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BUILDING MOMENTUM
FOR THE LONG-TERM CCS DEPLOYMENT
IN THE CEE REGION

CCS Regional Cooperation Roadmap for Central and Eastern Europe

[Integrated Policy Roadmap]

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Aim of the roadmap: to prepare a first-of-its-kind Central and Eastern European (CEE) policy roadmap to support successful CCS deployment across the region. It should set a course for a broader political discussion and engagement of CEE national-level policy-makers into EU-level initiatives and platforms. It falls under a broader integrated policy roadmap, which consists of three separate reports focused on CCS deployment: (1) this roadmap for regional cooperation initiatives prepared by WiseEuropa; (2) the policy roadmap developed by the Institute for European Integration with the support from the EUROPEUM Institute for European Policy and (3) an analytical input on the links between the CEE policy roadmap and the European-level initiatives prepared by The Bellona Foundation.

Scope: Outlining prospective initiatives and areas for joint international efforts aimed at CCS deployment in the CEE region.

Target group: European and national policy-makers, public and private CCS stakeholders, research institutions and financial institutions, civil society.

Note: Due to the current situation, Ukraine is excluded from the scope of this roadmap. Our thoughts and prayers are with Ukraine.

[1] Executive summary

Executive summary

There are several key elements to enable successful CCS deployment in the CEE region. This policy roadmap outlines necessary actions to be implemented by 2050, with a particular focus to accelerate these actions in the current decade to deliver net-zero climate targets. The report summarises 14 short-term actions, prospective in terms of regional cooperation (i.e. they can be more efficiently carried on together than on one's own), that stakeholders deem critical, which will be disseminated and implemented within the next stage of our project (Work Package 5).

Throughout our works on this roadmap we found that the main barriers to to CCS deployment in the CEE region as a whole are enshrined in legal provisions, both national and international. We however found that that these obstacles might be overcome and we strongly recommend to the region to:

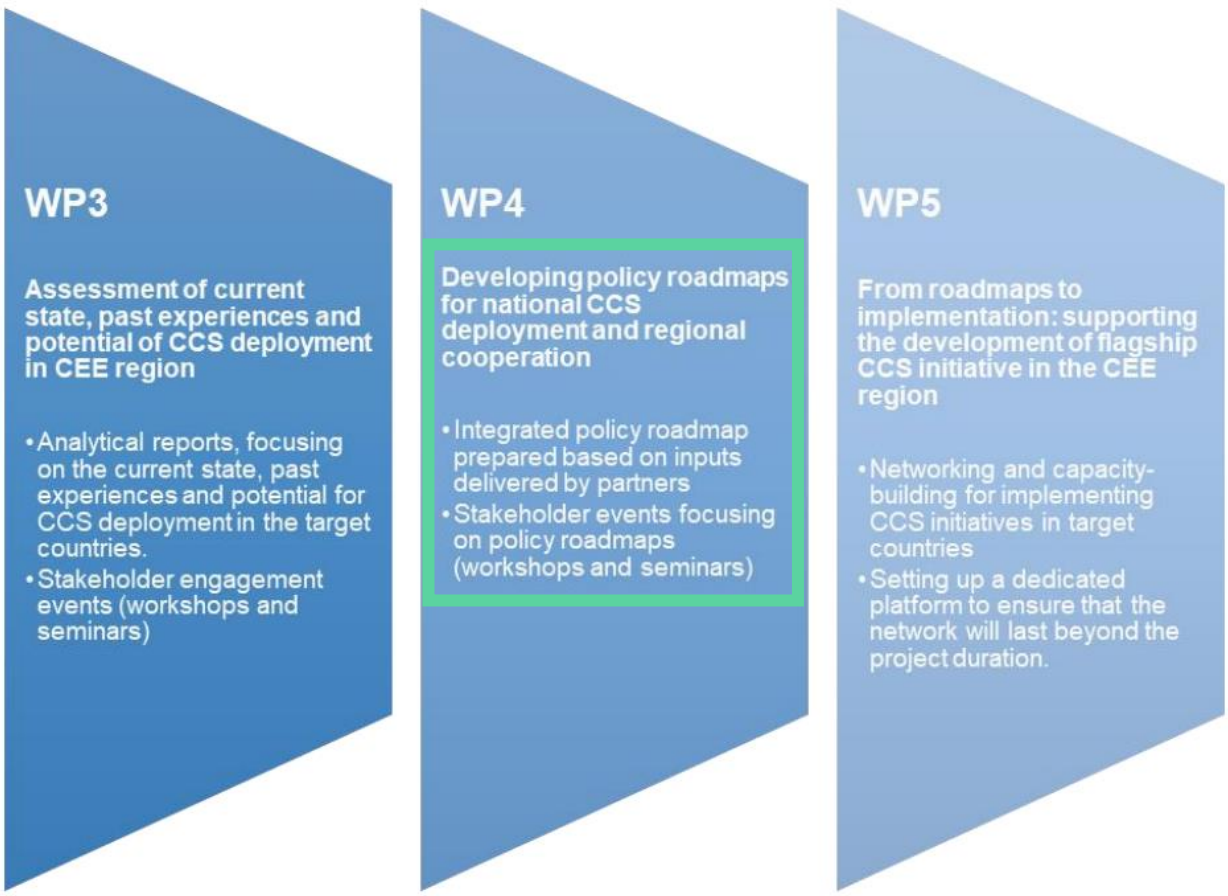
1) harmonize national legislations and allow for underground CO_2 storage,
2) enable and support cross-border infrastructural cooperation (e.g. with the use of European funding for PCIs and IPCEIs),
3) act for necessary amendments to international and EU legal provisions, which would play for the favour of CEE region. This can be achieved only if the countries from Central and Eastern Europe make use of their joint bargaining power. Because an effective implementation of CCS in our region can be successful only when acting together.

[2] CCS4CEE project overview

The "*Building momentum for the long-term CCS deployment in the CEE region*" project (CCS4CEE) aims to reinvigorate discussions and engage stakeholders on the potential of long-term deployment of CCS in the CEE region. Building evidence-based consensus among key stakeholders will pave the way to designing concrete policies, enabling regulatory frameworks and joint ventures. This requires a combination of analytical work with outreach, communication and capacity-building activities in the form of a series of national and regional publications and events advancing CCS deployment and international cooperation.

The project targets national and local policymakers, the private sector, research institutions and civil society and seeks their support for a socially acceptable mix of appropriate policies, enabling regulatory frameworks, financial instruments, RD&D and deployment activities. The project will ultimately benefit the CEE societies by supporting the implementation of CCS technologies and infrastructure necessary for a smooth transition to a low-carbon future.

