



Poland's potential to deploy CDR at scale and speed

Background report

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A collaboration between

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gap

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About the Carbon Removal Readiness Assessments

Many governments have committed to net-zero; moreover, the IPCC forecasts the need for hundreds of billions of tonnes of carbon dioxide removal (CDR) to stabilise global temperatures well below 2°C. Yet, few, if any, countries currently have a robust plan to develop and deploy atmospheric CDR at the capacity required to counteract remaining emissions at the point of net-zero. Forecasted CDR needs are typically global in scope and do not inform CDR planning and policy design at the country level.

The Carbon Removal Readiness Assessments (CRRA) aim to fill this information gap and to support national policymakers in complementing their climate strategies with ambitious yet realistic CDR goals. The CRRA estimates the extent to which CDR countries can realistically deploy CDR using a bottom-up approach and provides country-specific roadmaps, developed in consultation with local stakeholders, to assist decision-makers in understanding the opportunities and the actions needed to realise them.

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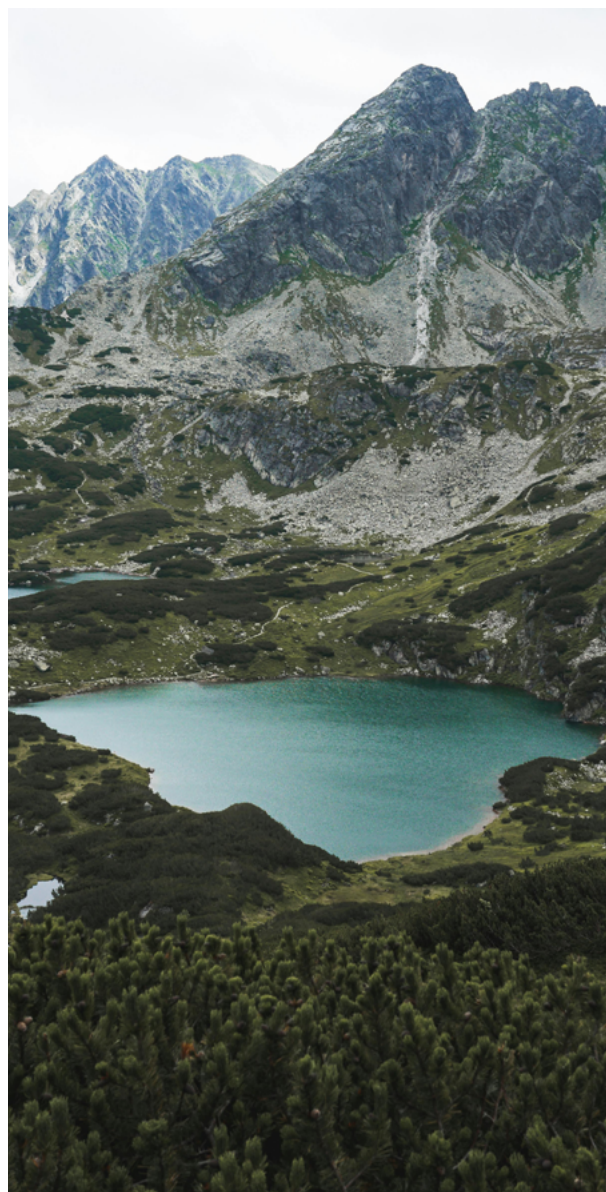
Disclaimer

This document presents a quantified estimate of Poland's potential for the deployment of CDR methods. As most of the methods assessed in this report are still in the early stages of development, the assessment includes significant uncertainties: some methods may not prove viable, while others that are excluded in this report may develop quicker than expected.

For some of the physical resources included in the assessment, which were the basis for evaluating the carbon removal potential, there was no precise

or reliable data available regarding the quantity of the resources or their expected development in the future. In these cases, available data was used to evaluate the historical development of the resource, and based on this, either current quantities or predicted future quantities were estimated. For some carbon removal methods, there was not information or reliable estimates about their historical or current utilisation, and thus the potential assessment for those relied to a larger extent on expert opinion.

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Executive summary

As an EU Member State, Poland is legally bound by the European Climate Law, which sets the Union-wide objective of achieving climate neutrality by 2050¹. However, Poland has not yet fully embedded this target in national legislation, nor has it adopted a dedicated climate law or a comprehensive long-term strategy setting out how it intends to achieve climate neutrality domestically. This reflects ongoing political and economic debate around the pace and distributional impacts of the transition, particularly considering Poland's continued reliance on coal and broader concerns relating to energy security, industrial competitiveness, and the socioeconomic implications of decarbonisation². Achieving climate neutrality will require not only substantial emissions reductions across all sectors of the economy, but also a significant scale-up of carbon dioxide removal (CDR) to address residual emissions from hard-to-abate sectors and, over the longer term, to contribute to net-negative emissions capable of counterbalancing historical emissions and potential temperature overshoot.

Poland was chosen for the Carbon Removal Readiness Assessment because it combines high untapped CDR potential with limited current engagement. As a large country with significant natural and industrial resources, it has a strong capacity for deployment, yet little policy, discussion, or strategic momentum exists for CDR. This gap creates an opportunity to assess its potential and drive greater awareness, investment, and policy action.

This report provides initial quantified insights into Poland's potential to deploy CDR based on a bottom-up analysis of Poland's available resources and estimating both (a) theoretical and (b) realistic potentials for implementing various CDR methods through 2030 and 2050. Recognising that CDR deployment is not solely a technical challenge, the report also analyses the 'social geography' of the issue, capturing perspectives through stakeholder interviews and a citizen panel.

The assessment follows six key steps:

1. Identification and selection of relevant CDR methods;
2. Mapping of available resources for CDR, including renewable electricity, waste heat, biomass, land, water, and geological storage capacity, among others;
3. Estimation of the maximum theoretical CDR potential;
4. Evaluation of Poland's regulatory, economic, and political landscape
5. Analysis of societal attitudes toward CDR deployment in Poland, based on stakeholder interviews and a citizen panel;
6. Estimation of practical CDR potential for 2030 and 2050 based on two scenarios.

Main results on Poland's CDR potentials

The report reviews a range of CDR methods – grouped into ecosystem management, biomass conversion, geochemical, and synthetic approaches.

As a first step, it estimates the **theoretical CDR potential**, which excludes socio-political and economic constraints, and results in a total potential of approximately **362 Mt of CO₂ emissions removed** per year in Poland by 2050. This figure represents a maximal benchmark, achievable only under highly unrealistic mobilisation conditions. The estimate is largely driven by agroforestry, electrochemical DACCS, and BECCS with anaerobic digestion. It assumes that all available resources (after priority uses) are fully dedicated to CDR - an assumption that does not hold under real-world conditions.

Next, **two realistic scenarios** that account for socio-political constraints were developed for both 2030 and 2050:

- **Scenario A: a low ambition** CDR scenario, which depicts a situation close to the status quo, in which only limited efforts are made to deploy CDR, and the resources are assumed to be primarily used for other purposes. The scenario is based on Poland's National Climate and Energy Plan's WEM (With Existing Measures) scenario for assumptions on the availability of electricity for CDR; and
- **Scenario B: a high ambition** CDR scenario, which assumes significant efforts to deploy CDR, allocating more resources to the various CDR methods. The scenario is based on Poland's National Climate and Energy Plan's WAM scenario for assumptions on the availability of electricity for CDR.

The results of these scenarios are shown in Figure 1, along with Poland's **estimated residual emissions**, which according to the different studies are expected to be in range of **30-50 Mt of CO₂ in 2050**³⁴. Compared with the theoretical scenario, these realistic scenarios account for socioeconomic constraints and employ conservative assumptions about available resources that could be used for CDR, thereby making them implementable with high confidence without deviating significantly from current conditions.

In Scenario A the annual CDR potential for Poland is **~7 MtCO₂ in 2030 and ~16 MtCO₂ in 2050**. Adding the capacity of the projected natural sink, Poland could remove ~47 MtCO₂ in 2030 and ~56 MtCO₂ in 2050. **In Scenario B** the CDR potential is **~15 MtCO₂ in 2030 and ~45 MtCO₂ in 2050**. If the natural carbon sink projections are considered, the CDR potential is ~55 MtCO₂ in 2030 and ~85 MtCO₂ in 2050. The biggest differences between the two scenarios stem from the availability of geological CO₂ storage capacity, and also the deployment of forest management, afforestation and peatland restoration.

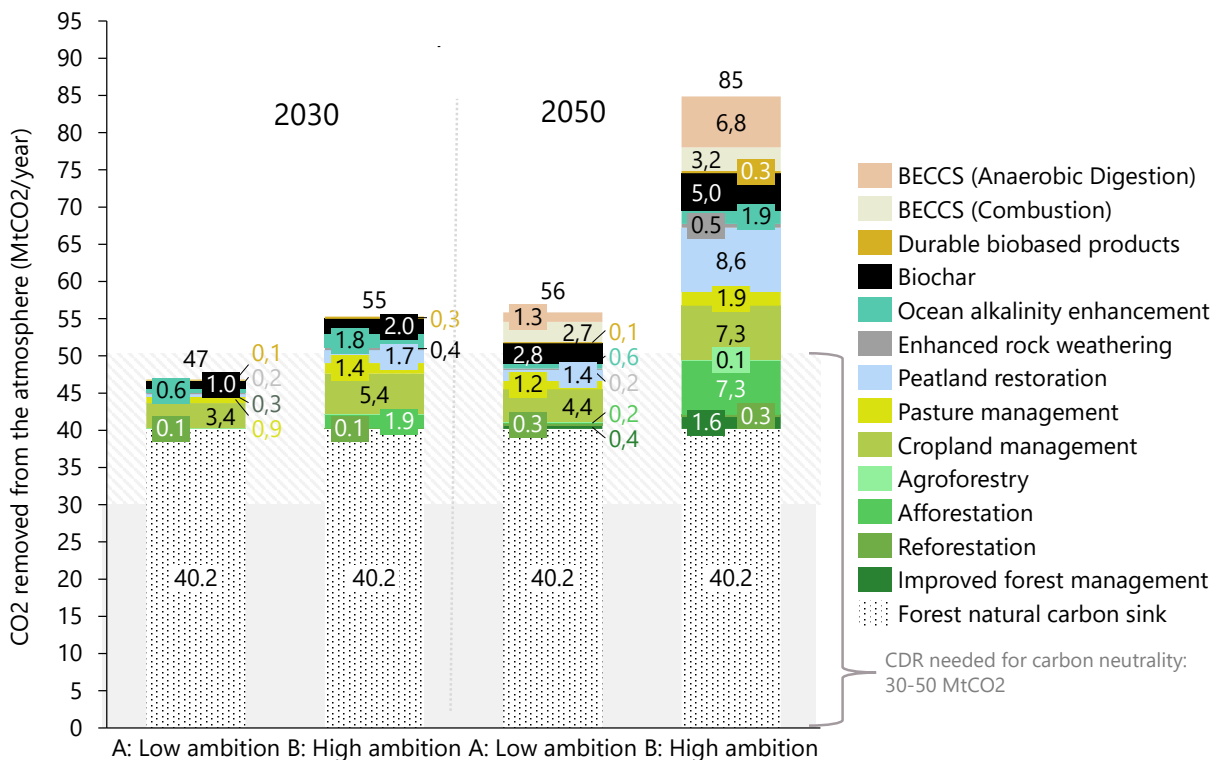


Figure 1. Poland's CDR potential in the Low ambition and High ambition scenarios in 2030 and 2050. Each CDR method deployed in the scenarios is described in Chapter 2.

