Notes from workshop on cross border CO_2-transport on June 16 2025 – notes are based on input from stakeholders

1. Regulatory barriers and uncertainties for cross-border transport

1.1 Ownership Models

The development of cross-border CO_2 transport infrastructure raises important questions about ownership structures and governance models.

Should infrastructure be owned and operated by public entities, private consortia, regulated monopolies, or public-private partnerships? How do ownership models affect access, pricing, liability, and long-term operational responsibility? And what is the optimal solution for a regulatory package addressing these issues?

A: What are the main challenges that need to be addressed?

Absence of regulations/definitions:

- Regulations need to be in place for different transport possibilities
- Missing definition of third-party access boundaries
- Capacity and sizing
- Determining the level of regulation at the outset-certainty
- Ownership of leakages across the value chain

Public vs private ownership

- Does public ownership better facilitate public acceptance?
- Risk profile between public and private ownership
- Conflict between market development and ownership (unbundling)

Other challenges:

- Access to financing
- Ownership of trunk line from Germany. Size and dimension.
- Unrealistic timelines for cross border Co2 pipeline transport

B: How can these be addressed optimally?

Private

- Be realistic about what private sector wants to invest
- Measures for competitive market planning
- Storage operators form consortia where each takes partly ownership of the trunk line. (Example from Norway: storage operators will take part ownership in the pipeline network)

Public

- Some degree of public investment required
- Bearing in mind that state-owned companies have different structures
- Speeding up regulation and approval processes (e.g. Germany)
- Appointed TSO, State-owned trunk line, capacity booking

Other:

- Look to e.g. hydrogen for lessons learned (no silos)
- Planning mechanisms to allow for oversizing
- More storage opportunities. More emitters need more storage locations to reduce risk.

C: What knowledge is lacking in order to find the optimal solution?

General

- Is there private sector alignment in infrastructure?
- Is there the possibility of "opting in" to a regulated or less regulated model?
- TSO to coordinate market consultations
- Overall numbers of storage locations impact how much infrastructure is required

EU-level

- Market study of CO_2 supply. How much Co2 will come from the various countries
- Funding plans and opportunities across member states.

<u>D: In the case that regulation on EU-level is relevant, how should it be addressed at this level</u>?

- Cross country coordination, like it has been done with hydrogen (ENNOH).
- Discussing supply and demand
- Ensure funding for CAPEX infrastructure
- No private investment until clarity on regulation
- Addressing trade-off between incentives/regulation
- Third party access provisions
- Standardization of tariff measures

Main takeaways

A. What are the main challenges that need to be addressed?
There is currently a lack of clear regulation and definitions regarding third-party access, capacity planning, and ownership boundaries, which creates uncertainty for stakeholders.

Questions remain about the balance between public and private ownership, including how each impacts public acceptance, risk management, and market development. Additionally, practical challenges such as access to financing, ownership and sizing of trunk infrastructure (especially cross-border from Germany), and unrealistic timelines for cross-border CO_2 transport must be addressed.

B. How can these be addressed optimally?
To attract private investment, it is important to align with what the private sector is realistically willing to invest in, and to enable competitive and coordinated market planning. A potential model could involve storage operators forming consortia to co-own trunk infrastructure, as seen in Norway.

On the public side, some level of state investment appears necessary, especially in early-stage infrastructure such as trunk lines. Speeding up regulatory approvals and appointing a national TSO could also provide clarity and reduce risk. Cross-sector planning, drawing lessons from hydrogen development, can support better infrastructure design (e.g. oversizing), and ensure that storage capacity keeps pace with demand from emitters.

C. What knowledge is lacking in order to find the optimal solution?

It remains unclear to what extent private actors are aligned on infrastructure models, or whether a flexible regulatory framework (e.g. optional levels of regulation) could be introduced. Coordination from a TSO in consulting the market could be needed to clarify future needs.

Additionally, better data is needed on how the number and distribution of storage sites will influence infrastructure design. At the EU level, a clearer picture is needed of the total expected CO_2 supply across member states, along with a consolidated view of funding opportunities.

D. In the case that regulation on EU-level is relevant, how should it be addressed at this level?
EU-level regulation should enable coordination across borders, potentially drawing on models like ENNOH from the hydrogen sector. Key elements include aligning supply and demand, ensuring CAPEX funding, and creating regulatory clarity before inviting private investment.

The framework should also strike a balance between regulation and incentives, define third-party access rules, and standardize tariff structures to facilitate a coherent market across member states.

1.2 Third Party Access

Ensuring fair and non-discriminatory access to CO_2 transport.

How could third-party access to CO_2 transport networks be regulated in a cross-border context? Are there lessons to be learned from the gas and electricity sectors? If so, how should exemptions, capacity allocation, tariff-setting, etc. be handled to balance investment incentives with market access?

A: What are the main challenges that need to be addressed?

Capacity

- Capacity of the pipeline infrastructure
- Varying capacity across borders
- Can third party capacity be forced?