Figure 1: Main work packages (WP) of the CCS4CEE project[1]



[1] https://ccs4cee.eu/wp-content/uploads/2021/11/PUBLICATION_CCS4CEE-Summary-report.pdf

The project is formed of three main work packages that run in sequence across a period of three years (2020-2023). Intended outcomes of the project include improved stakeholder communication at the national and regional level, concrete plans for national or regional pilot projects and input into policy-making to accelerate the deployment of CCS projects in CEE countries.

Work package 3 (WP3) assessed the current state of CCS in CEE countries through desk research and stakeholder engagement (interviews and workshops with relevant stakeholders). Each country partner produced a national report on the current state and the outlook for CCS, which were then synthesised into a summary report.

In Work Package 4 (WP4) each partner prepared a national policy roadmap which was subsequently discussed at national workshops with relevant stakeholders and its final version presented in national seminars. A workshop in Brussels in the fall of 2022 was targeted at an international audience and provided a project overview and presented all roadmaps. The workshop was partially designed as a matchmaking event to bring CEE stakeholders closer to other regional and European-level initiatives focused on CCS deployment.

See WP3 reports on the current state, past experience and potential for CCS deployment in the CEE region:

- All national reports included in the previous work package – WP3
- Focus on CCS development in the CEE region – Summary report – Energy Policy Group
- CCS technologies and the EU policy framework – Summary report – Bellona Europa
- Regional cooperation on CCS – Summary report – WiseEuropa

See WP4 national CCS roadmaps:

- Croatia
- Czechia
- Estonia
- Hungary
- Latvia
- Lithuania
- Poland
- Romania
- Slovakia
- Slovenia

The CCS4CEE project is led by WiseEuropa and supported by Bellona Foundation as an expert partner. The project is funded by the EEA and Norway Grants Fund for Regional Cooperation. Other partners include Energy Policy Group, Institute for European Integration and Civitta Latvija. The project is supported by the EUROPEUM Institute for European Policy.

[3] Role of CCS in decarbonisation pathways

CCS technological perspective

In 2019, the EU launched the European Green Deal to transform the EU into a modern, resource-efficient and competitive economy, cut greenhouse gas (GHG) emissions by at least 55% by 2030 and reach net-zero GHG emissions by 2050. Many 1.5°C compatible scenarios have assessed these targets and shown that a credible but narrow pathway exists and will require the use of all decarbonisation tools available. **Renewables and energy efficiency** are key components of that pathway, accounting for 80% of emissions reductions. But to reach net-zero emissions, renewables and energy efficiency **need to be supplemented by CO_2 capture and storage (CCS), utilisation (CCU) and carbon dioxide removal (CDR)** (particularly bioenergy with CCS/CCU also known as BECCS/BECCU) **technologies** (Figure 2), particularly in sectors such as cement, chemicals, iron and steel, waste incineration, and power and heat production. To address emissions from other sources as well as historic emissions, the role of direct air capture with storage (DACCS) or utilisation (DACCU) should be further explored. While these technologies are distinct in some ways, they use the same components of the value chain: CO_2 transport, storage and utilisation. Together they can mitigate **20% of global CO_2 emissions**, but to do so, **the scale of their deployment has to increase significantly** (Figure 3) from the current 0.04 gigatonnes (Gt) of CO_2 per year to approximately 8.5 Gt of CO_2 per year in 2050[2].

The **benefit of CDR processes is that they remove CO_2 from the atmosphere**, not simply reduce what was added and in combination with long-term storage can result in negative emissions. As such **they are a critical component of net-zero pathways** in the European Green Deal and most recently in line with the COP26 Glasgow Climate Pact. There are however preconditions to be assessed, such as biomass for BECCS needs to be sourced sustainably, while DACCS requires access to abundant and low-cost renewable energy.

The pace of progress in validating and deploying these technologies across sectors has been slow to date and in many cases with significant cost overruns. Currently, CCS, CCU and CDR plants **globally capture 40 megatonnes (Mt) of CO_2 per year**[3], with **many more being developed. An increasing number of pilot and demonstration projects** focus on safety issues, environmental impacts and costs, and generate lessons learned to be used to further improve these technologies and bring their costs down.

To remain on track to reach net-zero emissions by 2050, activities and changes to the current status quo have to be significantly accelerated already in the current decade. That requires **activities at the national and regional levels to enhance the collective understanding** of the issues surrounding CCS, CCU and CDR, **build confidence** and massively **scale up CCS deployment** to **reduce costs** of these technologies and related infrastructure.

[2] https://irena.org/-/media/Files/IRENA/Agency/Technical-Papers/IRENA_Capturing_Carbon_2021.pdf
[3] Ibid.

Figure 2: Carbon cycle with the use of CCS/CCU, BECCS/BECCU and DACCS/DACCU technologies[4]