Forest management, reforestation, afforestation and peatland restoration

The natural carbon sink in forests constitutes a major share of carbon sequestration potential in both scenarios, with 40 Mt CO₂ assumed in both 2030 and 2050⁵. Since there are no scenarios available of natural carbon sinks with different harvesting level and the potential of forest management calculated separately, the natural carbon sinks in forests have been assumed to be the same in both scenarios and over time. With **improved forest management**, the carbon removal potential of forests could contribute **~0.4-1.6 MtCO₂** in 2050. **Reforestation and afforestation** potential ranges between **~0.5 and 7.6 MtCO₂** in 2050, depending on the scenario. The high variation is due for example to the fact that in Scenario A the afforestation potential was based on historical data, whereas in Scenario B the potential was based on conscious efforts to meet the national target to increase forest coverage. **Peatland restoration** becomes increasingly significant by 2050 when it could result in **~1.4-8.6 MtCO₂** removed. In Scenario A, this potential reflects current and projected rates of rewetting, while Scenario B assumes restoration efforts aligned with EU peatland restoration targets. Current geopolitical conditions and public sentiment also appear to be increasingly supportive of peatland restoration initiatives.

Cropland, pasture management, and agroforestry

Cropland and pasture management are amongst the most prominent CDR methods across both scenarios, contributing between **~5.6 and 9.2 MtCO₂** in 2050. This is assuming that a larger share of arable land and grassland is deployed for soil carbon sequestration. **Agroforestry** holds far less potential, with modest growth expected by 2050 (0.1-0.2 MtCO₂).

Biochar and bio-based products

Biochar shows considerable potential reaching an estimated **2.8-5 MtCO₂ by 2050**. This is partly driven by the availability of suitable biomass feedstocks, which are assumed to be directed to biochar instead of BECCS due to limited geological storage capacity. **Durable bio-based products** provide a smaller but relatively stable removal potential of around 0.1-0.3 MtCO₂ across both scenarios. This reflects the assumption that harvesting levels remain broadly constant through to 2050, given the absence of long-term projections, and that the share of biomass allocated to CDR applications does not significantly change over time.

BECCS

In both scenarios, BECCS shows potential due to the availability of biomass resources. In practice, however, deployment is constrained by the availability of geological CO₂ storage capacity, which is assumed to be prioritised for CCS applications. Scenario B assumes a larger expansion of geological storage capacity than Scenario A, resulting in greater long-term BECCS potential. **In both scenarios, no BECCS deployment is assumed by 2030** due to the limited availability of CO₂ storage infrastructure and capacity.

In Scenario A, **BECCS with combustion** reaches an estimated removal potential of approximately **2.7 MtCO₂/year** by 2050, while **BECCS with anaerobic digestion** contributes around **1.3 MtCO₂/year** by 2050. In Scenario B, where geological storage capacity expands more substantially, the estimated potential increases to approximately **3.2 MtCO₂/year** for BECCS with combustion and **6.8 MtCO₂/year** for BECCS with anaerobic digestion by 2050.

In the allocation of limited storage capacity, **in the short-term, BECCS with combustion is prioritised**, as anaerobic digestion relies on more dispersed feedstocks and smaller-scale facilities, making early deployment more complex and less economically efficient. However, **over the longer term, BECCS with anaerobic digestion demonstrates greater expansion** potential because it can utilise currently underused agricultural residues. By contrast, BECCS with combustion depends largely on woody biomass, whose availability is constrained by competing uses and by the need to avoid increased harvesting that could weaken natural forest carbon sinks.

Although Scenario B assumes greater CO₂ storage availability than Scenario A, this capacity is still fully allocated to BECCS rather than DACCS, which is not deployed in either scenario. This reflects cost optimisation rather than inherent energy efficiency: BECCS can generate both removals and revenue-generating energy, improving its economics (subject to feedstock, process, and carbon accounting). By contrast, DACCS delivers only removals, requires substantial low-carbon energy, and depends solely on removal credits for revenue.

Geochemical methods

The most significant geochemical CDR method included in both scenarios is mineral **ocean alkalinity enhancement**, with limestone and dolomite utilised to their full assumed potential. Mineral OAE capacity in 2030 ranges between ~0.61 and 1.8 MtCO₂ in 2030, increasing to **~0.64-1.9 MtCO₂** in 2050. **Enhanced rock weathering** was also assessed, although with a comparatively smaller contribution. In all scenarios, the available basalt resource is assumed to be fully utilised for ERW, resulting in an estimated removal potential of around ~0.2-0.4 MtCO₂ in 2030 and **~0.2-0.5 MtCO₂** in 2050.

Scenario A versus Scenario B

Scenario A represents a pathway broadly aligned with current trends and relatively modest efforts to scale CDR. For several methods (e.g. afforestation) the projected potential largely reflects current deployment rates and existing policy trajectories. However, the scenario also includes emerging approaches, such as ocean alkalinity enhancement, which have so far seen little or no deployment in Poland. Realising this potential would therefore still require targeted policy support, investment and technological development. A substantial share of the total CDR potential in Scenario A is derived from natural forest carbon sinks, although uncertainties remain due to the limited availability of robust scenarios assessing the long-term impacts of current harvesting levels.

Scenario B reflects a more ambitious pathway in which CDR deployment is actively pursued across multiple sectors, including land use and large-scale technological removals. Achieving this scenario would require significantly accelerated deployment of measures such as peatland restoration and rewetting, alongside the development of technical CDR solutions. Beyond forest carbon sinks, a large share of the projected potential in Scenario B depends on the availability and development of domestic geological CO₂ storage capacity. Given that several CDR approaches remain at an early stage of deployment globally and in Poland, achieving the higher-end potential, especially in the near term, would likely require a substantially faster pace of policy development, infrastructure build-out and investment than is currently observed.



Key takeaways

- **Poland has substantial domestic resources that could support the deployment of a variety of CDR methods**, giving it comparatively strong CDR potential within Europe. Extensive forest cover, agricultural land and peatlands create favourable conditions for nature-based CDR approaches, while abundant biomass resources could support pathways such as BECCS and biochar. Poland also has access to mineral feedstocks suitable for geochemical CDR methods.
 - **Poland has significant geological CO₂ storage potential**, although this capacity remains largely underdeveloped and is currently prioritised for emissions reduction activities rather than CDR. If fully developed, Poland's geological storage resources could play an important role not only domestically but also in supporting wider European carbon management needs, particularly after 2050.
 - **Between now and 2050, most (>80%) of the CDR potential comes from enhancing ecosystems** (forests, agricultural lands, peatlands...). These methods are more mature and leverage Poland's natural assets, but face higher risks of reversal, that were hard to estimate with precision.
 - **The long game for Poland is to develop its geologic storage and scale permanent CDR.** This requires authorities to engage already today the planning and measures needed to double down on grid decarbonization and build the CO₂ transport and storage infrastructure.
 - **Poland currently lacks national CDR targets** and has yet to establish a comprehensive climate neutrality framework aligned with the EU Climate Law. The absence of a long-term climate strategy that integrates both emissions reductions and carbon removals and that links climate neutrality objectives, CCUS, industrial policy and carbon removals represents a major barrier to progress, particularly for hard-to-abate industrial sectors that will require access to credible carbon management solutions.
 - **Poland is nevertheless seeing growing momentum in the CCUS space**, including government investments, industrial initiatives, research programmes and emerging business clusters. Combined with its substantial geological storage potential, this creates an opportunity for Poland to become an important regional actor in carbon management.
 - **Public awareness of CDR in Poland remains limited, although support for carbon removal solutions can be strengthened** through public engagement and education. Findings from the citizen panel and stakeholder interviews indicate growing interest in CDR technologies and increasing openness to discussion. Nature-based approaches — particularly afforestation, peatland restoration and carbon farming — received the strongest public support. Technologies such as BECCS and biochar also generated interest, although participants raised concerns regarding costs, effectiveness and environmental impacts.
 - **Deploying CDR at scale in Poland will require overcoming two fundamental economic barriers: investment bankability and revenue certainty for negative emissions.** Many CDR projects involve high upfront capital costs and long payback periods, which are unlikely to attract private investment without predictable revenue streams. The future viability of CDR in Poland will therefore depend on the development of credible support mechanisms, such as integration within the EU ETS, Carbon Contracts for Difference (CCfDs), or dedicated public procurement schemes for carbon removals. Poland is an important piece of the carbon management puzzle in Europe. This assessment reveals a significant CDR potential validating the prospect of net zero, but also potential to grow beyond that and become a carbon management hub supporting neighbouring countries in realising their own CDR potential, notably through developing a strong carbon transport and storage infrastructure.
- Yet the deployment of the identified potential remains highly contingent on the country catching up on climate policies to create a framework and provide the visibility needed to put investors and project developers in motion.
- Overall, CDR is gradually becoming part of the Polish climate policy discussion and has the potential to become an important component of the country's long-term decarbonisation strategy. However, effective deployment will require stable regulation, stronger institutional coordination, increased public awareness, improved use of domestic resources, and, particularly for technological pathways, the development of enabling CO₂ transport and storage infrastructure.