Uncertainty

- Uncertainty of income
- Post-regulation/implementation takes time and creates uncertainty
- Prices can be squeezed up
- The CO_2 stream composition can be a challenge

Access

- Ensuring non-discrimination
- Secure clear definitions of TPA for the different parts of the value chain

B: How can these be addressed optimally?

Boundaries/reservation of capacity

- Setting boundaries on assets, setting limits and capacities
- Reservation of capacity - users book this
- Bundling of capacity across borders
- Determining capacity and availability

Coordination:

- State-owned and operated grid
- TSO or someone coordinates the access to the trunk line
- Standardization of approach

Other:

- Anchoring customers
- Creating measures for dealing with seasonal swings
- Mitigation (license) inspired by Oil &Gas

C: What knowledge is lacking in order to find the optimal solution?

- Is it likely that CO_2 specs can be standardized?
- How easy is it to enable an emitter to connect to an existing pipeline? Learnings from hydrogen?
- What is the capacity and availability on the market? Where is the storage capacity?

D: In the case that regulation on EU-level is relevant, how should it be addressed at this level?

- Discussing different modes of transport to enable flexibility
- Does there need to be an organization that has oversight for how the network operates? Eu-wide collaboration
- Take a full value chain approach to regulation

Main takeaways:

A. What are the main challenges that need to be addressed?
A challenge lies in ensuring sufficient and consistent capacity within the CO_2 pipeline infrastructure, particularly given the variation across national borders. There is also uncertainty regarding future income streams, regulatory implementation timelines, and potential fluctuations in CO_2 prices. Additionally, differences in CO_2 composition could pose technical complications.

Ensuring fair, non-discriminatory access to the network remains a central issue.

B. How can these be addressed optimally?
Capacity management can be improved through clear boundaries on asset use, reservation systems for pipeline capacity, and cross-border capacity bundling to streamline access.

Effective coordination is needed, for instance via a state-owned or state-operated grid with a designated TSO to manage access and standardize the approach. Additional strategies include securing long-term commitments from anchor customers, introducing mechanisms to manage seasonal demand fluctuations, and applying lessons from licensing practices in the oil and gas sector.

C. What knowledge is lacking in order to find the optimal solution?

It remains uncertain whether a standardized specification for CO_2 composition is feasible. Further insight is needed into how easily emitters can connect to existing pipelines—potentially drawing on hydrogen infrastructure experiences.

There is also a lack of clarity around current and future market capacity, particularly in relation to available storage.

D. In the case that regulation on EU-level is relevant, how should it be addressed at this level?
EU-level regulation should support flexibility by considering multiple transport modes and promoting cross-border collaboration.

There may be a need for a central coordinating body to oversee the functioning of the CO_2 network across the EU. Regulation should be designed with a full value chain perspective, integrating capture, transport, and storage considerations.

2. Addressing "practical" challenges for cross-border transport

2.1 Technical and Operational Standards

Standards for CO_2 purity, pressure, metering, compression, and material compatibility, taking price, security etc. into consideration

What are the hurdles from a technical and economic perspective today? Has the equilibrium between safety and economic optimum been found yet? Is there a place for regulation to kick start the market? To what extent should flexibility be allowed for sector-specific or national variations?

A: What are the main challenges that need to be addressed?

Uncertainty related to specifications/standards

- Regarding specifications we are still on a learning curve
- Issues related to agreeing on specifications between safety requirements and CAPEX.
- What is the acceptable risk?
- Specifications will come from DSOs/TSOs.
- Still lacking coordination between countries on specifications
- Differences between metering/measurement equipment

Requirements

- Some industry sectors may struggle to reach specific quality requirements
- Shall not be protective technical barriers

Related to the value chain

- Potentially a competition factor between storage locations /value chains.
- Where risk and cost are placed in the value chain
- Dealing with liability for off-shore CO2

Public perception

- Potentially risk with social acceptance with the level of impurities in the CO2 injected.

Other:

- For biogenic emissions: ETS applicable on the CO2 transportation.

- There are important distinctions between other industries and CO2, especially regarding cross border transport

B: How can these be addressed optimally?

EU-wide standards:

- EU regulations on min/max level for CO2 content and impurities
- Specifications from the Storage locationsvalue chains to be set individually within the EU regulated standards
- Standardization of meters
- Organizations per member state that can move quickly to resolve/share issues

Coordination and cooperation: public and private

- A state entity owning the pipeline.
- Clear roles for industry and government in setting standards
- Varying specifications throughout the day

C: What knowledge is lacking in order to find the optimal solution?

- Further lab results on NOX/SOX content
- Ongoing challenges in CO2/mitigation reaction
- Trunk line effects on the quality.
- Setting specifications

D: In the case that regulation on EU-level is relevant, how should it be addressed at this level?

- Harmonization of standards
- Guidance on damages for off-spec CO2
- EU regulations on min/max level for CO2 content and impurities

Main takeaways

A. What are the main challenges that need to be addressed?

There is uncertainty around technical specifications and standards, as stakeholders are still in a learning phase and struggling to align safety requirements with capital expenditures. Determining acceptable levels of risk remains unresolved, and the responsibility for setting specifications—primarily DSOs and TSOs—is not yet clearly coordinated across countries.

