CCS POSSIBILITIES AT SC ACHEMA

EU policy regarding CO_2

- EU set Green Deal direction with an ambitious target to become carbon neutral by 2050
- As an intermediate step some proposals now are considered under Fit for 55 plan (still under Trialog) :
    1. Reduce CO_2 emission by a minimum of 55% until 2030
    2. RED II directive – 50% of the hydrogen used by industry must be green by 2030
- During yaer 2026 - 2032 all CO_2 free allowances will phase out as per CBAM regulation
- Current EUA price reaches 80-90 Eur/ton with future forecasts to reach 150 Eur/ton and more
- The philosophy of that is THE INDUSTRY OF EU WILL BECOME LEADER IN BRAKE THROUGH DECARBONISATION TECHNOLOGY

Challenges of CCS projects for SC Achema

- Sustainability of CCS technology in the European region
- Development of required capacities to reasonably support decarbonisation
- SC Achema has to go for big scale CCS project to achieve significant impact (i.e. 0,5-1 MTPY)
- Logistics of high quantities of CO2 is a challenge by itself.
- CO2 related investments decrease competitiveness in World Market
- Reasonable combination of CCS with other decarbonization possibilities
- Absence of sustainable technology for decarbonization of ammonia production process
- Possibility of political influence (MSR and other)

CO_2 emissions at SC Achema

- Working at full capacity SC Achema emits about 2 500 000 tons per year of CO_2
- For about 2 000 000 TPY ammonia production is responsible, 300 000 TPY – nitic acid production and 200 000 TPY cogeneration power plant
- About 120 000 TPY out of 2 500 000 is indirect CO_2 emission recalculated from N_2O emitted during nitric acid production
- About 1 180 000 TPY out of 2 500 000 is CO_2 emission from flue gas as a result of burning natural gas at ammonia, nitric acid and power plant facilities.
- Rest 1 200 000 TPY out of 2 500 000 CO_2 is pure CO_2 emitted from ammonia plants as a result of using natural gas as feedstock for hydrogen.
- Out of 1 200 000 TPY of pure CO_2 about 530 000 TPY is consumed for urea production and 50 000 TPY is sold as a CO_2 product (dry ice, liquified or compressed), the rest 620 000 TPY is vented.

CO_2 capture at SC Achema

- First possibility is to capture 620 000 TPY of pure CO_2 stream.
- We already have experience with operating two 100 TPD and 90 TPD CO_2 liquefaction units. No technological challenges
- First project could be 100 000 – 200 000 TPY CO_2 capture
- Capturing CO_2 from the flue gas stream is more complicated. Usually, amine absorption/desorption systems are used. Low pressure, high energy demand, large investments, as well as very low references, are the limiting factors.

CO_2 sequestration and storage

- Currently CO_2 storage in Lithuania is prohibited. Biggest potential to store CO_2 in Lithuania is by mineralization (bonding with rocks), but such process is not mature.
- SC Achema must find CO_2 storage partner to cooperate with. The nearest geographical possibility is at North sea fields. Possible partner Equinor – Northern Lights Project. Maybe in the future some locations in Baltic sea will be discovered.
- Logistic chain with storage tanks at Achema and at Klaipeda port, transportation fleet of trucks or trains must be organized.
- Final CCS price including capturing, liquefaction, transportation and storage should be less than ETS price for the project to be viable.
- Few kTons of CO2 were sold to “Minijos Nafta” for the EOR needs.