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List of abbreviations

BAU	Business as usual	mcm	Million cubic meters
bcm	Billion cubic meters	mm	Milli-meter
BECCS	Bioenergy with carbon capture and storage	Mm3	Million cubic metres
CAPEX	Capital expenses	MMdt	Million dry tons
CCS	Carbon capture and storage	MRV	Monitoring, reporting, and verification
CCUS	Carbon capture, utilization and storage	Mt	Million tonnes
CDR	Carbon dioxide removal	MtCO₂	million tonnes of carbon dioxide
CL	Carbon Limits	Mtpa	Million tonnes per annum
CO₂	Carbon dioxide	MW	Megawatts
CO₂e	Carbon dioxide equivalents	NATO	North Atlantic Treaty Organization
COP	Conference of the Parties	NDC	Nationally determined contribution
CRCF	Carbon Removal Certification Framework	NECP	National Energy and Climate Plan
DAC	Direct air capture	NTC	Net Transfer Capacity
DACCS	Direct air carbon capture and storage	OAE	Ocean alkalinity enhancement
DOCCS	Direct ocean carbon capture and storage	OECD	Organisation for Economic Co-operation and Development
EEA	European Environmental Agency	OPEX	Operational expenses
EEZ	European Economic Zone	pH	Potential of Hydrogen
EIB	European Investment Bank	PLN	Polish złoty
ESAB	European Scientific Advisory Board on Climate Change	QGIS	Quantum Geographic Information System
ESR	Effort Sharing Regulation	R&D&I / RDI	Research, development and innovation
ETS	Emission Trading System	S-DAC	Solid sorbent direct air capture
EU	European Union	STEM	Science, technology, engineering, and mathematics
GDP	Gross domestic product	t	Tonnes (metric)
GHG	Greenhouse gases	tha	Thousand hectares
GUS	Main statistic office (Główny Urząd Statystyczny)	TRL	Technology readiness level
Gt	Giga-tonne	TSO	Transmission system operator
GW	Gigawatts	TWh	Terawatt-hour
HWP	Harvested wood product	UNFCCC	United Nations Framework Convention on Climate Change
IEA	International Energy Agency	USD	United States Dollar (\$)
IMF	International Monetary Fund	VCM	Voluntary carbon market
IPCC	Intergovernmental Panel on Climate Change	WAM	With Additional Measures
LCA	Life cycle assessment	WEM	With Existing Measures
LULUCF	Land use, land use change, and forestry		

1. Introduction

Climate change is one of the most significant challenges of the 21st century, endangering ecosystems, human health, economies, and global security. In response, the 2015 Paris Agreement committed signatories to

Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.⁶

Meeting these targets requires not only rapid and deep emissions reductions across all sectors, but also the removal of carbon dioxide (CO₂) from the atmosphere to offset residual emissions⁷. With a 70% likelihood that the 1.5°C threshold will be temporarily exceeded between 2025 and 2029⁸, CDR is increasingly viewed as a critical tool—not just for balancing emissions, but for actively reversing temperature overshoot. Its role will be essential throughout the remainder of this century to help bring global temperatures back within safe limits.

CDR refers to anthropogenic processes used to remove CO₂ from the atmosphere and store it to prevent further warming. CDR is not an alternative to emissions reductions, but it is a necessary addition, particularly in hard-to-decarbonise industries such as agriculture, aviation, and heavy industry.⁹ CDR methods range from biological and nature-based solutions to technological processes that physically and-chemically separate CO₂ directly from the air and store it durably in underground geological formations.

Despite growing recognition, CDR faces significant uncertainties around technical maturity, economic feasibility, environmental risks, and public acceptance. Country-specific assessments are crucial for tailoring solutions to local socio-economic and geographical contexts, thereby enhancing the feasibility and effectiveness of these solutions.

The European Union (EU) has committed to achieving greenhouse gas (GHG) neutrality by 2050 and net-negative thereafter¹⁰, and as a member state, Poland must chart its own path toward this goal. Poland was selected for the Carbon Removal Readiness Assessment (CRRRA) project due to its substantial theoretical CDR potential, its early-stage national dialogue on the topic, and the need for tailored strategies that reflect its distinct socio-economic and geographic conditions.

This report addresses a critical gap in the literature by evaluating Poland's readiness for CDR, mapping existing capacities, barriers, and opportunities. It offers actionable insights for policy makers, multidisciplinary researchers, and stakeholders aspiring to integrate CDR within national climate strategies – advancing Poland's contribution to global climate goals and sustainable development.

This report was prepared using a bottom-up approach, which included desk research, interviews with relevant national stakeholders, and public engagement through a citizen panel.

The following Chapter 2 outlines the various CDR methods available and the ones selected for this study. Chapter 3 then describes Poland's geographical landscape, including current and prospective resources and feedstocks necessary to deploy CDR. In Chapter 4, a preliminary estimation of CDR potential is presented based only on the physical resources – the so-called "theoretical" potential. Following this, chapters 5 and 6 outline Poland's social geography by analysing the socio-economic, regulatory, and political landscape to describe the results of the stakeholder interviews and citizen panel. Finally, Chapter 7 presents the estimation of CDR potential across various scenarios, taking into account the results of both physical and social geography. The report concludes with targeted recommendations for policymakers, researchers, and stakeholders, aimed at integrating CDR into national climate strategies and advancing Poland's contribution to global climate goals.

2. CDR pathways and their resources requirements

This report's definition of CDR follows three key principles:

- The CO₂ captured must come from the atmosphere, not from fossil sources;
- The subsequent storage must be durable over climate-relevant timescales (typically decades to centuries or millennia), in either geological, terrestrial, oceanic, or durable products.
- The removal must be the result of human intervention, additional to the Earth's natural carbon cycling;¹¹

It is important to clearly distinguish CDR from other related concepts, such as carbon capture and utilisation (CCU) and carbon capture and storage (CCS). While CCU and CCS share some components with certain CDR methods, they do not necessarily result in durable net removal of CO₂ from the atmosphere, as illustrated in Figure 2.

2.1 Diversity of CDR methods

The net-negativity of CDR methods depends not only on the amount of CO₂ removed but also on the durability of storage, scalability, and social acceptability. CDR methods can be classified into four main categories: enhanced ecosystem management, biomass conversion/preservation, geochemical carbon removal, and synthetic carbon removal, as shown in Figure 3. A short description of each CDR method is provided in the following sections.

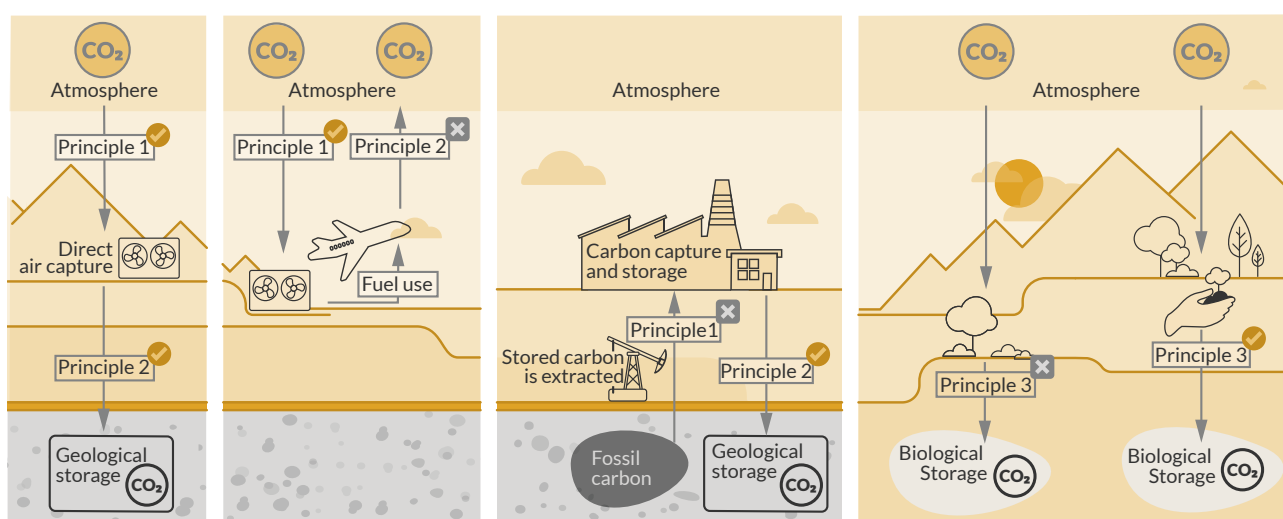


Figure 2. illustrates direct air capture (DAC) with permanent geological storage, a configuration that satisfies all three core principles of carbon dioxide removal. In contrast, Image B depicts DAC where the captured CO₂ is used in short-lived

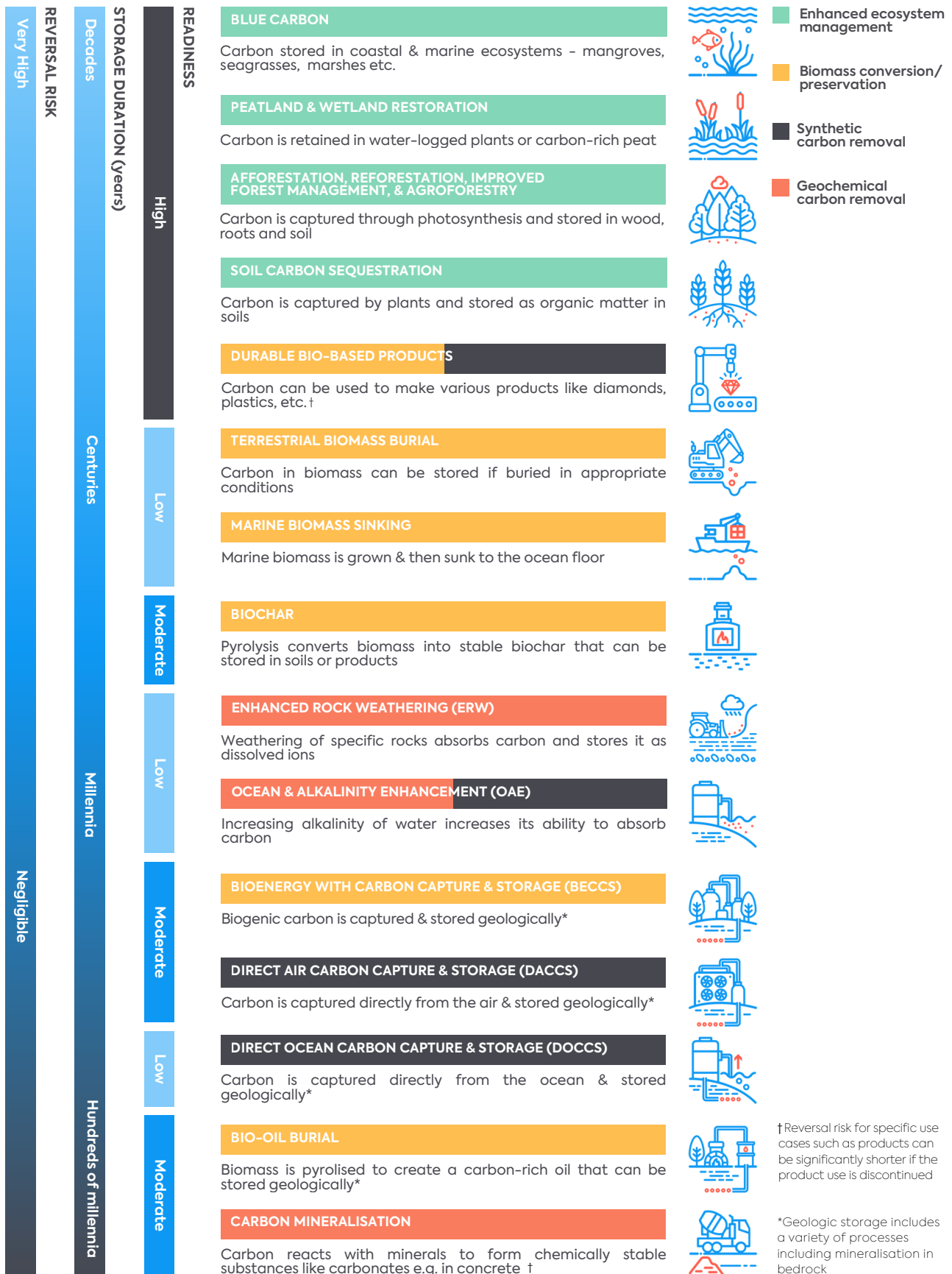


Figure 3. CDR Methods with their respective storage duration and deployment readiness (Carbon Gap).

