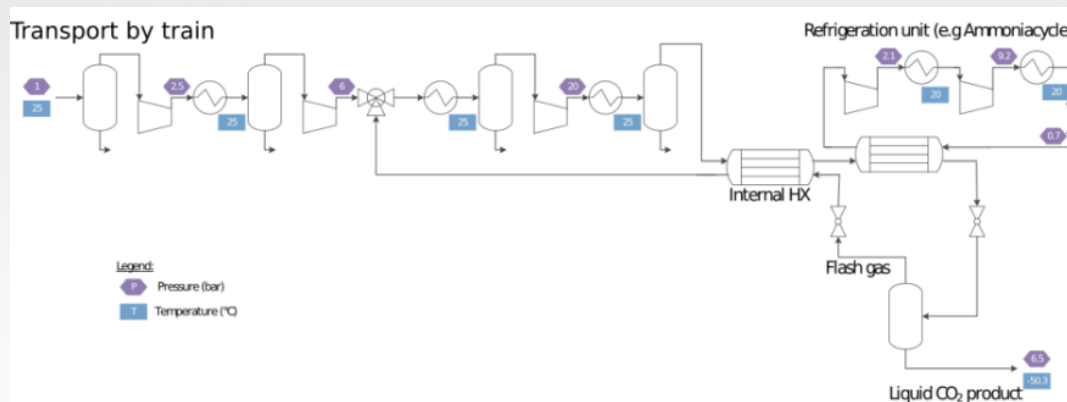
Technical model

- Transport via Pipeline (Compressor station)



- Operating pressure - 8.6 to 20 MPa
- Operating temperature - 4 °C to 38 °C

- Transport via railway/liquid phase (Compressor station)



For Railway

- Operating pressure - 0.52 MPa to 7.3 MPa
- Operating temperature is about -50 °C



Base case

- The feed stream from a Rectisol-based capture process

	CO ₂	CO	H ₂	Ar + N ₂	MEOH	H ₂ S	Temperature	Pressure	Flow rate
	[mole %]						[°C]	[bar]	[kg/s]
Stream I	99.06	0.0124	0.012	0.025	0.839	0.0409	-19.6	1	5.83
Stream II	99.41	0.0087	0.0089	0.04	0.505	0.0256	-17,4	2	21.8
Stream III	98.78	0.031	0.166	0.679	0.315	0.0137	-9,9	6	25.3
Stream IV	74.25	0.802	16	7.75	0.246	0.0077	-2	15	0.86

- The final composition of mixtures from a Rectisol-based capture process:

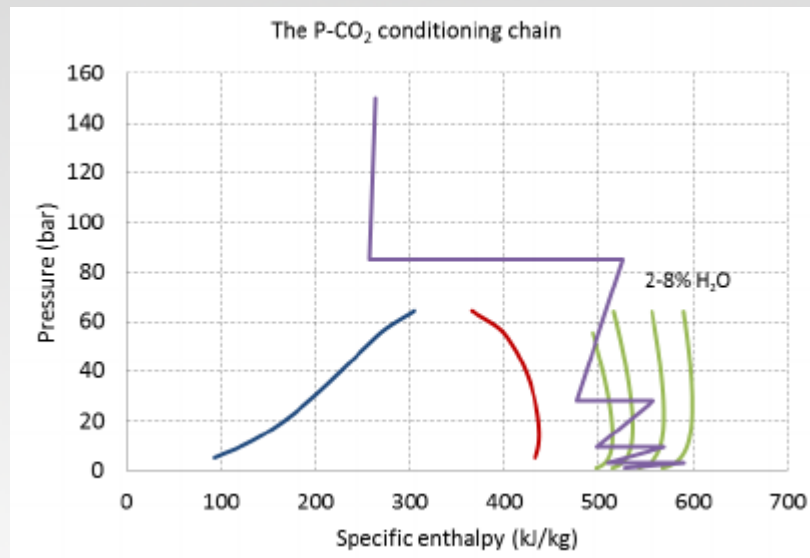
Pipeline	CO ₂	CO	H ₂	Ar + N ₂	MEOH	H ₂ S	Temperature	Pressure	Flow rate
	[mole %]						[°C]	[bar]	[kg/s]
Mixtures	98.67	0.032	0.356	0.466	0.448	0.02	37	150	53.79
Recommended composition	> 95.5	0.2	4	-	0.02				