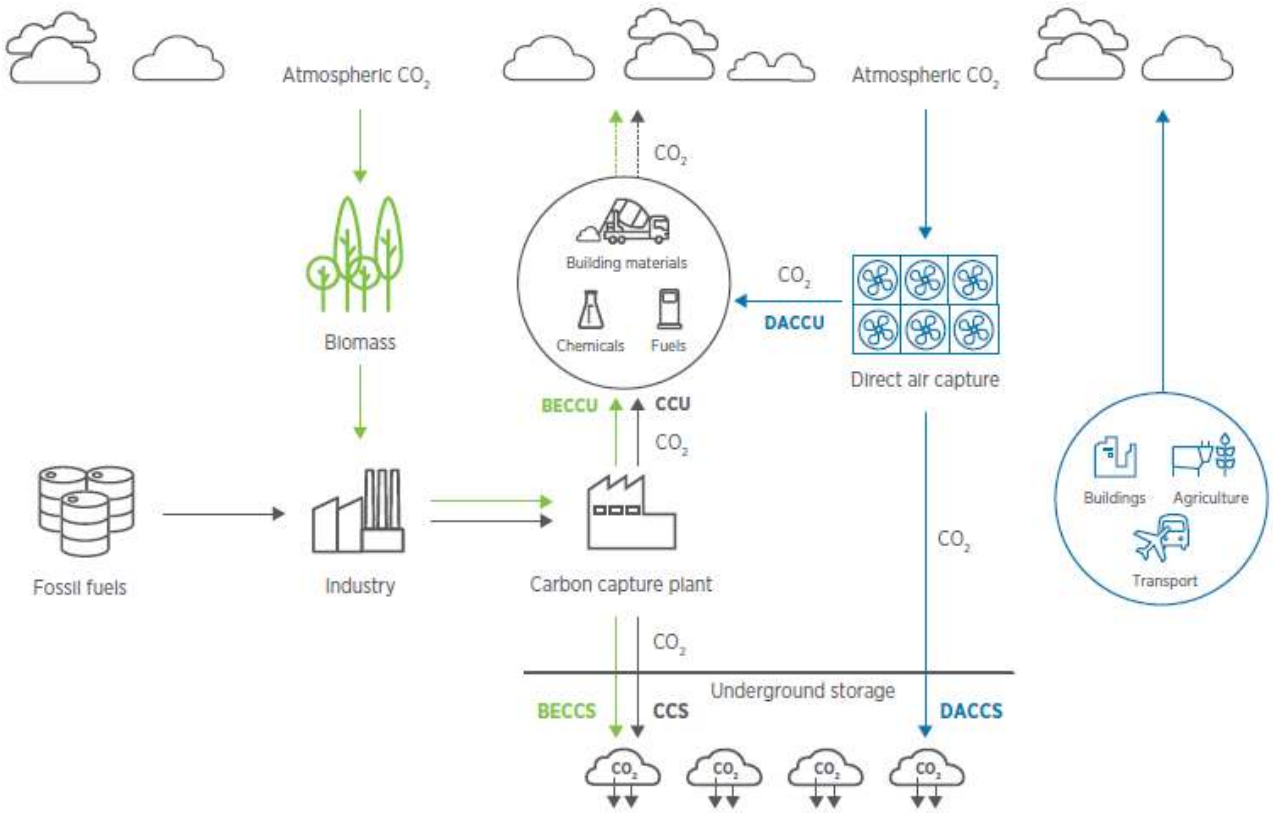
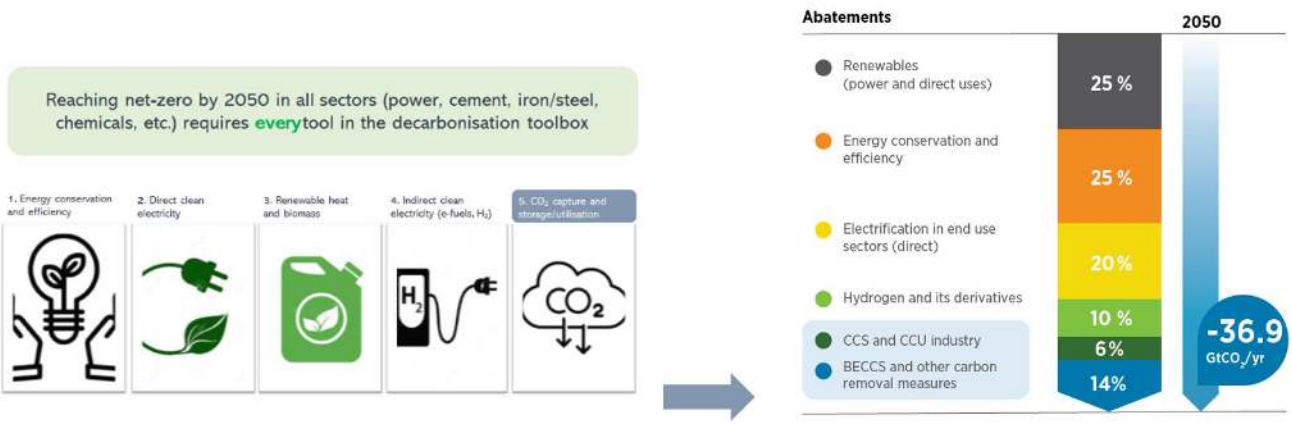


Figure 3: Carbon capture and storage as a part of the global decarbonisation toolbox[5]



[4] Ibid.
[5] Ibid.

CCS deployment at the European level[6]

The EU has put forward several mechanisms and instruments to enhance the understanding of various decarbonisation pathways consistent with the 1.5°C scenarios and trigger action. One of the mechanisms, the **European Strategic Energy Plan (EU SET-Plan)** aims to accelerate the development and deployment of low-carbon technologies. Its Implementation Working Group 9 (IWG9, or **CCUS SET-Plan**) specifically focuses on **strengthening international cooperation** and **speeding up the deployment** of CCS and CCU technologies. While all CEE countries are members of the EU SET-Plan, only Czechia and Hungary are members of the SET-Plan's Implementation Working Group 9 (IWG 9) working on on CCS and CCU.

IWG9 of the SET-Plan estimates that under the **1.5°C scenario**, **230-430 $MtCO_2$ per year would have to be captured and stored by 2030. This will increase to 930-1200 $MtCO_2$ per year in 2050**. BECCS itself would need to be scaled up **to capture and store approximately 30 $MtCO_2$ per year in 2030, increasing to 400 $MtCO_2$ per year in 2050**[7].

In November 2021, CCUS SET-Plan published the CCUS Roadmap to 2030[8], in which it advocates for the launch of the **EU strategy for CCS and CCU** as a pivotal component of net-zero GHG emissions goals. The Roadmap also proposes amendments to existing plans and regulations including **strengthening the role of CCS in National Energy and Climate Plans (NECPs), Trans-European Networks for Energy (TEN-E) Regulation, CDR accounting scheme and the CCU guidance**.

Furthermore, the **European Commission** initiated and launched the first high-level forum to engage and facilitate discussions on carbon capture, utilisation and storage in **2021** – **CCUS Forum** – which gathered relevant stakeholders, representatives of the EU institutions and EU countries who discussed **how to facilitate deployment of CCUS technologies.** In 2022, the Commission also began to prepare the first-ever official EU CCUS vision document to guide the industries and set the CCUS deployment pathway – **CCUS Vision – which should be published in 2023.**

Focusing on CCS deployment in the CEE region

The CCS4CEE project focuses on the CEE region with this **first-of-a-kind report that summarizes necessary policy actions to enable and accelerate CCS deployment in the CEE region.** Many of the proposed actions are also addressed by CCS reports published by international initiatives and platforms covering the CEE region.

The CCUS Roadmap to 2030[9] by **CCUS SET-Plan** sets a specific 2030 target for the region, which stresses a need for "*at least 10 additional EU Projects of Common Interest (PCI) for CO_2 transport infrastructure, with a focus on Central, Eastern, and Southern Europe.*"

[6] For further information, see the analytical input on the links between the CEE policy roadmap and the European-level initiatives prepared by The Bellona Foundation available at https://ccs4cee.eu/news-articles/.
[7] https://www.ccus-setplan.eu/wp-content/uploads/2021/03/CCUS-SET-Plan_Review-of-CCU-and-CCS-in-future-EU-decarbonisation-scenarios_09.2020.pdf.
[8] https://www.ccus-setplan.eu/wp-content/uploads/2021/11/CCUS-SET-Plan_CCUS-Roadmap-2030.pdf
[9] Ibid.

The **CO_2GeoNet** network comments in the recent report[10] that "*detailed and comprehensive national storage atlases and databases are available in Norway, the UK, Spain and the Nordic countries (Nordic CO_2 Storage Atlas), less detailed or partial assessments have been performed in many other countries, while in some countries, particularly in Eastern and South-Eastern Europe, only basic assessments have been carried out*."