2.1.1 Enhanced ecosystem management

CDR methods based on enhanced ecosystem management increase the amount of carbon sequestered and retained across both natural and managed ecosystems. By optimising land use or restoring degraded or altered ecosystems, these approaches strengthen the capacity of landscapes to operate as carbon sinks. Methods within this category include:

1. **Afforestation** creates new forests by planting trees on land that previously lacked forest cover, often targeting degraded farmland, grasslands, or other open areas.
2. **Reforestation** restores tree cover on land that has been deforested or ecologically degraded, helping to restore ecosystem function and carbon storage.
3. **Forest Management** enhances forestry practices to increase carbon sequestration within forest ecosystems, including longer rotation periods, reduced harvesting, and conservation of old growth stands.
4. **Agroforestry** integrates trees and shrubs into agricultural systems, combining crop and livestock production with perennial vegetation to improve resilience, biodiversity, productivity and carbon storage.
5. **Soil carbon sequestration** improves soil organic carbon through regenerative practices in cropland and pasture management such as no-till farming, cover cropping, compost application, and crop rotations, reducing emissions and enhancing soil health.
6. **Peatland restoration** aims to restore peatlands' natural capacity to store carbon
7. **Blue Carbon** focuses on the restoration and conservation of coastal ecosystems - like mangroves, salt marshes, and seagrasses – that naturally capture and store large amounts of carbon in biomass and sediments.

2.1.2 Biomass conversion/preservation

Biomass-based CDR methods harness the natural ability of plants to absorb atmospheric CO₂ through photosynthesis, storing it in their biomass - leaves, stems, roots, and other organic tissues. To prevent this carbon from returning to the atmosphere via natural decomposition or combustion, these approaches deliberately intervene in the carbon cycle. Biomass is intentionally processed in ways that stabilise or permanently sequester the captured carbon, ensuring long-term storage. Methods included in this category are:

1. **Durable bio-based products** refer to carbon stored in materials such as timber and bioplastics. These products delay carbon release by extending the lifecycle of biomass-derived carbon.
2. **Biochar** is produced via pyrolysis of biomass under low oxygen conditions, resulting in a stable, carbon-rich material. When applied to soils or materials, biochar resists decomposition and stores carbon for decades to millennia.
3. **Bio-Oil Storage** converts biomass into bio-oil via pyrolysis and injects it into stable geological formations. This method sequesters liquid carbon underground for hundreds to thousands of years.
4. **Marine Biomass Sinking** cultivates or collects seaweed and other marine biomass, depositing it in deep ocean layers (>1,000 m). This accelerates the natural carbon pump and sequesters carbon for centuries to millennia.
5. **Terrestrial Biomass Burial** involves harvesting plant biomass and burying it in engineered, low-oxygen environments to prevent decomposition. This method locks carbon absorbed via photosynthesis into stable storage for extended timescales.
6. **Bioenergy with Carbon Capture and Storage (BECCS)** combines biomass use with CO₂ capture and geological storage. It prevents CO₂ release from biomass combustion or processing, enabling net-negative emissions.
 - a. **BECCS with Combustion** captures CO₂ from biomass combustion in power or industrial plants and stores it underground, while generating usable energy.
 - b. **BECCS with Anaerobic Digestion/Fermentation** captures CO₂ released during biomass breakdown for biogas or ethanol production, diverting it to secure geological storage.

2.1.3 Geochemical carbon removal

Geochemical and ocean-based methods accelerate or enhance naturally occurring chemical interactions between carbon dioxide and reactive rocks or minerals. In nature, such reactions unfold slowly over geological timescales. However, by increasing the surface area of reactive materials—typically through grinding—and applying them to terrestrial or marine environments, the rate of CO₂ conversion and storage can be significantly enhanced. Key methods include:

1. **Enhanced Rock Weathering (ERW)** applies finely ground silicate minerals to soils, where they react with CO₂ to form stable carbonates, sequestering carbon over long timescales.
2. **Ocean Alkalinity Enhancement (OAE)** increases seawater alkalinity to accelerate natural CO₂ absorption, converting it into stable bicarbonate and carbonate ions.
 - a. **Mineral OAE** involves dissolving alkaline minerals (e.g., olivine, lime) into seawater to boost alkalinity and enhance CO₂ uptake.
 - b. **Electrochemical OAE** uses electricity to modify seawater chemistry, increasing its alkalinity, and therefore its capacity to absorb and retain CO₂.
3. **Carbon mineralisation** facilitates the reaction of CO₂ with calcium- or magnesium-rich rocks to form solid carbonates. This can occur in controlled reactors (ex situ) or within geological formations (in situ), enabling permanent carbon storage.
4. **Ocean fertilisation** adds nutrients to ocean regions to stimulate phytoplankton growth and CO₂ uptake. It can be done with iron, nitrogen/phosphorus or artificial upwelling. Overall, results are variable and may involve ecological risks and rapid carbon re-release.

2.1.4 Synthetic carbon removal

Synthetic carbon removal encompasses engineered systems designed to extract CO₂ from the atmosphere or oceans and store it permanently. Two principal approaches in this category are Direct Air Carbon Capture and Storage (DACCS) and Direct Ocean Carbon Capture and Storage (DOCCS). Both offer the advantage of long-term, measurable carbon sequestration.

1. **Direct Air Carbon Capture and Storage (DACCS)** involves capturing CO₂ directly from ambient air using solid sorbents or liquid solvents. Once captured, the CO₂ is released through the application of heat, pressure, or chemical reactions, yielding a purified CO₂ stream. This concentrated CO₂ is then compressed and stored in geological formations or other long-term sequestration sites.
 - a. **Electrochemical DACCS** utilises electrochemical reactions to selectively capture and release CO₂.
 - b. **Moisture-Swing DACCS** employs sorbents that adsorb CO₂ in dry conditions and release it when exposed to moisture.
 - c. **Mineral Looping DACCS** captures CO₂ by reacting it with Ca- or Mg-rich minerals, forming stable carbonates such as calcite or magnesite.
 - d. **Low-Temperature DACCS** (<100 °C) uses solid amine sorbents or alkaline solutions, often powered by low-grade or waste heat, to capture CO₂.
 - e. **High-Temperature DACCS** (>400 °C), techniques like calcium looping operate at elevated temperatures, enabling rapid CO₂ capture.
2. **Direct Ocean Carbon Capture and Storage (DOCCS)** targets CO₂ dissolved in seawater, where it exists in large quantities as part of the ocean's inorganic carbon pool. The pH swing method alters chemical equilibria to release CO₂ from solution, allowing it to be captured and stored permanently.

2.2 Selected CDR methods

Poland's natural conditions and geography provide a favourable foundation for deploying a wide range of ecosystem-based CDR methods. However, the country's relatively short coastline along the Baltic Sea limits the potential for coastal revegetation. This pathway has therefore been excluded from this study, given the limited research available on its applicability in Polish coastal environments and its potential carbon sequestration outcomes.

Given the significant volumes of residual biomass generated by Poland's forestry and agricultural sectors, biomass conversion methods are well aligned with the national context and have been included in the assessment. In contrast, bio-oil storage was excluded due to its low technology readiness level (TRL). Similarly, terrestrial biomass burial and marine biomass sinking were not considered, owing to insufficient research.

Geochemical CDR methods show promising potential in Poland, supported by the availability of suitable minerals. Approaches such as enhanced rock weathering and carbon mineralisation could enable durable and verifiable carbon storage with relatively limited land-use competition. In this report, carbon mineralisation is included only in the form of

in-situ applications. Ex-situ mineralisation has been excluded as a standalone pathway, with all suitable mineral resources instead allocated to enhanced rock weathering, due to insufficient data to robustly assess carbon removal rates for ex-situ applications. Ocean fertilisation and artificial upwelling are not suited to Polish marine ecosystems and are currently constrained by regional and international legal frameworks. And were therefore excluded from this study due to low TRL. By contrast, ocean alkalinity enhancement remains a promising area for research and development and has been included in the study, although its large-scale application is limited by the shallow and sensitive ecosystems of the Baltic Sea.

Synthetic CDR methods offer permanent, additional, and measurable CDR potential for Poland, albeit with relatively high energy and cost requirements. Direct Ocean Capture with Carbon Storage (DOCCS) has not been included in this report, as it remains in early stages of research, particularly regarding its suitability for the specific conditions of the Baltic and North Seas.

Figure 4 summarises the CDR Methods that have been included and excluded from the study, with a timeframe considered up to 2050.

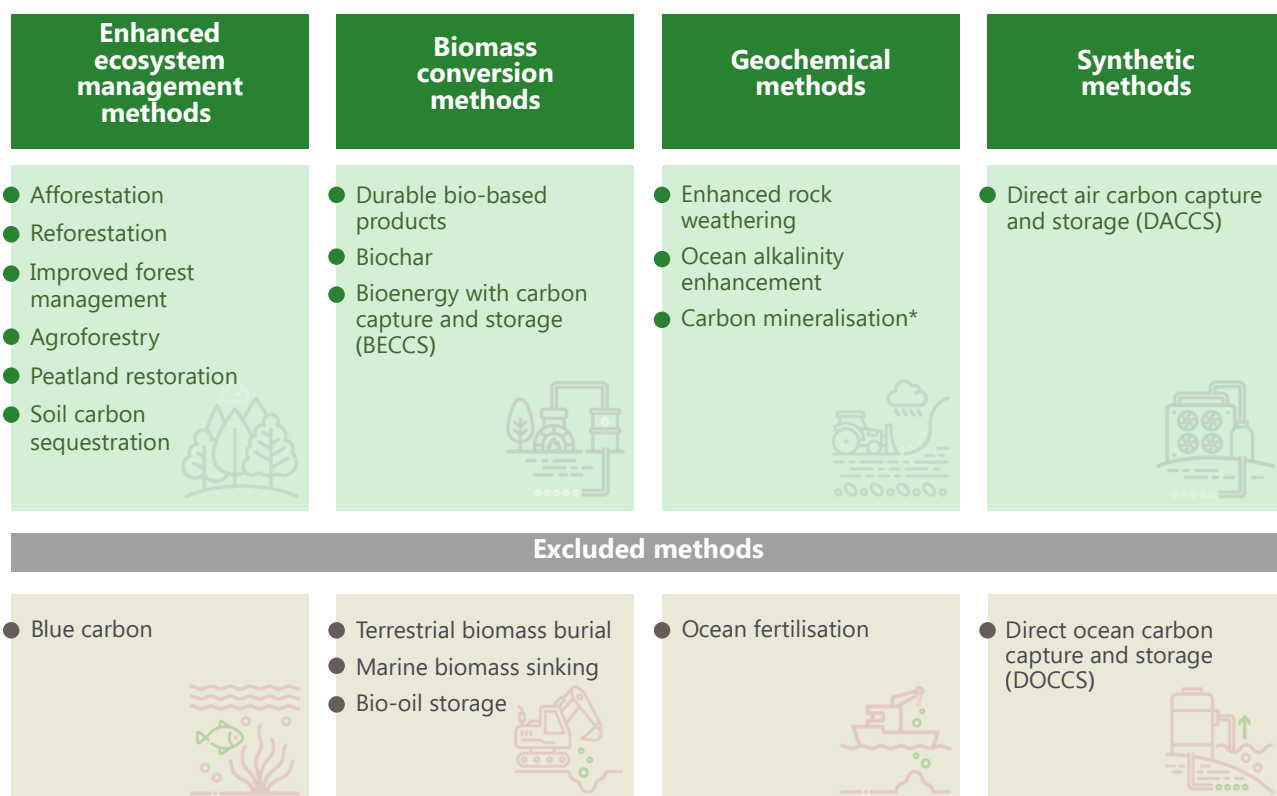


Figure 4. Summary of the CDR Methods that have been included and excluded from the study.*Carbon mineralisation is a storage method.