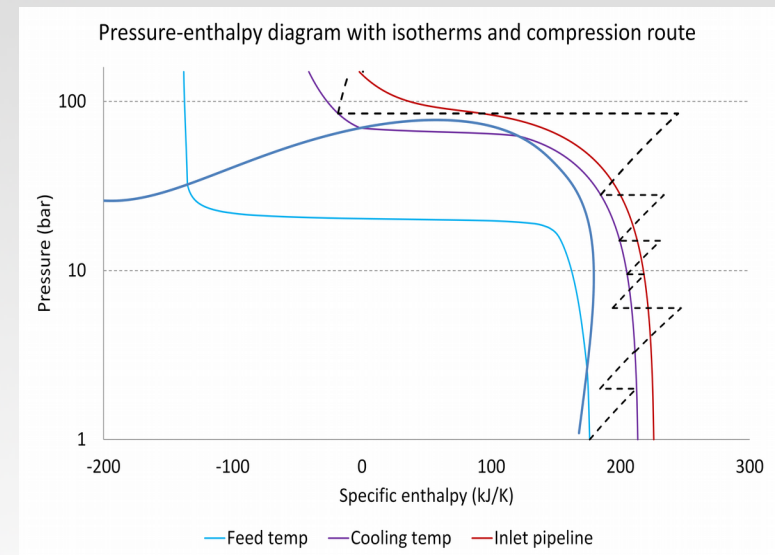
Technical model

- Transport via Pipeline

Theoretical model



Real model for base case





Results and analysis input

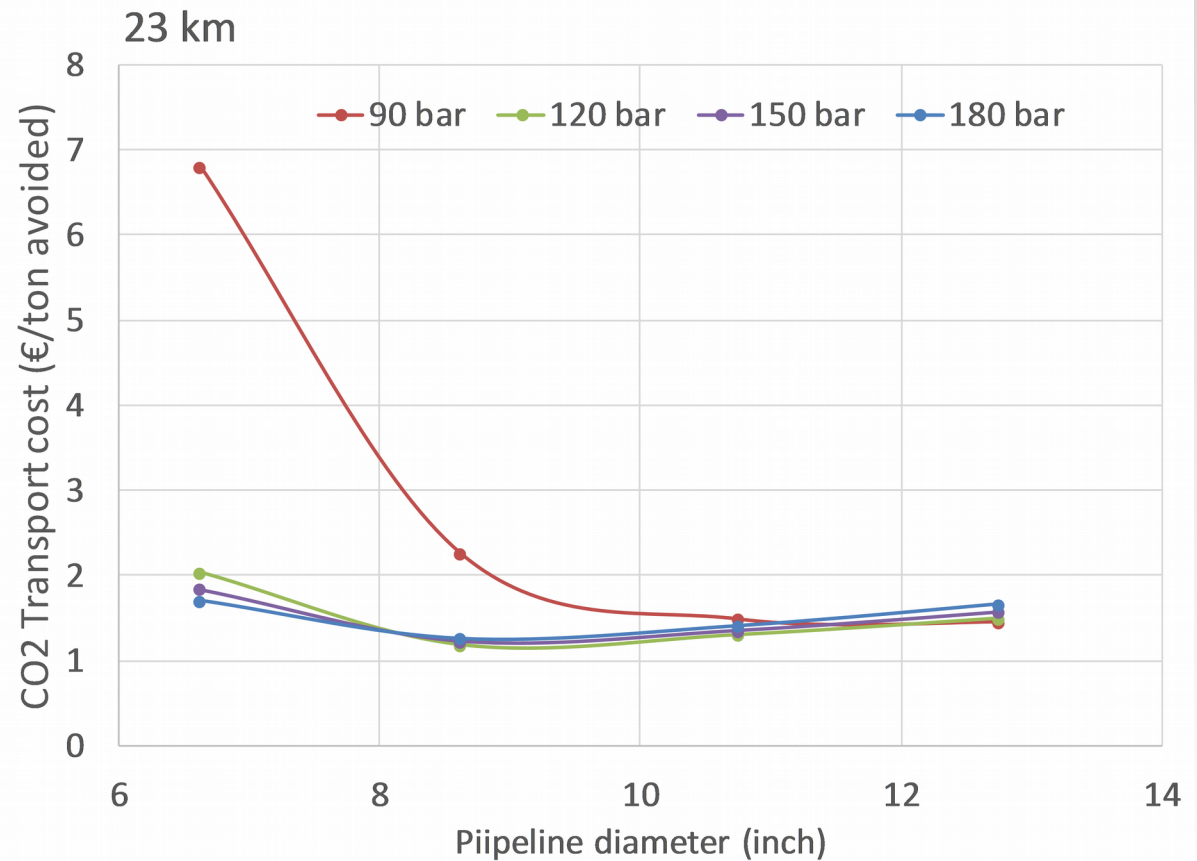
Transport via pipelines

- Gas phase
 - 8.625 inch (150 bar) = 5.9 €/ton (offshore)
 - 8.625 inch (120 bar) = 1.2 €/ton (onshore)
- Liquid phase
 - 8.625 inch (150 bar) = 14.8 €/ton (offshore)
 - 8.625 inch (120 bar) = 9.1 €/ton (onshore)
- For Pipeline:
 - Results are for real dimensions pipeline - according to the norm ASME B31.4-2002:
 - Four different dimensions of pipeline
 - Results are for four output pressure from compression station:
 - 90, 120, 150 and 180 bar



Results

- For Pipeline – Onshore
 - Gas phase



Results

- For transport via railway
 - First study on this way of transport
 - Purpose: train may have similar benefits as train transport – cost-competitive for small volume and long distances
- Depending of the transport distance considered train may be a interesting option considering the "small" volume considered.
- In addition of case evaluation, it is also planned to identify the switching distance between pipeline and train for the project volume to identify the potential of train-based CO₂ transport



source: Benchmarking of CO₂ transport technologies: Part I – Onshore pipeline and shipping to an onshore areas, S. Roussanly, J.P. Jakobsen, A.L. Brunsvold, E.S. Hognes, International Journal of Greenhouse Gas Control



Thank you for your attention

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