

# Cost of Large Scale CO<sub>2</sub> Transport

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European Technology Platform for Zero Emission Fossil Fuel Power Plants

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# The CCS Cost Challenge



## Why is the ZEP Cost Report unique?

- ▶ Publicly available cost data on CCS are scarce
- ▶ New, live, in-house data provided exclusively by ZEP member organizations
- ▶ Over 100 contributors and nearly 2 years of work...
- ▶ Complete CCS value chains; individual reports analyse costs for:
  - Capture
  - Transport
  - Storage
- ▶ Establishes reference point for costs of CCS, based on a “snapshot” in time (CAPEX referenced to Q2 2009)

# An approach to transport cost estimation

Method, Assumptions & Networks

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## Approaches to transport cost estimation

Bottom-up



Detailed component cost built into dimensioning model for specific CCS cases  
 Focusing on material costs, operating expenses  
 Static, detailed view on cost

Top-down



Analyzing "the market", potential capture projects coming on stream in a coordinated mode  
 Based on phased-in volumes, approximating required, optimal transport capacities  
 Focusing on total CAPEX  
 Dynamic volume development view, extrapolations on cost

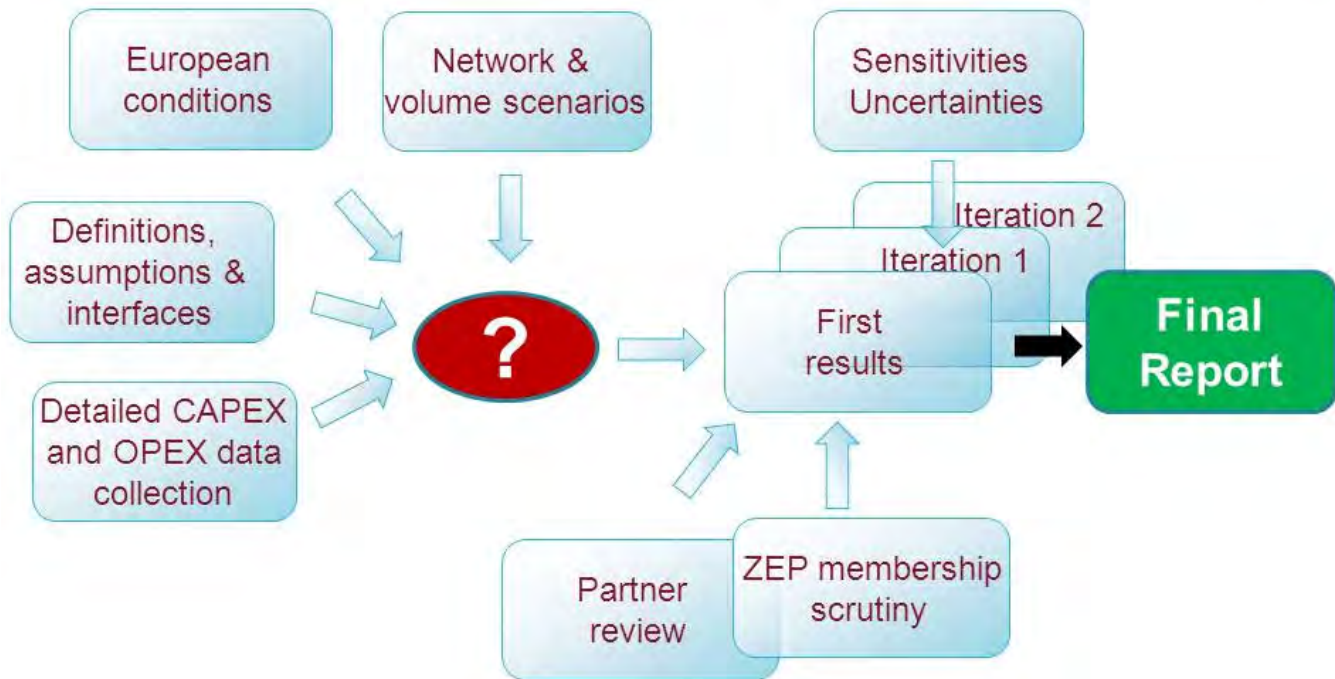
**Integrated**



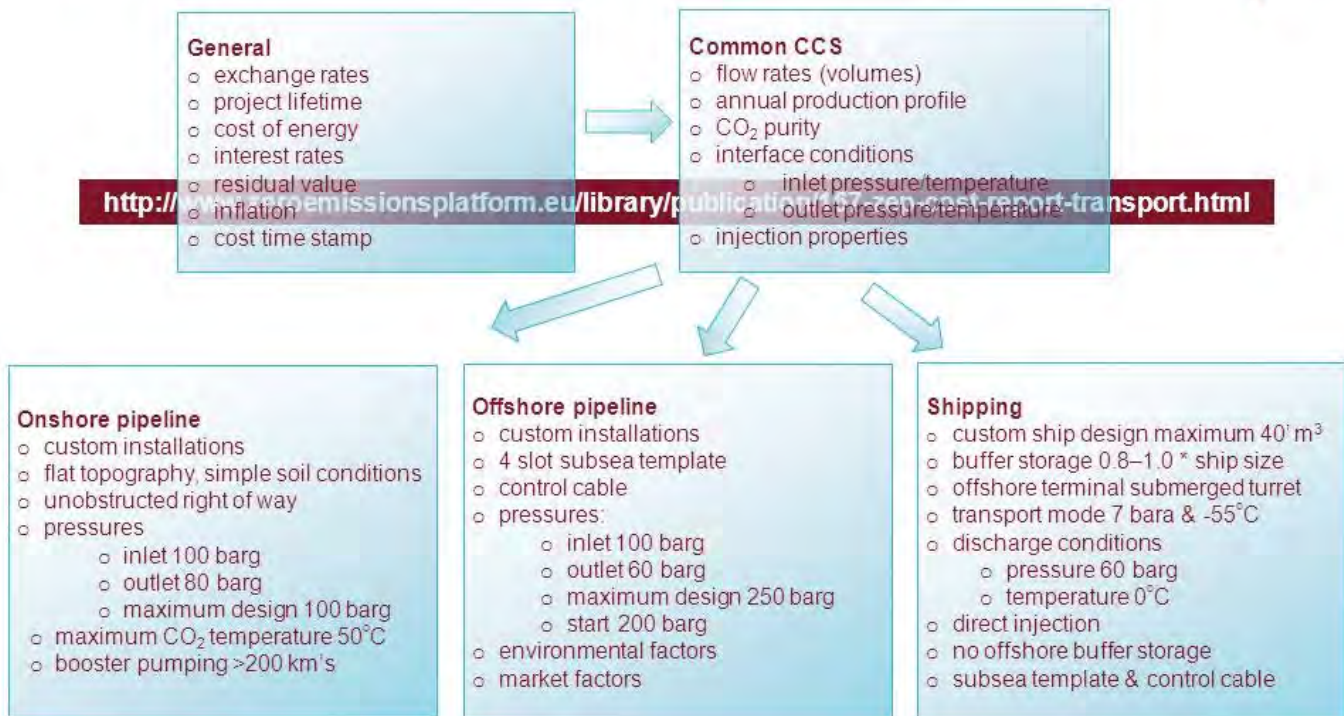
**Live, transport chain cost components, CAPEX and OPEX**  
**Simulated transport volume demands and network developments**  
**Integrating network scenarios and component costs**  
**Dynamic, generic view on cost and volume**



# ZEP: The costs of CO<sub>2</sub> transport – method



# Key Assumptions

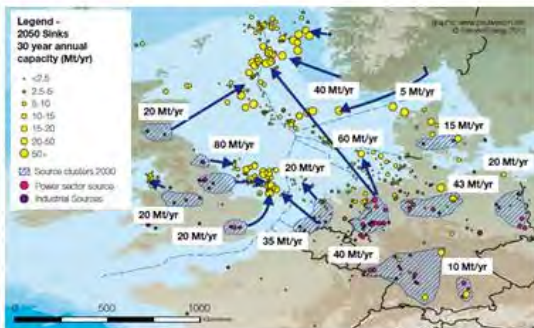


# Collection of Component Costs - Example

	Source	Capture/Compression	Onshore pipeline	Pump	Launcher/Landfall	Offshore Pipeline	Template Storage	Offshore Pipeline	Template Storage	Control Cable
Length			10 km			180 – 1 500 km		10 km		50 km
Pressure		110 barg	110 → 100 barg	100 → 200 barg	200 barg	200 → 60 barg	60 barg	60 barg	60 barg	
	A	B	C	D	E	F	G	H	I	J

## Battery limits and cost zones for offshore pipeline

# More robust scenarios built in other studies...



One North Sea study  
"Very High scenario 2050"  
May 2010



CO2Europe  
Reference scenario 2030  
September 2011



Feasibility Study for Europe-wide  
CO2 Infrastructures  
2050 Mid CO2 Capture Scenario  
October 2010