2.3 Resource requirements for selected CDR methods

To assess the deployment potential of each CDR method, it is essential to understand their resource requirements—such as water usage, land area, and energy consumption—per net tonne of CO₂ removed. However, accurately quantifying these inputs presents two key challenges:

- The diversity of CDR methods, each with multiple variants that differ significantly in design, scale, and operational parameters.
- Limited availability of reliable data, as most methods remain in early stages of development and lack robust field-based evidence.

Moreover, comparing methods requires a consistent basis. Since all CDR approaches generate some GHG emissions during operation, resource requirements must be evaluated per net tonne of CO₂ removed - accounting for emissions subtracted from gross removal volumes. This makes life cycle analysis (LCA) a critical tool for generating meaningful data.

Scientific literature offers valuable insights, particularly due to its methodological transparency and peer-reviewed rigor. However, most studies rely on laboratory-scale experiments or modelling, often based on limited datasets. As a result, their applicability to real-world conditions remains uncertain, and few include comprehensive LCAs.

Operational self-declared data from companies - those developing pilot projects or commercial-scale deployments - is rare but increasingly available. For instance, application files submitted to the Frontier fund provide performance metrics from actual projects. While these figures reflect current technological capabilities more accurately, they are often self-reported and lack peer review, making them “declarative” in nature.

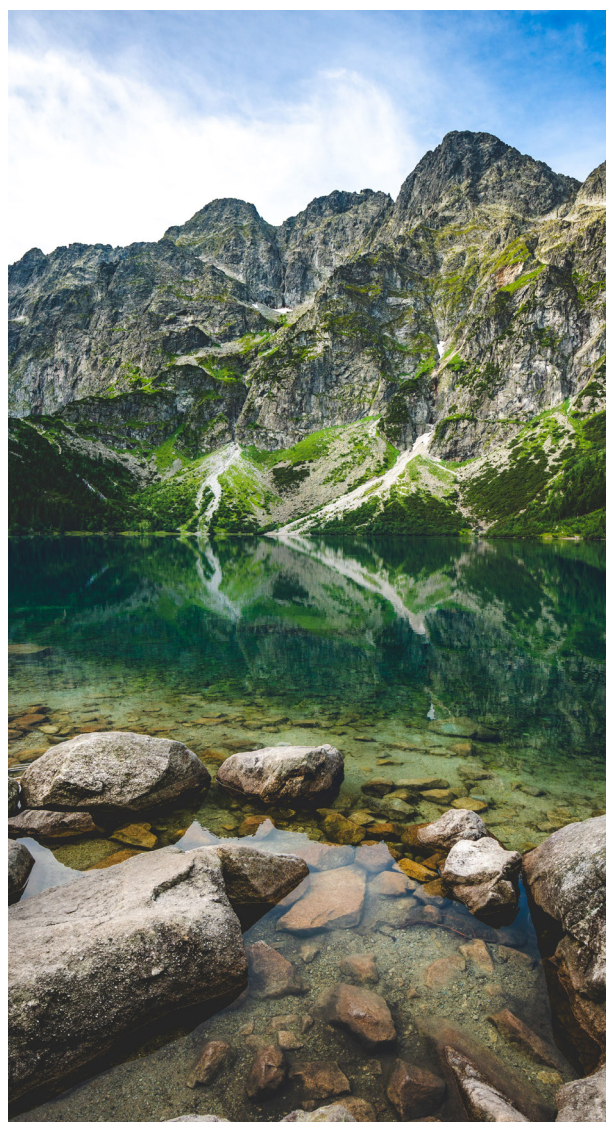
To overcome these limitations and build a robust database of resource requirements, Carbon Gap partnered with RMI. The resulting dataset is grounded in three complementary sources: peer-reviewed scientific literature, publicly available Frontier fund applications (across three cohorts), and direct surveys conducted with active CDR operators.

The database will continue to evolve after the publication of this report, but at the time of publication includes:

- 442 data points obtained from 129 scientific articles;
- 200 data points obtained from 113 Frontier files;
- 330 data points obtained from 57 survey responses.

The database is accessible from the [CRRA website](#).

The data was compiled to produce consolidated values for each of the resources required for CDR methods. These values are used in the rest of the report to estimate the potential of CDR methods based on the available resource feedstocks. When values are not available from the database or if alternative values more relevant to the national context where preferred, they are explicitly reported together with the source.



3. Poland's resources & feedstocks

Poland has sufficient - and in some cases abundant - resources to support a wide range of CDR methods, including energy, agricultural land, forests, peatlands, and minerals. However, its geological CO₂ storage capacity poses notable constraints. The following overview assesses these key resources to evaluate both the theoretical and practical potential for deploying CDR in Poland.

3.1 Energy

Over the past decade, Poland has steadily diversified its energy mix, reducing its reliance on coal, with further growth in renewables expected. In 2024, the Polish Transmission System Operator curtailed 940 GWh of solar¹² and 731 GWh of wind generation due to oversupply.¹³ In total, around 1.7 TWh of renewable electricity (if combined with appropriate battery storage infrastructure) could have been available for CDR. If renewable expansion continues as planned, this could rise to approximately 8.3 TWh by 2050.

Thermal energy available for CDR can be sourced from waste heat, currently estimated at 8.48 TWh, out of 96.14 TWh of total heat production.¹⁴ Based on historical trends, we can estimate that around 5.3 TWh of this could be available for CDR by 2050.

3.1.1 Electricity

Total electricity generation in Poland reached 166.99 TWh in 2024¹⁵, with the breakdown by source shown in Figure 5. Generation remains dominated by conventional sources: fossil fuels accounted for over 72% of output, while renewables contributed around 28%.

However, comparison with 2018 shows a significant rise in renewable generation, increasing by more than 30 TWh. This marks a clear shift toward a less carbon-intensive electricity system.

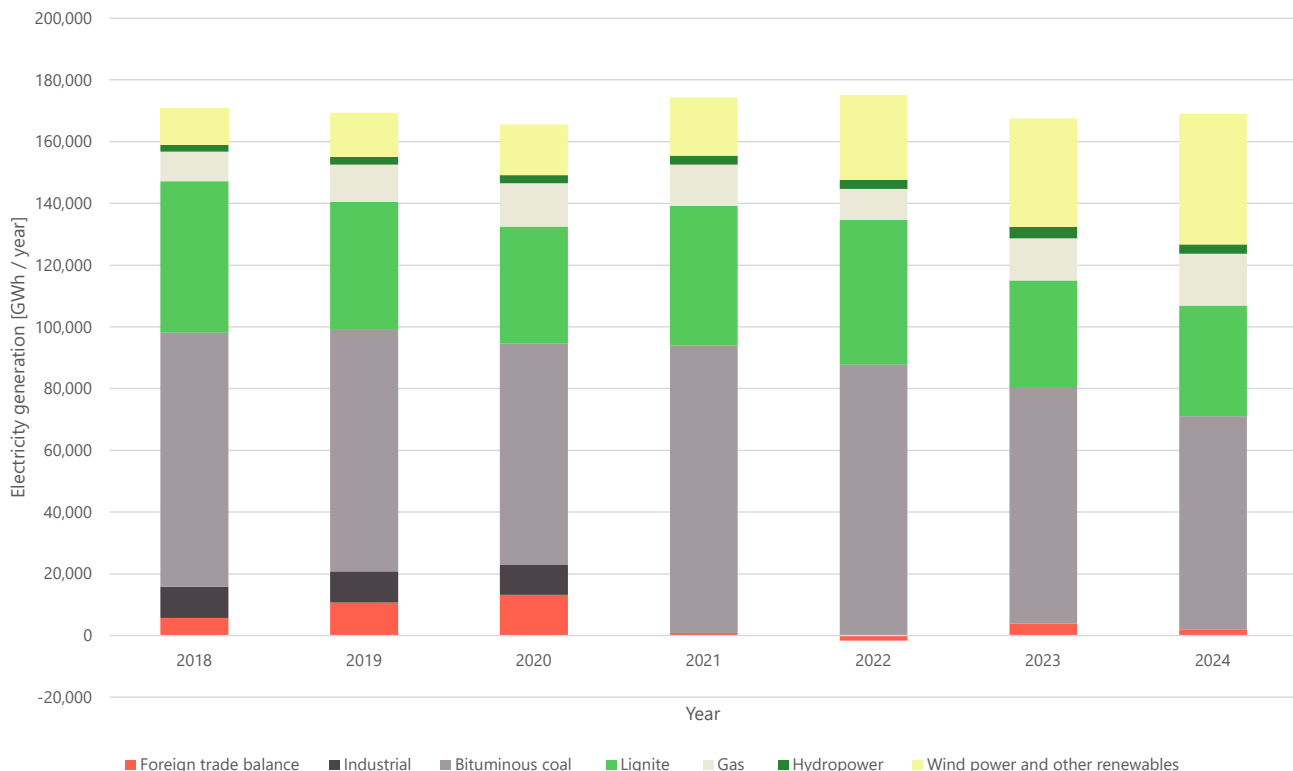


Figure 5. Electricity generation in Poland in 2018-2024 [GWh/year].