The most recent report[11] by **Clean Air Task Force** (CATF) notes that „*to ensure Europe's emitting industries have equal access to the decarbonising potential of this infrastructure, it is vital to promote and facilitate the development of other suitable storage geology throughout the region, including onshore storage in Central and Eastern Europe*." CATF then recommends to "*identify promising, large-scale onshore or offshore storage regions in Southern, Central, and Eastern Europe and ensure they are developed to the point where they are 'injection ready*".

[10] Release of the CO2GeoNet report State-of-play on CO2 geological storage
[11] https://cdn.catf.us/wp-content/uploads/2022/05/10050419/CATF_CCSEuropeStrategy_Report_final.pdf

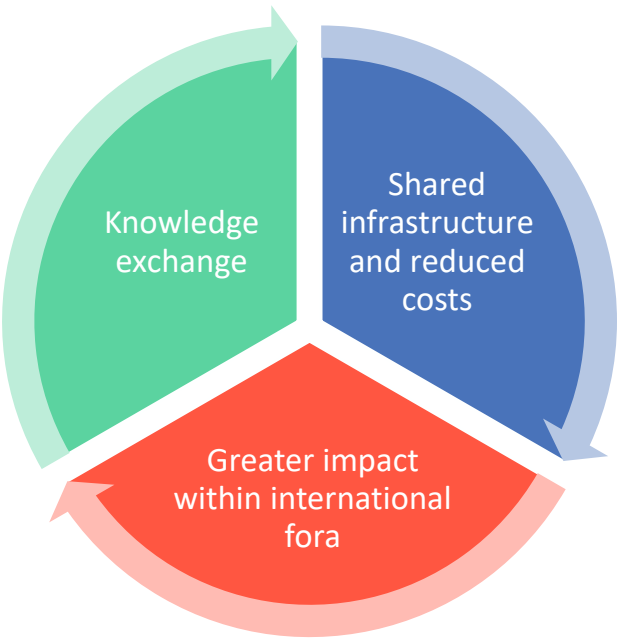
[4] Role of international cooperation on CCS deployment

The importance of international cooperation stems from the fact that it allows for developments that would be hardly achieved independently by particular states. This is particularly true in the case of CCS, a complex technology with a long value chain, which is still quite a novelty on a large, commercial scale, especially for CEE states.

CCS is a cross-cutting issue which requires dedicated regulations, technology, enough funding and advanced transport & storage infrastructure, the development of which does not only depend on the will of stakeholders, especially when it comes to CO_2 storage, as the CO_2 storage potential is a matter of favourable geological conditions.

Therefore, there are 3 principal benefits from international cooperation on CCS. These are **knowledge exchange**, **shared infrastructure** which leads to **reduced costs**, and **greater impact within international fora** (see: Figure 1).

Figure 4. Benefits from international cooperation



Knowledge sharing is essential since not all states are equally advanced in terms of CCS-related research and technologies. Hence, the CCS development could be facilitated by knowledge, technology and experience transfer. Briefly, regional cooperation allows to fill the gaps in knowledge met in one countries with input from partner countries.

Sharing storage sites is the solution for countries with limited underground CO_2 storage capacity. They could transport CO_2 captured within their territories to foreign storage sites, especially since this would mean reduced investment and operating costs. The costs and benefits of transport and storage facilities often go well beyond the interests and budgets of individual CCS projects developed separately in particular states. However, joint projects with shared storage sites and CO_2 transport networks across borders can improve the economics of transporting and storing CO_2 by reducing unit costs through economies of scale, as well as reducing commercial risk[12].

And when it comes to cooperation within international fora: it is crucial because agreeing common position on CCS-related issues translates into enhanced bargaining power, which may pave the way for pushing through necessary amendments to international legal provisions. This is important since there are some barriers to CCS deployment in the international law which need to be eliminated.

Therefore, as the International Energy Agency claims, *"[c]ontinuing to increase and expand international CCS co-operation across research, development and deployment will be important for accelerating the future pace of deployment*"[13].

International cooperation might however not give enough solutions for raising public acceptance for CCS. Although positive examples from other states can help convince people to CCS (but in CEE there is no such commercial, large-scale example to be showcased), dialogue with the public should be focused on and tailored to the needs of particular communities, as one of the stakeholders pointed out to us; international/regional campaign is not the way to win hearts and minds of local communities for CCS.

[12] http://basrec.net/wp-content/uploads/2013/11/INSA_report_BASREC_Final-1-12.3.2012.pdf.

[13] https://iea.blob.core.windows.net/assets/24c3d26b-aa44-4b54-b9c0-5201d4d86a04/20YearsofCarbonCapture-andStorage_WEB.pdf.

[5] Opportunities and barriers to regional cooperation on CCS deployment in CEE

LATEST DEVELOPMENTS REGARDING REGIONAL COOPERATION ON CCS IN CEE

Since the publication of the "*Regional cooperation for CCS/CCU deployment*", there have been several new developments regarding CCS technology in CEE:

- In April 2022, in Budapest (Hungary), four Central-European natural gas TSOs (**GAZ-SYSTEM** of Poland, **Transgaz** of Romania, **Eustream** of Slovakia, and **FGSZ** of Hungary) agreed on a strategic partnership to explore the possibilities of decarbonising their operation, transporting green gases and investigating the potentials in CO_2 transmission. The joint Memorandum of Understanding foresees sharing best practices in the field of CO_2 transportation, decarbonization of operation and drafting a relevant regulatory framework. According to the plans, the collaboration of the transmission system operators will also result in the preparation a feasibility study. To extend the scope of the cooperation, the initiative is open for other TSOs from the CEE region as well[14].

- In June 2022 the "Transnational scenarios report" developed within the STRATEGY CCUS project was released. One of the examined scenarios was the CO_2 pipeline route running from Poland, through Czechia, **Slovakia** and Hungary to Croatia[15].

- In October 13-14 2022, in Kaunas (Lithuania), the Baltic Carbon Forum 2022 was held[16], an annual conference aimed at identifying gaps for expediting the deployment of a large-scale CCS project in the Baltic Sea Region. Baltic Carbon Forum is hosted by BASRECCS.