## ....but more detailed and reality based cost element analysis in ZEP



- › Pipeline data from both existing CO<sub>2</sub> pipelines and....
- › ... in comparison with hydrocarbon networks
- › Data from current (2010) demonstrator projects
- › Detailed interface definitions with Capture and Storage experts
- › Shipping data from live projects and LPG tonnage
- › Process (compression, regas and liquefaction) from vendors and projects

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## Adding up, for Europe, we speak **BIG numbers...**

Infrastructure investment required is massive, yet overall numbers remain the results of highly approximate extrapolations, only, so no guarantees issued on this one

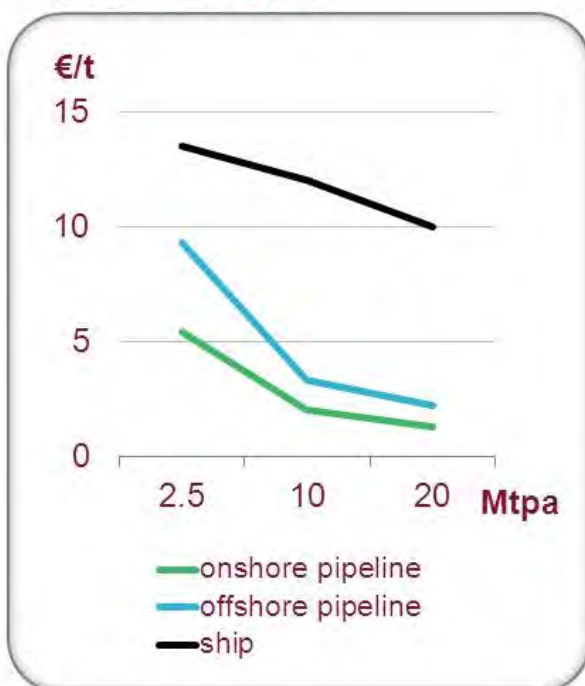
<i>report</i>	<i>year</i>	<i>CAPEX (b€)</i>
ZEP extrapolated	2011	40 - 50
CO <sub>2</sub> Europipe	2011	50 - 80

# Cost Predictions

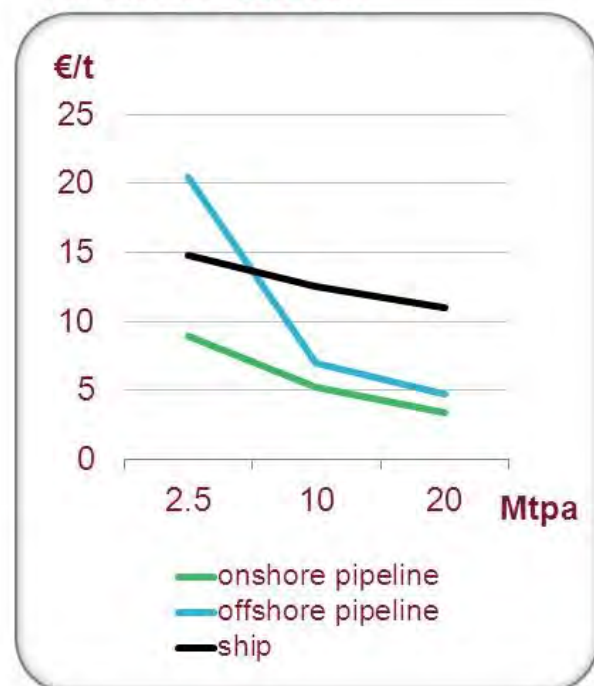
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## Scale effects are real (total cost €/t)