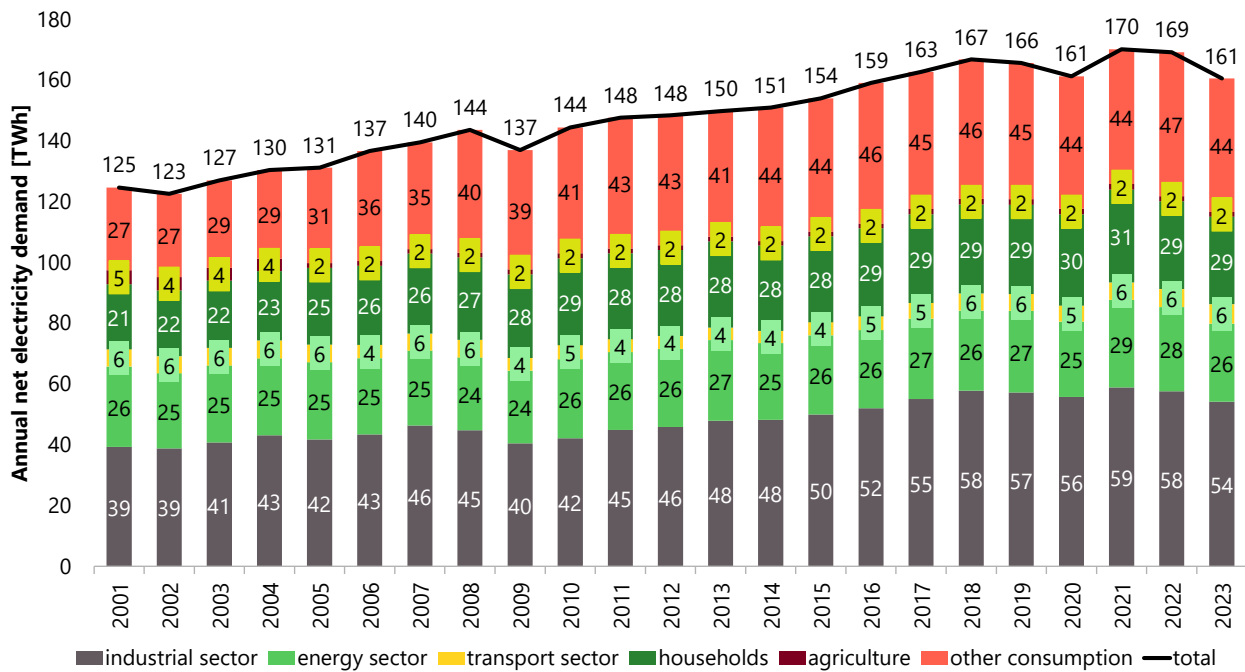


Figure 6. Annual net electricity demand for 2001-2023 [TWh] (adapted from GUS data).

Electricity consumption in Poland from 2001 to 2023 is shown in Figure 6. Over this period, the strongest growth occurred in the industrial sector¹⁶, particularly in the chemical, mineral, and steel industries, which account for the largest shares of electricity use. Household consumption also increased significantly, while electricity use in agriculture declined.

In 2024, Poland was a net electricity importer, with net imports totalling 1.97 TWh, supported by strong interconnections with neighbouring countries. These cross-border links enhance system flexibility and could increase electricity availability for CDR, particularly during periods of surplus or underutilised generation. The largest inflows came from Germany (8.83 TWh) and Sweden (2.63 TWh). At the same time, Poland exported electricity to the Czech Republic (4.55 TWh), Slovakia (3.42 TWh), Lithuania (0.94 TWh), and Ukraine (0.60 TWh).¹⁷



3.1.2 Electricity production scenarios

Poland's updated draft National Energy and Climate Plan (NECP), approved in July 2025,¹⁸ outlines two electricity development pathways to 2040: a **WEM (With Existing Measures)** scenario, reflecting a business-as-usual trajectory, and a more ambitious WAM (With Additional Measures) scenario aligned with strengthened climate policies.

The WAM scenario assumes a more active transformation of the energy system in line with the EU's *Fit for 55* package, while WEM captures outcomes based on currently implemented policies. However, according to the European Commission's assessment, the draft plan only partially aligns with *Fit for 55* targets, indicating that even under the more ambitious pathway, Poland is not yet fully on track to meet EU climate objectives. Under WAM, renewable electricity generation is projected to be significantly higher (18%) than in WEM by 2040, reflecting accelerated deployment of low-carbon technologies and stronger policy support.

Figure 7 presents the WEM and WAM scenarios for electricity production. The production volumes are based on the draft update of the National Energy and Climate Plan (NECP/KPEiK) for 2030 with a perspective to 2040¹⁹. Following completion of the current interministerial review process, the draft is expected to be submitted to the Council of Ministers (an auxiliary body to the Council of Ministers and the Prime Minister²⁰) for consideration. The final document is planned to be transmitted to the European Commission after approval by the Council of Ministers in the first half of 2026²¹.

The outlook for 2025–2040 suggests that baseline electricity demand in Poland will remain relatively stable, peaking at around 165 TWh in 2031–2032 before declining slightly by 2040 to below 2025 levels. At the same time, new sources of demand - such as heat pumps, electric boilers, electric vehicles, hydrogen production, and data centres - are expected to grow steadily²³. According to estimates from the Polish Transmission System Operator (PSE), total electricity demand could reach approximately 215 TWh by 2040²⁴. No official projections extending to 2050 are currently available.

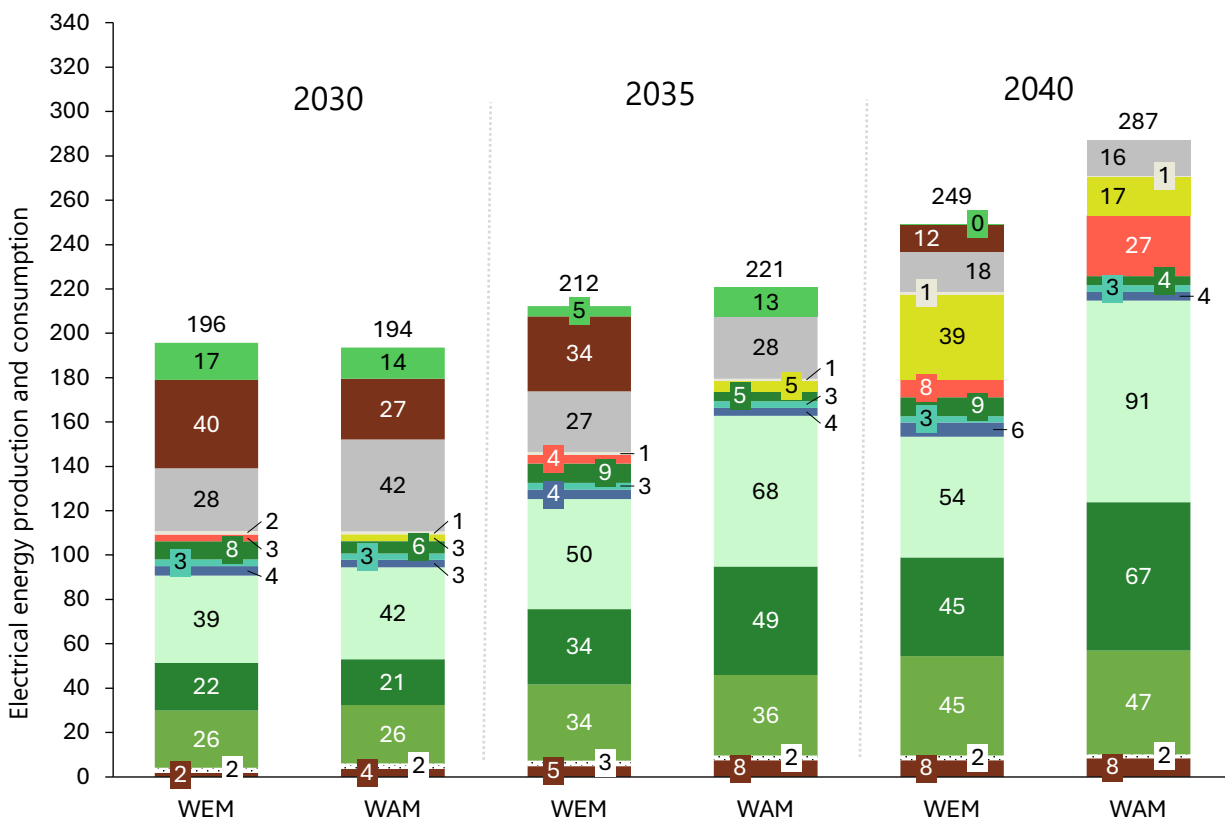


Figure 7. Electrical energy gross production in WEM and WAM scenario [TWh].²² *Including gas from coke oven and blast furnace, **High-methane and nitrogen-rich natural gas, gas from mine methane drainage, gas associated with crude oil, ***Inorganic industrial and municipal waste

Beyond 2040, scenario analysis by the Clean Air Task Force (CATF) explores pathways to a fully decarbonised power system by 2050²⁵. These scenarios project substantial expansion of renewables, with onshore wind capacity reaching around 73 GW (~192 TWh/year), offshore wind up to 28 GW (~123 TWh/year), and solar PV around 88–90 GW (~79 TWh/year)²⁶. Combined, this implies a theoretical renewable generation potential of roughly 394 TWh/year by 2050. Over the same period, electricity demand is expected to rise significantly - driven by electrification of transport and heating, as well as green hydrogen production - reaching about 280 TWh/year. If deducting that from the electricity produced based on renewable energy capacity, this suggests a theoretical surplus of around **113 TWh/year of renewable electricity that could be available for CDR by 2050**, assuming adequate system integration and storage.

In summary, Poland's power system remains heavily reliant on fossil fuels today, with renewables still representing a minority share. However, the curtailment of renewable generation already observed in 2024 points to emerging opportunities for deploying energy-intensive CDR. Looking ahead, the continued expansion of renewables is expected to significantly increase the availability of low-carbon electricity, strengthening the long-term potential for CDR deployment.

3.1.3 Thermal Energy

Poland's thermal energy sector has undergone significant changes in recent years, driven by economic pressures and geopolitical developments. Russia's invasion of Ukraine disrupted fuel supply chains, leading to higher energy prices and increased heating costs.

As of 2023, Poland's heating infrastructure²⁷ reflects its considerable scale, with a network spanning over 22,800 km and serving a wide range of consumers. Total high-grade heat production reached 96.14 TWh²⁸. Recovered heat played a crucial role, reaching about 8.48 TWh²⁹, demonstrating Polish companies' commitment to energy efficiency and environmental protection.