CURRENT PROSPECTS FOR REGIONAL COOPERATION ON CCS IN CEE

As we already highlighted in the diagnostic report on regional cooperation[17], in order to facilitate the deployment of CCS technologies in CEE countries, several common challenges can be addressed thanks to the synergies driven by regional cooperation. CEE countries face similar economic and emissions-related challenges, as **insufficient public awareness of CCS technology, lack of CO_2 transport infrastructure, insufficient political will and lack of interest from the representatives of public administration**. Moreover, cross-border cooperation on CCS pilot projects, research initiatives and sectoral collaboration is, as for now (October 2022). very low. Nevertheless, the urgent need of establishing cross-national CCS infrastructure can

[14] https://www.gaz-system.pl/en/for-media/press-releases/2022/april/07-04-2022-transmission-system-operators-from-poland-romania-slovakia-and-hungary-cooperate-on-the-development-of-a-regional-hydrogen-grid.html.
[15] https://strategyccus.eu/sites/default/files/D5.4_Trans_final.pdf.
[16] https://baltic-carbon-forum.com/2022/.
[17] https://ccs4cee.eu/wp-content/uploads/2021/11/CCS4CEE-regional-analysis.pdf.

be identified throughout most CEE countries. In general it seems that lack of government and industry involvement is the main hurdle that may influence CEE regional cooperation[18].

OPPORTUNITIES

Potential for cooperation obviously emerges from high CO_2 emissions, especially from the so-called hard-to-abate industry sectors of cement, chemicals and iron and steel, and from high storage potential, but unevenly distributed between CEE states (see: Table 1). For some CEE states (e.g. Estonia) this translates into the necessity to transport CO_2 captured within their terriotry abroad for storage, which is obviously a prospective field of international/regionalcooperation.

Table 1: Overview of the CO_2 storage potential and current experience[19]

Country	Total $MtCO_2$ emissions 2019	$MtCO_2$ emissions from hard-to-abate industries 2019	Storage capacity in $MtCO_2$*
Croatia	17.9	3.5	3,361
Czechia	101.7	17.1	853
Estonia	12.4	0.6	0
Latvia	7.7	0.9	804
Lithuania	13.9	3.4	42
Hungary	48.2	7.1	847
Poland	318.5	38.5	15,500
Romania	77.0	16.7	22,600
Slovenia	14.0	1.5	94
Slovakia	33.8	11.6	1,850

* Conservative estimates of the CO_2 GeoCapacity project.

Another opportunity for regional cooperation is to build on already existing frameworks for regional cooperation, i.e. **Baltic Sea Region Energy Cooperation** (**BASREC**) and create new platforms and agreements. In Europe, including CEE, there are a large amount of transboundary arrangements for oil, gas and electricity transportation and transmission. The experience from these transboundary arrangements is valuable when establishing the regulatory framework for transboundary CO_2 transportation[20].

New collaboration platforms should be dedicated to sharing research experience and redearch facilities. As the reports show[21], CCS-related research experience is concentrated in Poland (described as one of the European research "hot spots"[22]). Poland appears to have had the most practical CCS and CCU projects of all

[18] CCS4CEE country report: Poland, Estonia, Slovakia, Ukraine, Hungary, Latvia, Lithuania, Romania
[19] Information collected during Work Package 4 and https://ccs4cee.eu/wp-content/uploads/2021/11/PUBLICATION_CCS4CEE-Summary-report.pdf.
[20] http://basrec.net/wp-content/uploads/2013/11/INSA_report_BASREC_Final-1-12.3.2012.pdf.
[21] http://www.co2geonet.com/media/73750/co2geonet_state-of-play-in-europe_2021.pdf.
[22] Ibidem.

partner countries and is the only partner country that reports to possess larger scale CCS research infrastructure. This experience, not to mention research facilities, could be widely shared across the region, which would facilitate RD&D in the field CCS in te region. Research infrastructure could be shared to other CEE countries through a dedicated body , perhaps modelled on **ECCSEL**[23]: within this infrastructure network five countries, France, Italy, the Netherlands, Norway and the UK, coordinate a large part of their CO_2 research infrastructure through the EU-funded ECCSEL network and the ECCSEL European Research Infrastructure Consortium (ERIC). ECCSEL offers open access to their CCUS research facilities.

Barriers

The most obvious barriers arise from international regulations, especially London Protocol and Helsinki Convention.

The "*Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*" (London Convention or LC) was one of the first global conventions to protect the marine environment from human activities and to prevent pollution of the sea by dumping of wastes and other matter. It has been in force since 1975. The London Protocol (LP) was agreed during 1996 prohibiting all dumping except for some acceptable wastes (specified in the so-called "reverse list") and **prohibiting CO_2 export for offshore storage**. The Protocol entered into force in 2006 and it supersedes the London Convention as between Contracting Parties to the London Protocol which are also Parties to the LC. An amendment to Article 6 of the London Protocol was adopted in 2009 allowing for the export of CO_2 streams for geological storage. For the amendment to come into force, a ratification by two thirds of the contracting parties is required. However, ratification, i.e. approval from all signatories, has not been achieved so the amendment still is not in force. To overcome this barrier to the implementation of CCS projects involving transboundary transport of CO_2, a provisional application of this amendment was accepted in October 2019, thus, cross-border CO_2 transport to offshore storage sites is now permissible based upon agreements or arrangements between the countries concerned. In more detail, this means that countries who wish to allow cross-border transport of CO2 for injection and permanent storage under the seabed must currently deposit a Unilateral Declaration of the Provisional Application of the 2009 Amendment to the London Protocol Article 6 to the Secretary-General of the International Maritime Organisation, i.e. both the importing and exporting country must deposit the declaration. This procedure is only possible for parties to the London Protocol[24]. Building on this momentum, the two countries (Norway and the Netherlands) signed a memorandum of understanding in November 2021 agreeing to finalise a bilateral agreement in 2022. Other two countries which recently entered such a partnership are Belgium and Denmark[25].

Likewise, for the protection of the marine environment in the Baltic Sea area, the "*Convention on the Protection of the Marine Environment of the Baltic Sea Area*" (Helsinki Convention) was signed in 1974 by all Baltic Sea coastal countries. It forms the foundation of the Baltic Marine Environment Protection Commission, an intergovernmental organisation also known as the Helsinki Commission (HELCOM). The Helsinki Convention "seeks to protect the Baltic Sea from all sources of pollution […], to preserve biological diversity and to promote the sustainable use of marine resources". With this line, it **prohibits the disposal of waste under the Baltic Sea**. As yet, no amendment has been made to the Helsinki Convention to explicitly exclude anthropogenic CO_2 from the list of wastes. In addition, established regional organisations such as HELCOM will play an

[23] https://www.eccsel.org/.
[24] http://www.co2geonet.com/media/73750/co2geonet_state-of-play-in-europe_2021.pdf.
[25] https://www.offshore-energy.biz/danish-belgian-ccs-agreement-paves-way-for-creating-actual-market-for-maritime-transport-of-co2/.

important role in regional marine spatial planning to potentially implement CO_2 storage while ensuring protection and sustainable use of the marine environment[26, 27].

Table 2 shows the current status of the above mentioned international treaties in the CEE region.