Point-to-Point 180 km

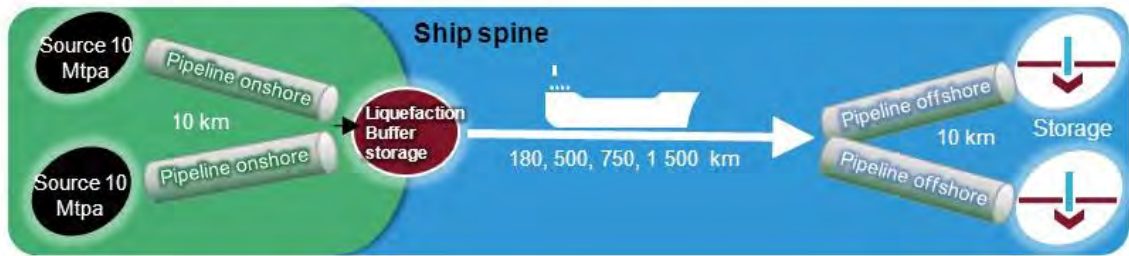


Point-to-Point 500 km



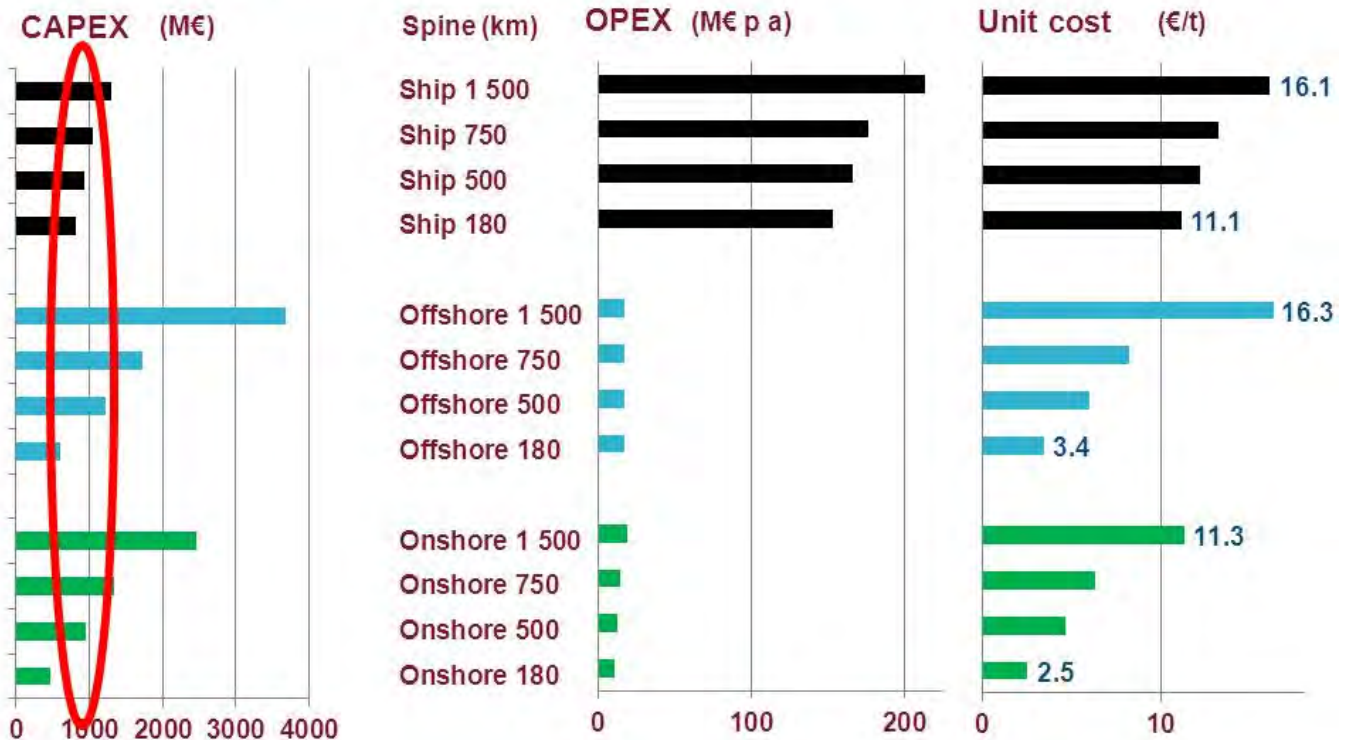


# Selected Networks: 20 Mtpa, 2 sources, 2 offshore storages



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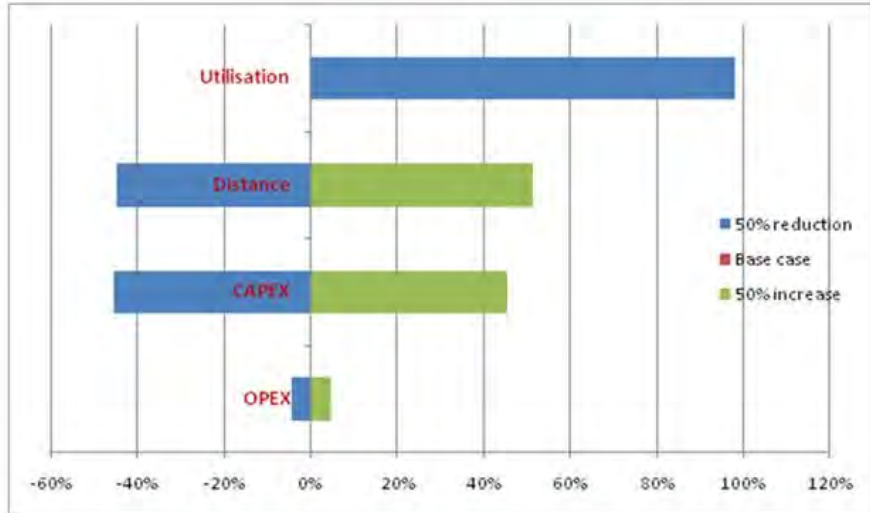
# Network costs: 20 Mtpa, 2 sources, 2 offshore storages



# CAPEX = RISK

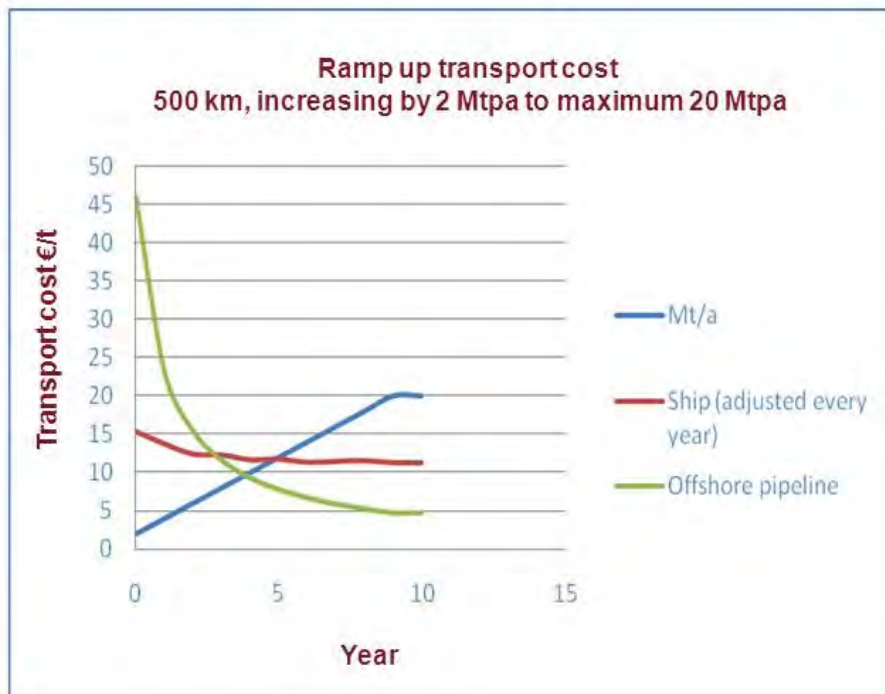
## Pipelines sensitive to load factor

Pipeline  
% changes in cost per ton



Sensitivities for offshore pipeline 10 Mtpa and 500 km

## Volume Ramp-up the most likely RISK scenario







## Some Baltic Sea Region Implications - Or just a vision?

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### CCS in the Baltic Sea Region is much about transport and storage