Of this total, 35.38 TWh was used for the sector's own consumption, while 69.24 TWh was fed into the grid. Distribution losses amounted to around 9.12 TWh, resulting in 60.12 TWh of heat delivered to final consumers. Heat generation and consumption patterns are illustrated in Figure 8. In 2023, industry and construction accounted for 55.2% of final heat consumption (including non-commercial heat use in industry), while households represented 35.8%.³⁰

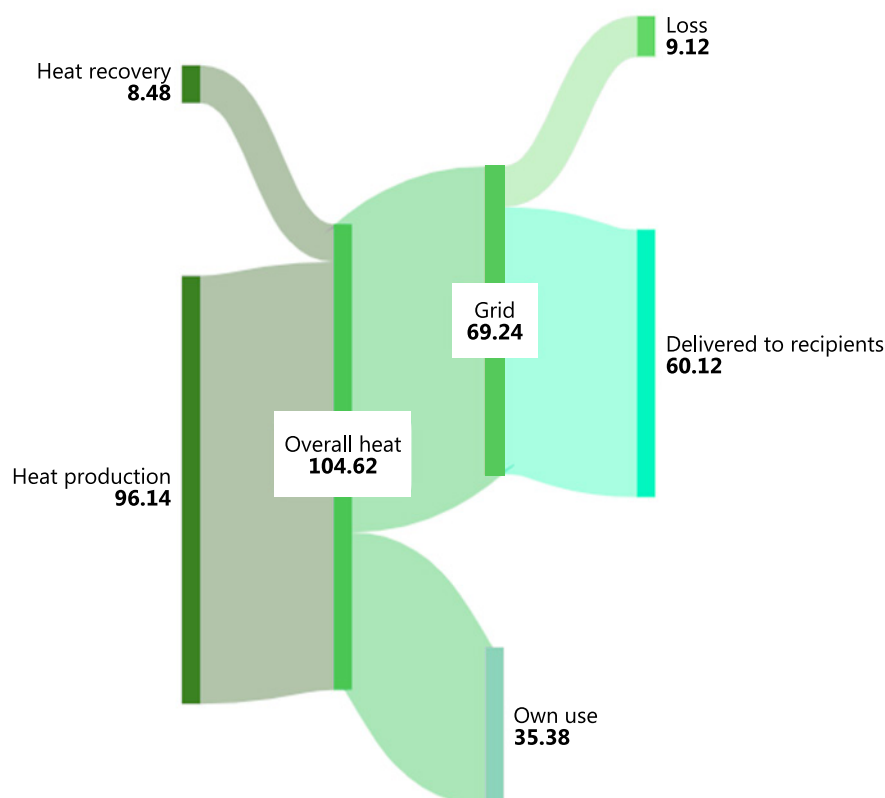


Figure 8. Heat generation in 2023 [TWh] ³¹

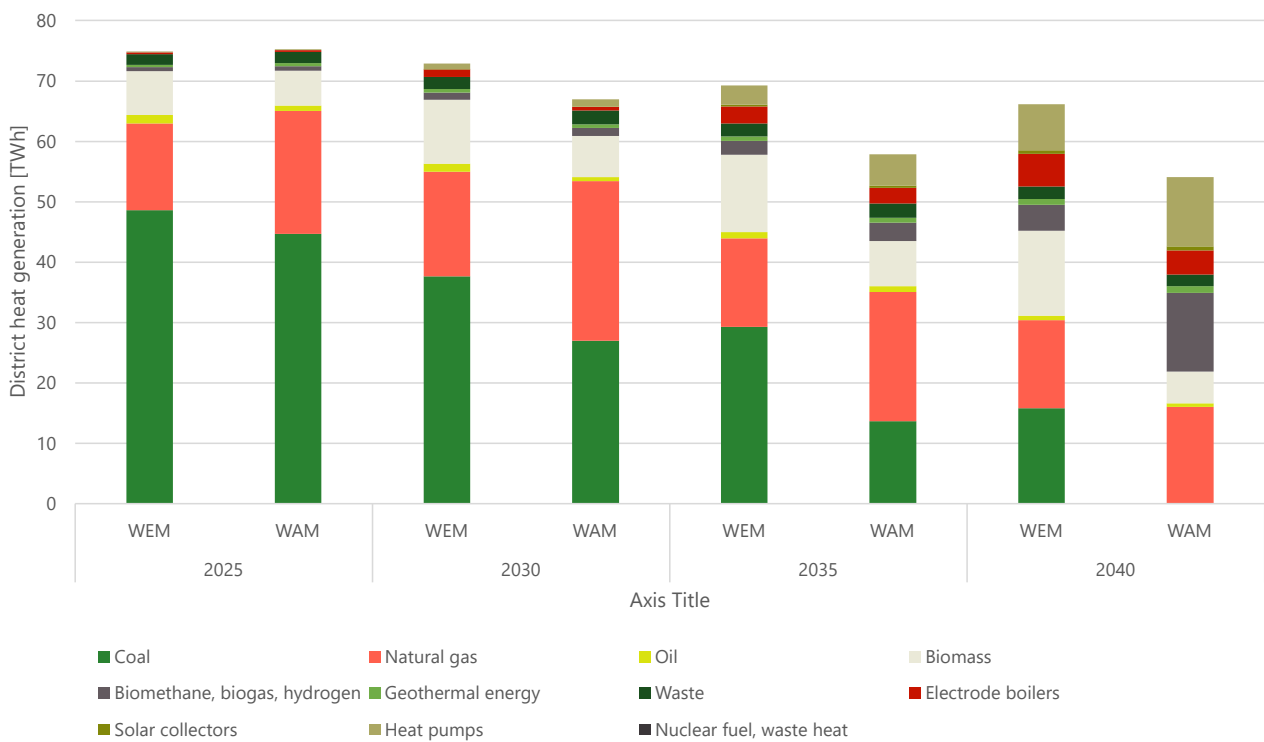


Figure 9. District heat generation by fuel [TWh] ³⁵.

3.1.4 Thermal Energy scenarios

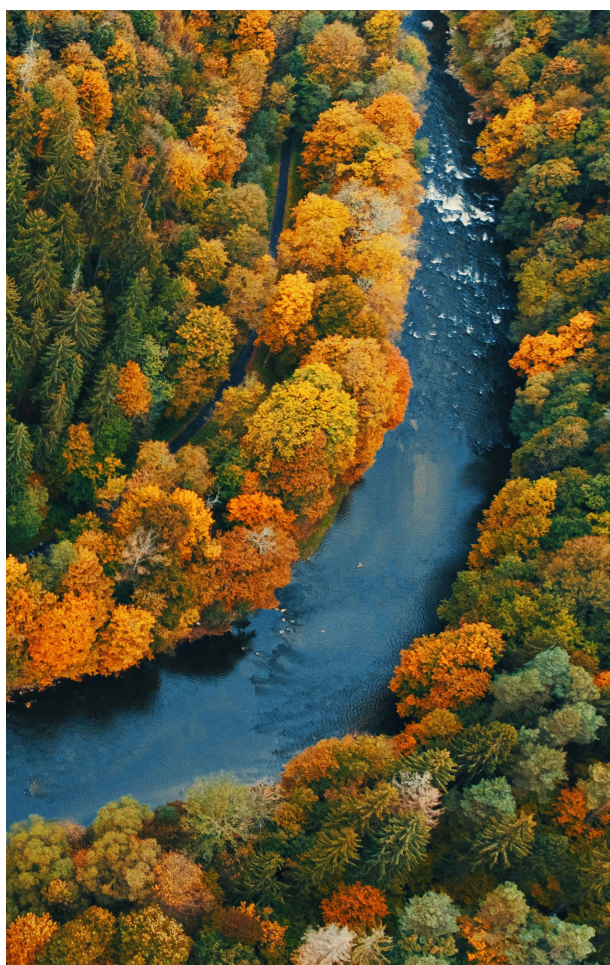
Similar to electricity generation, Poland's draft National Energy and Climate Plan (NECP) outlines two scenarios for the development of district heating through 2040: **WEM (With Existing Measures)**, reflecting a business-as-usual pathway based on current technological and economic trends, and **WAM (With Additional Measures)**, which assumes a more ambitious transition aligned with the EU's *Fit for 55* targets. However, even under WAM, Poland is not expected to fully meet all Fit for 55 objectives.

Figure 9 presents the WEM and WAM projections based on the draft update of the National Energy and Climate Plan (NECP/KPEiK) for 2030 with a perspective to 2040³². Following completion of the current interministerial review process, the draft is expected to be submitted to the Council of Ministers (an auxiliary body to the Council of Ministers and the Prime Minister³³) for consideration. The final document is planned to be transmitted to the European Commission after approval by the Council of Ministers in the first half of 2026³⁴.



By 2040, district heating is expected to significantly decline in the use of fossil sources, especially coal, which drops dramatically from substantial shares in 2025 to nearly zero. This is due to a combination of reduced heat demand and structural policy shifts, stricter efficiency standards, the “Energy Efficiency First” principle, and the uptake of heat pumps and waste heat recovery. The shift towards non-fossil sources is evident, with biomass, biomethane, biogas, hydrogen, and heat pumps constituting a larger portion of the energy mix. For instance, in the WAM scenario, heat pumps share grows from 0.11% in 2025 to 11.47% in 2040. The expected decline in fossil sources aligns with global sustainability goals and the rise in more renewable and efficient heating technologies.

Assuming all currently recovered waste heat could be used for CDR methods, the theoretical maximum availability is 8.48 TWh³⁶, based on current recovery levels. In comparison, total heat production in Poland amounts to 96.14 TWh³⁷. While there are no official projections for future waste heat recovery, if historical trends continue, **approximately 5.30 TWh may be theoretically available for CDR by 2050.**



3.2 Water

Poland has almost 10,000 lakes larger than 1 ha, giving it one of the highest lake densities in Europe (second only to Finland)³⁸. However, water quality has historically been a major issue. In 1990, 65% of river water was so contaminated that it corroded industrial equipment, and 95% was considered undrinkable. The Vistula River, after absorbing pollutants from urban and industrial sources, was a major contributor to Baltic Sea pollution, and river water was unsuitable for irrigation. Since 1989, water quality has improved significantly due to the decline of heavy industry and stronger environmental regulation, although quality concerns persist in some regions.³⁹

Despite its extensive river and lake network and significant groundwater reserves, Poland's overall water availability is moderate compared to European averages and subject to seasonal variation and quality concerns. Annual renewable freshwater resources amount to approximately **57.8 bcm**, while per capita availability is **below 1,600 m³/year**, indicating a structural risk of water stress⁴⁰. Annual precipitation exceeds 201 bcm based on a long-term annual average⁴¹, and there is about 8 bcm of treated water⁴².

Annual water withdrawals amount to approximately **16.2 bcm**, with majority consumed by industry (79%), followed by households (13%), and agriculture (8%).⁴³ Of the water used in industry, most is for energy needs (89%).

Poland has a well-developed and expanding water supply and wastewater treatment network⁴⁴. In 2024, average water use per capita was **35.5 m³/year**. Surface water accounts for most of the supply (around 80%), while groundwater of higher quality is primarily used for drinking water.

Based on current estimates, around **24.8–26.5 bcm of water** could be considered available for CDR after accounting for existing consumption by households and industry. However, this figure should be interpreted as a theoretical national potential, as actual availability will depend on spatial distribution, seasonality, infrastructure access, water quality, and competing uses.

In conclusion, while Poland's water resources are moderate by European standards and constrained by variability and quality issues, existing infrastructure and overall resource availability provide a solid foundation for CDR deployment. Water availability is therefore unlikely to be a binding constraint at the national level, although it may become a limiting factor in specific locations or under certain conditions.