Variations in metering and measurement equipment further complicate this. Some industrial sectors may find it difficult to meet quality requirements, raising concerns about unintentional technical trade barriers. Across the value chain, there are challenges related to the distribution of risk and cost, potential competition between storage providers, and liability issues for offshore CO_2.

Public perception is also a factor, particularly regarding the level of impurities in injected CO_2.

Lastly, biogenic emissions and their interaction with ETS, as well as differences between CO_2 transport and other industrial sectors—especially for cross-border flows—present additional complications.

B. How can these be addressed optimally?

A harmonized EU regulatory framework defining minimum and maximum thresholds for CO_2 content and impurities is essential. Within these boundaries, individual storage sites and value chains should be able to set their own specifications to fit their needs. Standardizing metering equipment and establishing responsive national organizations to manage technical issues quickly would also improve consistency.

Stronger coordination between public and private actors is needed. Some point to the option of a state entity potentially owning pipeline infrastructure and a clear delineation of roles between industry and government when it comes to setting and enforcing standards. Flexibility may also be required to manage varying CO_2 specifications over the course of the day.

C. What knowledge is lacking in order to find the optimal solution?
More laboratory data is needed, particularly regarding the content and impact of NOx and SOx in CO_2 streams. Ongoing research is required to understand CO_2 behavior and mitigation reactions within transport systems. The impact of trunk lines on overall CO_2 quality is still unclear, as is how best to define and implement specifications in practice.

D. In the case that regulation on EU-level is relevant, how should it be addressed at this level?
EU-level action should focus on harmonizing technical standards, including setting clear limits for CO_2 content and impurities.

There should also be guidance on how to manage and assign liability for off-spec CO_2, ensuring clarity and consistency across borders to build trust in the system

2.2 Safety and Risk Management

Cross-border CO_2 transport raises important safety considerations, including leak prevention, emergency response, and health/environmental risk mitigation.

Should there be a common safety framework applicable to all transport modes, potentially through regulation or harmonized safety guidelines? How should liability, insurance, and operator responsibilities be addressed in a cross-border context?

A: What are the main challenges that need to be addressed?

General issues:

- Freezing & suffocation if pipelines rupture

Related to standards

- Specific on cross-border: if standards vary across countries, it could be too expensive to develop the pipelines
- More standards → lead to prolonged work processes

Lacking standards

- Safety distance standard for onshore pipeline transportation still not issued

Public Perception

- Main challenge is on public perception as the industry will follow common industry safety standard
- Risk perception depending on surroundings and locality

B: How can these be addressed optimally?

Average size fits none

- One approach could be to avoid over complicating and rather just piece together across countries rather spending time on standardizing

Inspiration from NL:

- General regulation of transport of hazardous substance. With CO2 low + high pressure in annexes.

Other:

- Proper risk hazard identification
- Safety level/site assessment

C: What knowledge is lacking in order to find the optimal solution?

Assessment of current safety standards- and regulations across EU countries. Evaluation of whether or not a potential gap between standards is actually a challenge, and if has to be bridged.

D: In the case that regulation on EU-level is relevant, how should it be addressed at this level?

- Focus on speed. If an early and overarching regulation can help accelerate local standards, then set EU standards. Otherwise develop locally.
- Ensuring that asset owner is responsible across EU countries.

Main takeaways

A. What are the main challenges that need to be addressed?
Key safety concerns include the risk of freezing and suffocation in the event of pipeline rupture. Cross-border differences in standards may lead to significant added costs and delays in pipeline development, as more standards can extend project timelines. A regulatory gap exists in the lack of a defined safety distance standard for onshore CO_2 pipeline transport.

Public perception remains a significant challenge—particularly because risk is perceived differently depending on local context and surroundings.

B. How can these be addressed optimally?
Rather than striving for a single uniform standard, it may be more efficient to adopt a pragmatic, modular approach—connecting systems across borders without overcomplicating the regulatory framework. Additional measures include comprehensive risk and hazard identification, along with tailored safety assessments for individual sites.

Inspiration can furthermore be drawn from the Netherlands, where general regulation on hazardous substance transport includes specific provisions for CO_2 under different pressure conditions.

C. What knowledge is lacking in order to find the optimal solution?
There is a need to assess and compare existing safety regulations across EU countries to determine whether discrepancies between national standards are truly problematic—and, if so, whether harmonization is necessary. A data-driven understanding of these gaps would inform whether EU-level intervention is warranted.

D. In the case that regulation on EU-level is relevant, how should it be addressed at this level?
Speed is essential: if EU-level regulation can help accelerate the development of local standards, it should be pursued early. Otherwise, allowing standards to develop locally may be more practical.

Regardless of the approach, regulations should ensure that the responsibility for asset safety lies clearly with the asset owner across all member states.