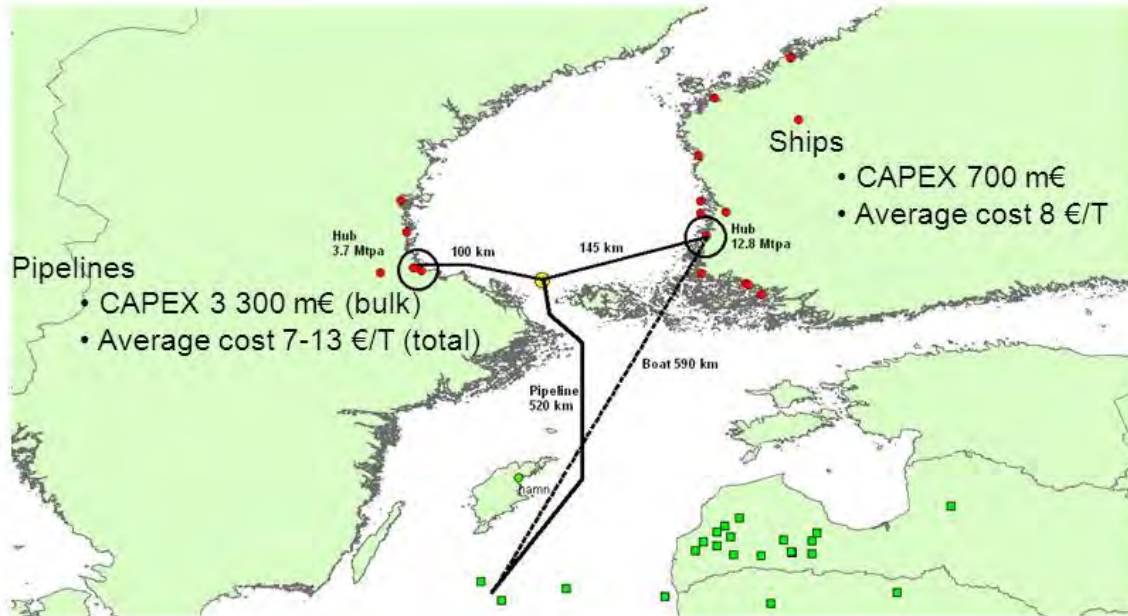
Excessive transport cost if there is no ground 🤔 for regional storage

Example:  
6% of Cementa's gross margin on cement from Gotland





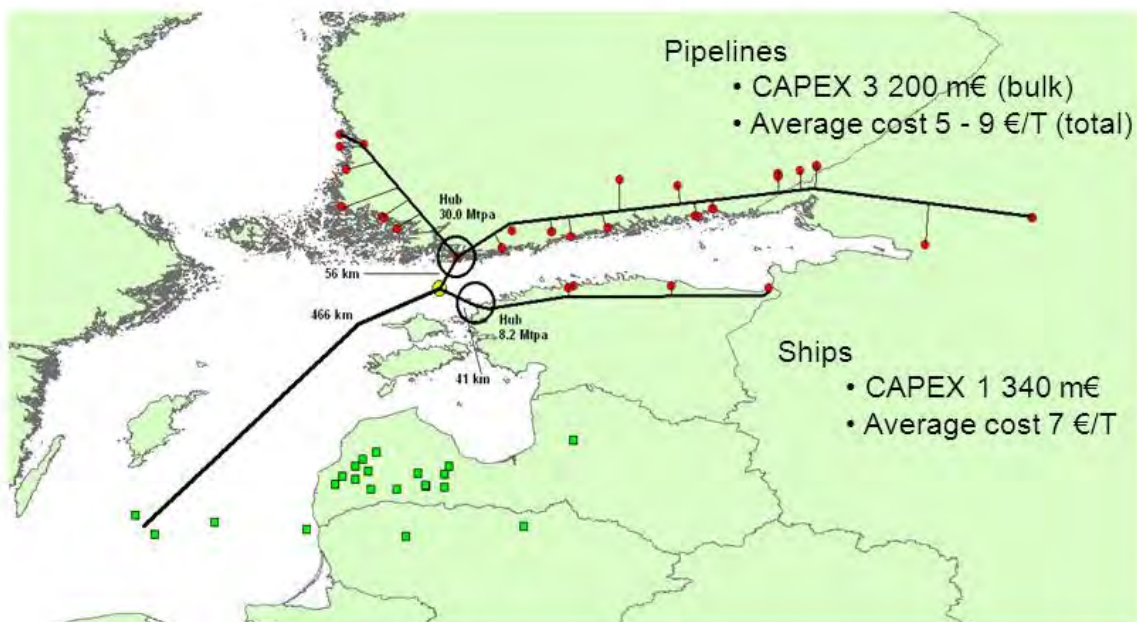
## Clusters Finland & Sweden 16,5 mTpa (example from CCS in Sweden, 2010)



Case: Jan Kjärstad, Chalmers, Swedish CCS Programme 2010  
Analysis: Chalmers, panaware ab

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## Clusters Finland & Estonia 38,2 mTpa



Case: Jan Kjärstad, Chalmers, Swedish CCS Programme 2010  
Analysis: Chalmers, panaware ab

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## Finally, your 3 take-aways...

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### Take-aways

**Early strategic planning of large-scale CO<sub>2</sub> transport infrastructure is vital to reduce costs**

**Cluster formations and combined ship and pipeline systems could provide considerable cost and risk relief**

**Cost efficient CCS infrastructure could become a key tool to secure the competitiveness of the region's base industry**