Table 2. CEE states and international treaties and regulations relevant for CO2 storage operations

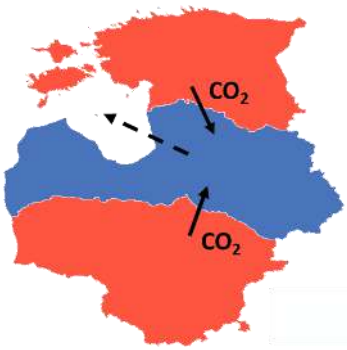
Country	Party to LC	Party to LP	Ratification of 2009 LP amendment	Party to Helsinki Convention
Croatia				
Czechia				
Estonia	Superseded by LP			
Latvia				
Lithuania				
Hungary				
Poland				
Romania				
Slovenia	Superseded by LP			
Slovakia				
Norway*	Superseded by LP			

*Norway is included as the most developed current CO_2 offshore storage site in Europe
green – Contracting Party, *red* – not a Contracting Party

Regulatory barriers are not only linked with international treaties. In the European Union, regulatory frameworks covering CO_2 transport have historically focused on access to pipelines and often overlook CO_2 transport by ship or other modes[28]. This approach gains in importance as the EU Emissions Trading System (EU ETS) allows the emitters to subtract the CO_2 emissions (and not to pay for them) that are captured and transported for storage via the "transport network". Up till now (October 2022), CO_2 transport network has been defined as transport by pipelines. Therefore, CO_2 quotas that are not emitted can be subtracted only when the CO_2 is transferred out of the installation to a pipeline with the purpose of long-term geological storage in a storage site[29]. Uncertainty in these regulatory frameworks can raise legal questions over whether or not CO_2 emissions from ship/road/rail transport can be accounted for under the ETS. As regards ETS compliance, it is unclear who should be held liable for the fugitive and operational CO_2 emissions associated with the transporting of CO_2 by ship, or how these emissions should be calculated or measured[30]. Therefore, stakeholders are not fully aware of the accounting method for CO_2 emission calculation, they do not know what avoided emissions can be deducted from their account, thus, paying the ETS price for the stored or utilised CO_2 as well. These regulatory issues translate into barriers in regional cooperation on CCS, which is demonstrated on the case study of the Baltic States (see: Box 1).

[26] http://www.co2geonet.com/media/73750/co2geonet_state-of-play-in-europe_2021.pdf.
[27] https://sci-hub.se/10.1007/978-3-319-75070-5_9.
[28] https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.
[29] https://www.preem.se/globalassets/om-preem/hallbarhet/preemccs---d4.2_legal-and-regulatory_final.pdf.
[30] https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.

Box 1. Barriers to cross-border CO_2 transport and storage – case study of the Baltic States



The geological formation within the Baltic States that is suitable for fossil CO_2 storage is the Baltic sedimentary basin. The basin in Estonia, however, is too shallow and contains potable groundwater; therefore, structures within it are not favourable for CO_2 storage (and this is why Estonia reports no geological CO_2 storage potential). Lithuania has several potential sites, but their capacity is negligible for making CO_2 storage economically justifiable[31]. The most suitable for CO_2 storage potential in the Eastern Baltic region (Estonia, Latvia and Lithuania) are 16 Cambrian onshore and 16 offshore deep anticline geological structures in Latvia[32] with still more to be possibly discovered and prospected[33]. Therefore, sharing storage sites is the only opportunity for a massive deployment of CCS in the Baltic States – Estonia and Lithuania could transport CO_2 captured within their territories to storage sites in Latvia.

However, **Latvia does not allow for underground CO_2 storage**. Moreover, the significant share of Latvian storage potential is located mostly offshore (if not the major share, it is to be evaluated yet), in the Baltic Sea, whereas **international conventions forbid to store CO_2 under the seabed**. For example, Estonia is a party to London Protocol, which does not allow for the export of CO_2 to other countries for dumping at sea, and Latvia is a party to Helsinki Convention which prohibits the disposal of waste (including CO2, although it is not explicitly stated in the Convention[34]) under the Baltic Sea.

To make matters worse, **the status of CO_2 shipment** (for example to offshore storage sites) **under the EU law is not clear**: the EU ETS allows subtracting the emissions that are captured and transported via pipeline for storage, but ship transport (to a storage site) is not mentioned[35].

Barriers to international cooperation on CCS in the CEE regions also stem from lack of deepened knowledge of CO_2 geological storage capacity which is not thoroughly prospected and explored in the CEE region. Detailed and comprehensive national storage atlases and databases are available in Norway, the UK, Spain and the Nordic countries (Nordic CO_2 Storage Atlas), less detailed or partial assessments have been performed in many other countries, while in some countries, particularly in Eastern and South-Eastern Europe, only basic assessments have been carried out[36].

[31] Potential of the Middle Cambrian Aquifer for Carbon Dioxide Storage in the Baltic States.
[32] Potential structures for CO_2 geological storage in the Baltic Sea: case study offshore Latvia.
[33] https://publications.vtt.fi/pdf/technology/2013/T101.pdf.
[34] http://www.co2geonet.com/media/73750/co2geonet_state-of-play-in-europe_2021.pdf.
[35] https://www.preem.se/globalassets/om-preem/hallbarhet/preemccs---d4.2_legal-and-regulatory_final.pdf; https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.
[36] http://www.co2geonet.com/media/73750/co2geonet_state-of-play-in-europe_2021.pdf.

[6] Policy roadmap for the scaled-up regional cooperation on CCS in CEE

This integrated policy roadmap is the final output of Work Package 4. It builds upon Work Package 3 and consultations with a diverse set of stakeholders. The roadmap defines policy actions along the innovation cycle, from research and development to the commercialisation of CCS technologies to reach climate targets set by the EU and national strategies. While it includes major steps and milestones needed to create an enabling environment to deploy CCS projects, it increasingly focuses on ways to develop transferable knowledge and skills by national stakeholders (government, research organisations, academia and the private sector) and set up channels to access knowledge and experience from international stakeholders. In addition, it underlines the importance of cross-border activities and the need for joint regional demonstration projects to increase stakeholders' prospects to access public and private funding.

Roadmap is structured as follows:

- **Scaling up RD&D activities and building national knowledge and experience**; this section is about how regional synergies in the field of RD&D can help bridge the valley of death and pave the way for CCS deployment in CEE.

- **Policy, standards and regulations**; this section is dedicated to policy and regulatory measures aimed at enabling the development of cross-border CCS infrastructure (especially CO_2 pipelines and storage sites).

- **Cross-border CCS infrastructure development**; this section outlines steps to develop cross-border infrastructure as soon as regulatory issues are resolved.

Technical note

Proposed actions, which have no prescribed order, were bundled under a common title. This is an integrated CEE roadmap for CCS deployment and does not describe national-level actions in detail, as well it is not addressed to particular national stakeholders. These are to be found in national roadmaps with each action including a description, relevant stakeholders and a proposed time frame.