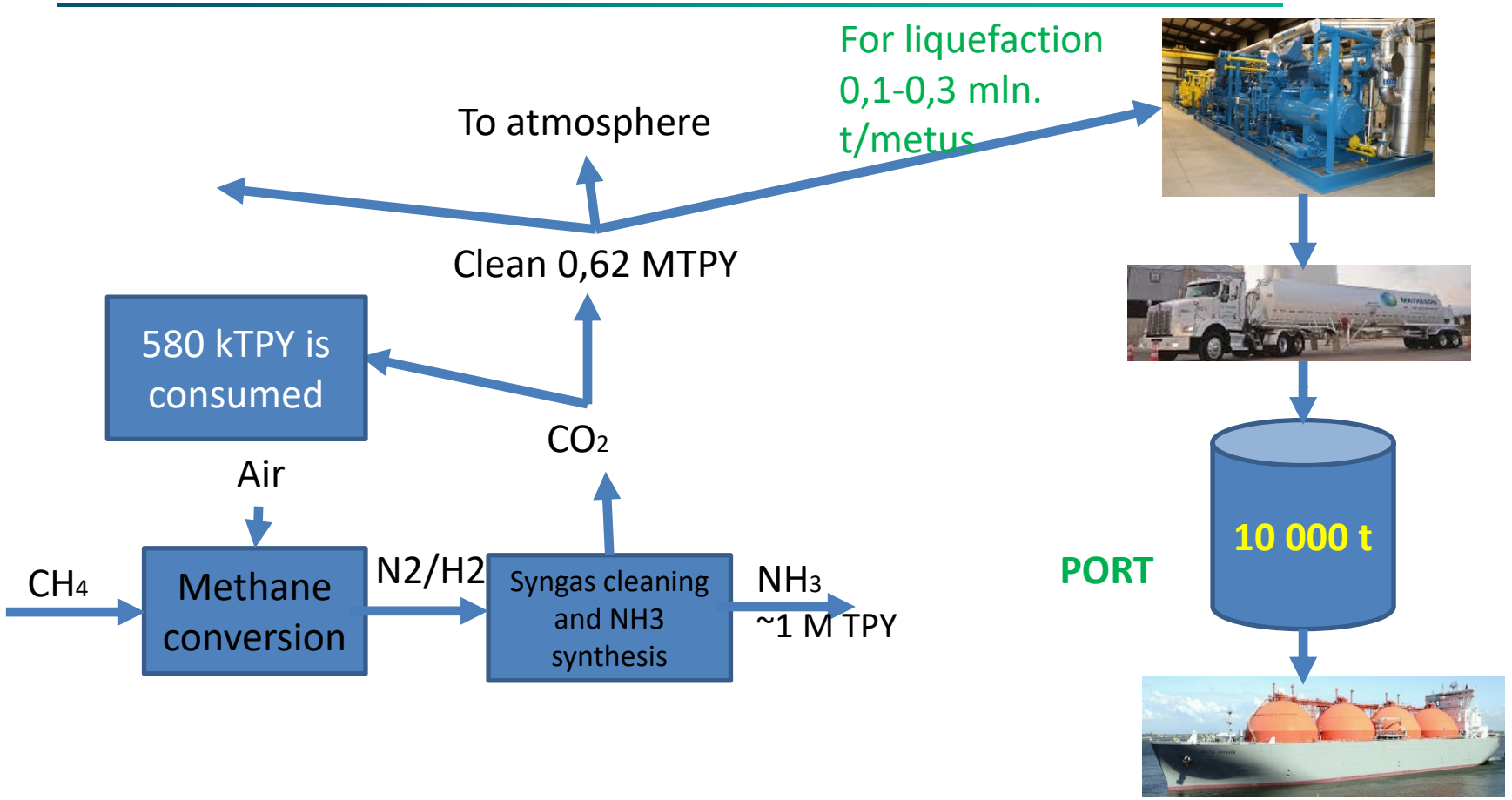
Geological potential

- In 2008 the potential of geological formations for CO_2 sequestration in Lithuania was made.
- No CO_2 storage potential as structural trapping in Lithuania. The structures known in Lithuania are too small.
- Great potential for solubility trapping of CO_2. Further considerations must be allowed to accept this technology as an alternative.
- Theoretical potential for mineral trapping. It is a much safer technology in comparison to other technologies but unacceptably expensive.
- A possibility of storage of CO_2 in Latvia should be discussed. Baltic See case would benefit the economy
- The main potential for Europe for CO_2 storage seems to be concentrated in North Sea area.

The Hydrogen Colour Spectrum

Colour	Fuel	Process	Products
Brown/Black	Coal	Steam reforming or gasification	$H_2 + CO_2$ (released)
White	N/A	Naturally occurring	H_2
Grey	Natural Gas	Steam reforming	$H_2 + CO_2$ (released)
Blue	Natural Gas	Steam reforming	$H_2 + CO_2$ (% captured and stored)
Turquoise	Natural Gas	Pyrolysis	$H_2 + C$ (solid)
Red	Nuclear Power	Catalytic splitting	$H_2 + O_2$
Purple/Pink	Nuclear Power	Electrolysis	$H_2 + O_2$
Yellow	Solar Power	Electrolysis	$H_2 + O_2$
Green	Renewable Electricity	Electrolysis	$H_2 + O_2$

Potential pilot project logistics scheme



European Funds and investments for pilot project

- Green hydrogen and renewable electricity are supported by most funds but not all of them support blue hydrogen and CCS.
- Only Innovation Fund fully supports CCS technologies development.
- Horizon Europe, CEF TEN-E, Modernisation Fund and Interreg Europe only partially support CCS. Note that no previous awards or funding an area compatible with Achema‘s interests.
- Liquefaction of 300 t/day CO_2, 100 000 TPY.
- Liquefaction unit price €15M.
- Liquid CO_2 10 000 t warehouse in port and infrastructure €20M.
- Total investments ~€35M.

CCS Economy

Carbon permits price	€70	€124	€70
	Without funding	Without funding	<43% CAPEX and OPEX funding
	Revenue/costs €/t CO_2	Revenue/costs €/t CO_2	Revenue/costs €/t CO_2
Savings on carbon permits	€ 70	€ 124	€70
Amortization (8y.)	-€ 44	-€ 44	-€ 25
Transport to port	-€ 50	-€ 50	-€ 29
Sequestration	-€ 20	-€ 20	-€ 11
Operating cost for liquefaction	-€ 10	-€ 10	-€ 5
Balance 1t CO_2	-€ 54	€ 0	€ 0

Commercial CCS facilities and projects

- There are a lot of small-scale CCS operational facilities around the globe. The oldest operates since 1972 in Terrell Natural Gas Processing Plant (USA). It captures 0,4 – 0,5 Mtpa.

- The biggest operational CCS facilities are in Brazil 4,6 Mtpa, Australia 3,4 – 4 Mtpa and US 1 – 3 Mtpa.

- In Europe the projects are still developing. Some of them are in construction already. For example, Norcem Brevik – Cement Plant in Norway should capture and store 0,4 Mtpa.

- Also, there are already developed CCS networks. Most of them are through pipelines. They are located in Norway, Scotland, England, Belgium, The Netherlands, Italy, Canada, UAE, USA, Australia, Canada, and China.

Take away points

- CCS is acceptable intermediate technology to decrease CO_2 emissions.
- SC Achema is ready to capture 100 000 – 300 000TPY, with the future increase to 600 000 TPY.
- SC Achema must find a CO_2 storage partner to cooperate with.
- Financial viability is a key decision-maker for the project.
- Support from the government is crutial.
- More funds should support blue hydrogen and CCS.
- Further CO_2 sequestration options must be investigated.