SCALING UP RD&D AND PREPARATORY ACTIVITIES AND BUILDING REGIONAL KNOWLEDGE AND EXPERIENCE

- **Storage site exploration**

CO_2 storage atlas of Central and Eastern Europe

Full-chain CCS projects will not be underway in CEE until safe and prospected carbon storage sites become accessible to CO_2 emitters. Only if emitters are well informed about storing possibilities (e.g. about the distance to the most convenient storage sites), they might consider implementing CCS technologies and develop full business cases, as they need to know where to transport and store CO_2 at lowest costs. Given that not all CEE states offer satisfactory geological conditions, the emitters should not be confined to geographical borders. Hence, there is a need for a deepened knowledge on geological CO_2 storage capacity, both onshore and offshore, in all CEE region. Therefore, an **interactive map of CO_2 storage sites within the CEE region** could be developed as a separate, regionwide research project. It might be a result of close cooperation of national geological research institutes from the CEE region. To that end, however, **prospecting and exploration of CO_2 storage sites should be allowed** in all CEE states[37].

- **Financing research**

Joint applications for RD&D funding

Research and innovation in CEE in the field of CCS might be particularly driven by EU funding. For this reason it is recommended to research institutes from the CEE region to **jointly apply for EU funds dedicated to research**, such as Horizon Europe, within regional consortia.

- **Knowledge exchange**

Establish regional knowledge exchange platform

The regional researdh efforts related to CCS could be coordinated by a regional knowledge exchange platform, comprising research institutes from CEE. The platform would serve to:

[37] This is not the case of Poland where exploration and prospecting of CO_2 sotrage sites is allowed only for CCS demonstration projects.

- **disseminating results of the scientific projects** (e.g. sharing information on national CO_2 storage capacity estimates and results of other CCS-related research, sharing and consulting observations from national CCS projects);
- **sharing research facilities** with states which lack in advanced, large-scale CCS research infrastructure;
- **establishing new research partnerships** and consortia thanks to linking major stakeholders within the CEE region
- establishing international collaboration between CEE region and countries experienced in CCS deployment such as Norway.

Although the platform is to be dedicated to RD&D, business should be invited in order to facilitate knowledge transfer from research institutes/academia, which would possibly translate into the implementation of research outcomes and, as a result, lead to the bridging the valley of death.

POLICY, STANDARDS AND REGULATIONS

- **Policies**

Agree on the role of CCS in national climate and energy strategies

In general, national climate strategies (e.g. NECPs and LTSs) of CEE states hardly address the issue of CCS, whereas they should be clear and coherent when it comes to the role of CCS and allow for making use of regional synergies in that field. The upcoming update of these documents (NECP by 30 June 2023) and the fact that Poland and Romania (potential CO_2 storage hubs) have not submitted their LTSs yet creates an opportunity to **develop common CCS strategy for the CEE region**.

- **International law**

Ensure compliance of CO_2 export and offshore storage with international law

CEE countries should overcome the barriers to CO_2 export and offshore storage laid out in the international treaties (London Protocol and Helsinki Convention).

When it comes to the issue of the LP, International Energy Agency advises[38]:

- For **Non-contracting Parties** (non-CP) **to LP exporting CO_2 to the Contracting Party** (CP) **to LP** (e.g. Poland, as a Party to LC but non to LP, exporting CO_2 to Norway): CP must establish an agreement or arrangement with the non-CP and notify this to the International Maritime Organization (IMO). CP must ensure that the CO2 received is "overwhelmingly" comprised of CO2 and that the exporting country demonstrates appropriate consideration of incidental associated substances in the CO2 stream, with treatment if needed.
- For **Contracting Parties to LP exporting CO_2 to another Contracting Party to LP** (e.g. Estonia exporting CO_2 to Norway): CPs must deposit a declaration of provisional application of the 2009 amendment with the IMO. CPs must establish an agreement or arrangement that includes "confirmation and allocation of permitting responsibilities, consistent with the provisions of the protocol and other applicable international law". This includes reference to the CO2 specific guidelines' conditions related to the composition of CO2 streams and CO2 storage permitting. These agreements or arrangements must be notified to the IMO.

38 https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.

These two options have been put under consideration as all potential European partners to CEE in the field of offshore storage (Norway, the Netherlands) are already parties to LP.

When it comes HELCOM, since the problem arises from the definition of waste, the IEA recommend to "*review definitions of hazardous waste, pollutants and commodities to ensure the classification of CO_2 under existing frameworks does not act as a barrier to CO2 transport or storage*"[39].

Undertake common, regional motions to amend EU law acts

Amendments of non-discrimnatory character in terms of CO_2 shipment by modes other than pipelines are needed to the CCS Directive, the EU ETS Directive and Monitoring and Reporting Regulations. This can be achieved in the EU forum, for example by **joining the Information Exchange Group (IEG) under the CCS Directive**. Another solution would be to follow the example of Norway and **sent a request for a legal interpratation to the European Commission**[40].

- **International agreements**

Intergovernmental/regional agreements on CO_2 transportation across borders

European Commission upholds that CCS and EU ETS Directives, which bind all the Member States, can act as a relevant "arrangement" or "agreement" between the Parties in the meaning of amended Article 6 of the London Protocol. Similarly, the EEA treaty and the incorporation of the two directives concerned in the EEA legal regime provides the necessary arrangement with EEA partners. Member States that are Parties to the London Protocol could therefore conclude additional bilateral arrangements with other EU Member States and EEA partner countries (e.g. Norway) only on issues that are not covered by the directives[41]. These additional bilateral arrangements should be strictly limited to the residual issues not covered by EU law and they should not refer to the subject matters covered by EU rules[42]. However, the agreement between CEE states collaborating within CCS projects is not only recommended under London Protocol – it might be also needed to resolve uncertainties

[39] https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.
[40] https://www.preem.se/globalassets/om-preem/hallbarhet/preemccs---d4.2_legal-and-regulatory_final.pdf.
[41] For example, see the Memorandum of Understanding signed between Denmark and Belgium on cross border transportation of CO_2 for the purpose of permanent geological storage: https://en.kefm.dk/Media/638000596525014193/Bilateral%20arrangement%20DK-BE.pdf.
[42] https://climate.ec.europa.eu/document/download/dfbbc90c-071e-4088-ada2-7af467084b30_en?filename=EU-London_Protocol_Analysis_paper_final0930.pdf

arising from unclear regulation of cross-border transport and storage of CO_2 and to clarify jurisdictional responsibilities between the actual nations as regards the major elements of CCS Directive.

CEE states intending to develop cross-border infrastructural CCS project shall therefore agree on[43]: sharing storage capacity, monitoring methods and obligations related to shared storage sites, decommissioning of shared storage sites, liability for CO_2 leakage (fugitive emissions from transboundary transport networks, e.g. pipelines, and shared storage sites) and remediation measures, handover of stewardship of hydrocarbon sites for CO_2 storage, clarifying emissions accounting rules for integrated CCS networks spanning multiple countries (with diverse sources, sinks and transport solutions), the permitting, construction, operation and risk management

For sinks that span national borders, **agreements on the management of potential impacts from a project developed in one country on a second country are necessary** (e.g. leakage on the other side of the border). This may include impacts on storage capacity in hydrocarbon and geothermal reservoirs (caused by underground migration of CO2 and propagation of pressure[44]). Therefore, mechanisms for the early identification and resolution of subsurface CO2 migration or pressure propagation across borders should be put in place. The issue of **CO_2 transit** should be also regulated.

In order to avoid concluding many separate agreements, it is recommended for CEE countries to set common regulatory framework for transboundary projects through a **regional, international agreement** adopted by all CEE states.

- **National legislations**

Harmonize national legislations and standards

Although some issues might have been solved by the provision of CCS Directive or may be solved in international agreements, the national regulations themselves, pertaining to transport and storage of CO_2, should be also harmonized or even made uniform in order to allow for transborder projects.

Firstly, **onshore CO_2 storage should be allowed across all the region**, especially in prospective storage hubs (e.g. Latvia) in order to realise full CCS potential in CEE.

National regulations should be also harmonized with regard to more technical issues, i.e.: **common technical standards for the CCS infrastructure** (they could be

[43] Sources: http://basrec.net/wp-content/uploads/2013/11/INSA_report_BASREC_Final-1-12.3.2012.pdf; https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.

[44] https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.

based on ISO standards), **allowed properties of CO_2 stream** (as to provide the same CO_2 stream quality and protect the regional CO_2 pipeline network from damages caused by impurities), **technical requirements for receiving, transporting and storing the CO_2** and the **technical conditions which must be satisfied by an installation before connecting to the CO_2 transport network system**.

CROSS-BORDER CCS INFRASTRUCTURE DEVELOPMENT

- **Transport network**

Develop long-term regional CO_2 pipeline infrastructure plans

Development of a cost efficient transportation system requires detailed knowledge of possible storage sites, their capacity and costs of injection, possible routing between capture and storage sites, details about routing geography, ground, geology, costs, obstacles and regulatory restrictions. Therefore, CEE countries **should develop national CO_2 transportation companies and make them cooperate with each other** (the agreement of Central-European natural gas TSOs on CO_2 transportation is a good prelude to that, see: Latest developments regarding regional cooperation on CCS in CEE). Their core competence will be **planning and development of optimal transportation systems**[45].

Integration of the existing infrastructure

There already exists developed natural gas infrastructure (pipelines) in the CEE region, including facilities dedicated to natural gas import and export – interconnectors. These structures could be **repurposed for CO_2 transport in the longer term**, which should be however conducted while maintaining consistency with development of the hydrogen market and Power to Gas storage technology.

- **Multinational companies**

Establish multinational companies

Private companies might not be able to invest in full-chain, commercial CCS projects on their own. Moreover, the costs and benefits of CO_2 networks often go well beyond the interests and budgets of individual CCS projects. Therefore, **CEE states may agree to establish various degrees of multinational companies and consortia**. Current natural gas transportation companies will, due to their expertise, experience and ownership of right of way for natural gas infrastructure, be obvious potential stakeholders in such companies. Infrastructure companies able to execute long term system planning, like in the natural gas and electricity business, should be developed. Governments may need to play a role in fostering such companies by taking ownership and **subsidise in an early phase**. In the longer term governments may

[45] http://basrec.net/wp-content/uploads/2013/11/INSA_report_BASREC_Final-1-12.3.2012.pdf.

substitute ownership with transmission company regulations. Operational guideline for such a company could be to maximise societal benefits from pipeline transportation[46].

- **International cooperation**

Joint infrastructural projects

Economics of scale may imply marginal costs of cross-border infrastructural projects to be lower than average costs and could justify governmental support, in particular in the early phase when regulatory risks are high and network externalities can be particularly relevant. Moreover, **cooperation through clustering of CO_2 emitters and CO_2 storage sites and using common infrastructure** could decrease these costs and will make easier communication with governments and local population, creating new working places[47]. Recent examples of such clusters, financed by the EU, include Aramis, Porthos and TransPorts, realised by consortia comprising entities from Belgium, France and the Netherlands, both CO_2 emitters and transport and storage service providers.

Apply jointly for EU funding

Finance may be an obstacle to deploying cross-border infrastructural projects, but the consortia of project developers from different CEE states should **apply jointly for EU Funding** within different funding frameworks: **INTERREG**, **Projects of Common Interest**, **Important Projects of Common Interest** (especially applicable in the case of CO_2 transport) and the **Innovation Fund**.

- **Public acceptance**

Mitigate the risk of social resistance to cross-border projects

Local governments should be engaged in regional cooperation on planning cross-border CO_2 transport and storage infrastructure.

[46] Cf. Ibidem.

[47] Cf. https://bcforum.net/presentations2020/02.01%20-%20Alla%20Shogenova,%20Carbon%20Neutral%20Baltic%20States%20-%20Do%20We%20Have%20CCUS%20Among%20Accepted%20Options.pdf.

[7] Next and immediate steps

The list below represents a complete list of 14 actions we propose and further elaborate in Chapter [6] *Policy roadmap for the scaled-up regional cooperation on CCS in CEE.*

Scaling up RD&D activities and building regional knowledge and experience

- CO_2 storage atlas of Central and Eastern Europe
- Joint applications for RD&D funding
- Establish regional knowledge exchange platform

Policy, standards and regulations

- Agree on the role of CCS in national climate and energy strategies
- Ensure compliance of CO_2 export and offshore storage with international law
- Proposing motions to amend EU law acts
- Intergovernmental/regional agreements on CO_2 transportation across borders
- Harmonize national legislations and standards

Cross-border CCS infrastructure development

- Develop long-term regional CO_2 pipeline infrastructure plans
- Integration of the existing infrastructure
- Establish multinational companies
- Joint infrastructural projects
- Apply jointly for EU funding
- Mitigate the risk of social resistance to cross-border projects

From now we will proceed with the Work Package which will focus on the implementation of recommended actions. This final project phase aims to turn recommended actions into reality and ensure that project results are taken up by all key stakeholders. Prescribed initiatives include:

1) Official involvement of project partners in the law-making process
2) Consultations/bilateral meetings with representatives of ministries
3) Engagement of project partners or project stakeholders in facilitating national, regional and transnational initiatives to support the CO2 capture
4) Letters of intent from representatives of different target groups, expressing the intent or need of developing future transnational/national pilot projects focusing on CO2 capture

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