3.3 Land

Poland's total area is **32.37 Mha**, of which 96.7% (31.19 Mha) is land, including inland waters. Internal maritime waters account for 0.20 Mha (0.6%)⁴⁵, while territorial waters in the Baltic Sea add a further **0.88 Mha (2.7%)**. Urban areas occupy a relatively small share of land (~**2.24 Mha**)⁴⁶, meaning that rural land - including agricultural and semi-natural areas - dominates and is particularly relevant from a carbon removal perspective.

According to the classification used by [Statistics Poland](#), land use is distributed as follows: arable land 47.2% (14.71 Mha)⁴⁷, forest land 29.6% (9.20 Mha)⁴⁸, shores and coastal areas 11.3% (3.53 Mha)⁴⁹, and wetlands (excluding peatlands) 9.9% (3.10 Mha)⁵⁰ (Figure 10). This composition highlights the importance of agricultural systems and forests in determining Poland's land-based carbon removal potential.

Based on the country's 2050 development concept (KRK 2050) and scenario analyses, the share of land available for CDR-relevant uses is expected to depend on the pace of technological progress, climate impacts, and competing land-use needs such as energy production, food systems, and urban development⁵¹. Although exact percentages are not yet determined, projections indicate that in high-tech, high-ambition 2050 scenarios – characterised by rapid decarbonisation, digitalisation, and productivity gains – traditional agricultural land may shrink due to higher yields and efficiency improvements. This could free up a measurable area that may be used for nature-based or biomass-related climate-mitigation measures.

The emerging policy environment, including KRK 2050 goals for carbon neutrality and the Polish NECP's focus on strengthening sinks and enabling CCUS for industrial decarbonisation⁵², reinforces the conditions for such land-use shifts.

At the same time, forests, wetlands, and other natural ecosystems are expected to be increasingly protected and restored for biodiversity, water-retention and climate-resilience, which may indirectly contribute to long-term carbon storage and could form part of potential future CDR-related approaches in Poland.

The LULUCF sector (Land Use, Land Use Change and Forestry) is reported in the national greenhouse gas (GHG) inventory as a **net carbon sink**.⁵³ However, independent research (such as Kotowski 2021⁵⁴, WWF⁵⁵) suggests that emissions from peatlands may be underestimated due to conservative emission factors; using updated values could reduce or even reverse the net sink. Despite this uncertainty, under the National Energy and Climate Plan (NECP) "with additional measures" (WAM) scenario, the LULUCF sector is projected to remain a net sink. In the baseline scenario, removals are projected to be **-46.5 MtCO₂e in 2030** and **-35.3 MtCO₂e in 2040**. These estimates cover all land-use categories, including forests, croplands, grasslands, wetlands, and peatlands.

Overall, while a gradual decline in sink capacity is expected after 2030, the LULUCF sector is projected to remain a significant contributor to Poland's emissions balance and a key component of achieving climate targets over the 2030–2040 period.

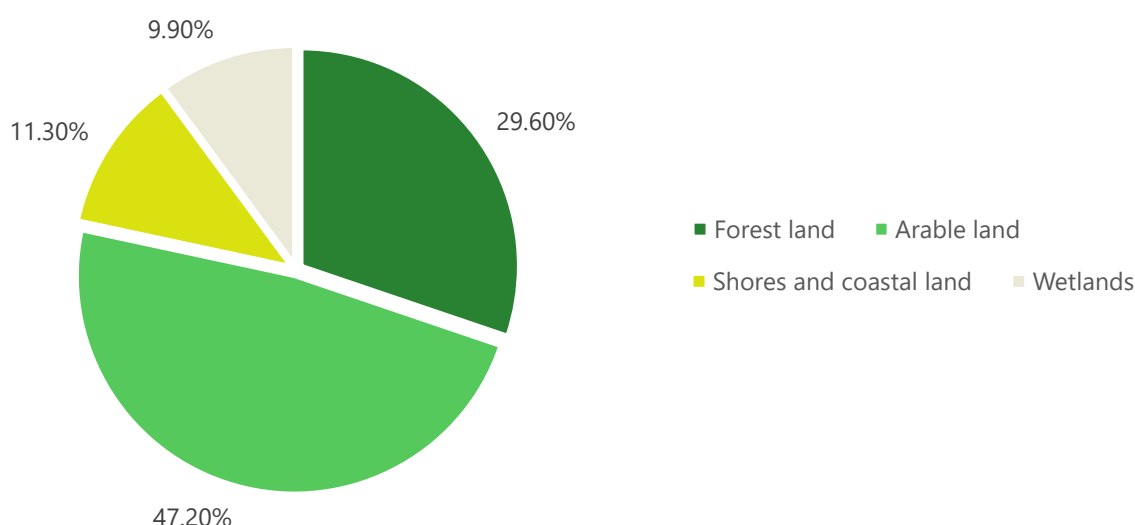


Figure 10. Division of Poland's land area according to type. Source: Own study based on data from GUS

3.3.1 Forest land

In 2024, forests covered 29.6% of Poland's land area, corresponding to about **9.29 Mha**⁵⁶. Around 42% of forest land is under protective status with no wood-production function. Forest area is expected to expand under the National Programme for Increasing Forest Cover (KPZL)⁵⁷, which targets 33% forest cover increase by 2050, implying an expansion of over 800 kha. Until 2022, about two thirds of Polish forests were FSC-certified⁵⁸. However, following the withdrawal of certification by the State Forests in 2022–2023, the certified area declined to about 20% (1.7 Mha). In 2024, a sectoral roadmap was introduced with the intention of re-establishing forest certification.

The forestry industry plays a significant role in the Polish economy. The report "What's Going on with the Forests" ("Co z tymi lasami") by B+R Studio⁵⁹ indicates that the forest-wood sector accounts for 8.5% of economic activity in Poland, equivalent to about one-twelfth of GDP when including consumption and trade. Sector output peaked at PLN 261 billion in 2022, declining to PLN 230 billion in 2023, driven by factors such as the war in Ukraine, rising wood prices, increasing labour and material costs, and restrictions on timber supply.

Poland's forests contain an estimated at 2.7 bcm⁶⁰ of growing stock, including approximately 105 million cubic meters of deadwood⁶¹. In 2024, forest renewals covered 60.7 kha⁶².

Forest ownership is predominantly public. In 2024, 80% of forest area was publicly owned, with 77% managed by the State Forests (Lasy Państwowe), while 19% was privately owned⁶³. Total forest area increased slightly from 9,484.2 kha in 2023 to 9,488.8 kha in 2024, with forest cover remaining stable at 29.6%. Forest area per capita rose marginally from 0.247 to 0.248 hectares.⁶⁴

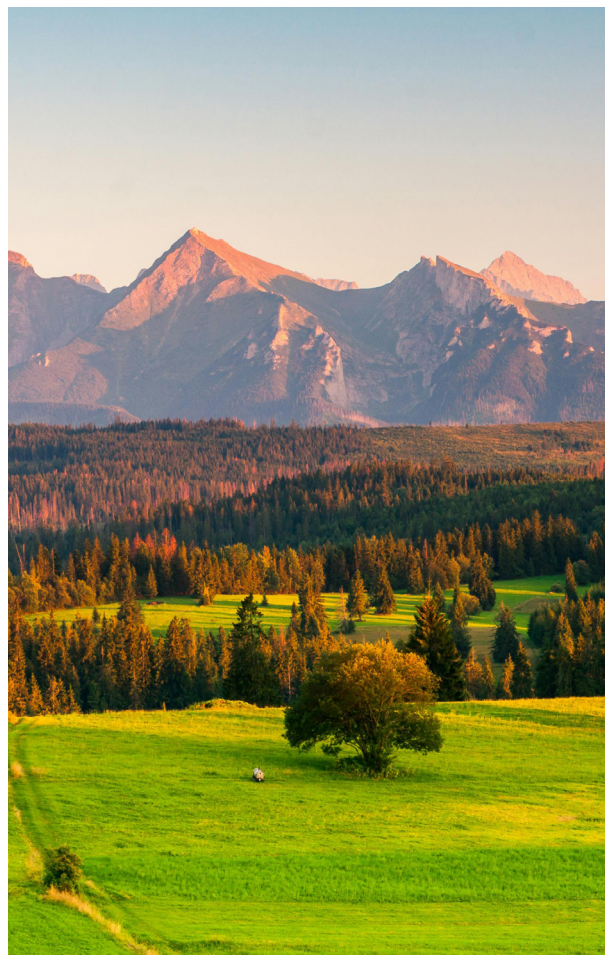
According to Poland's National Inventory Document (2025), forest land acted as a **net greenhouse gas sink of -40,185 ktCO₂e in 2023**⁶⁵. Projections of future sink dynamics are subject to considerable uncertainty, particularly due to limited publicly available data on future harvest levels, forest age structure, and the impacts of climate change. In the absence of robust, scenario-consistent projections, this study adopts a **simplifying assumption** that the forest sink remains constant at the 2023 level through **2030 and 2050**.

National climate scenarios indicate a policy objective to modestly increase the LULUCF sink, primarily through forest-related measures, with the potential for further enhancement under additional

interventions.⁶⁶ However, as these additional measures overlap with CDR options assessed separately in this study, incorporating them here would risk double counting. Therefore, the current sink estimate is used as a conservative baseline representation of the natural forest sink, rather than adopting forward-looking policy targets

Reforestation potential

Reforestation covers activities that aim to recover forest stand gaps and areas of lowered tree density. According to the Statistical Yearbook of Forestry⁶⁷, 803 ha were reforested in 2023, with relatively low annual variation observed between 2015 and 2023. However, the National GHG Inventory indicates significant fluctuations in forest carbon sinks due to natural disturbances. As no robust projections of future disturbances or national reforestation targets are available for Poland, a **theoretical reforestation potential of 32 kha by 2050** is assumed. This estimate is based on historical reforestation trends and EU-level analysis of increasing forest disturbance risks, particularly from wildfires.⁶⁸



3.3.2 Cropland and grassland

Arable land today in Poland covers about 11 Mha, including 9.5 Mha of cropland and 1.5 Mha of grassland, with a modest annual increase of 0.4%. Cereals dominate the cropping structure (65.2% of total sown area), followed by fodder crops (13.6%) and industrial crops (13.3%).⁶⁹ Farm structures remain highly fragmented: 50.5% of holdings are smaller than 5 ha Utilized Agricultural Area (UAA), while the share of large farms (≥ 50 ha) has gradually increased to 3.6% in 2023. The average farm size reached 11.9 ha.

Agriculture has undergone rapid modernisation, intensification, and regional specialisation. Rye, mixed cereals, and maize dominate in central, eastern, and north-eastern regions, while orchards and berry production are concentrated in Mazowieckie (Grójec), Lubelskie, Sandomierz, Wielkopolska, and Łódź regions. Intensive cereal production (mainly wheat), alongside sugar beet and rapeseed, is prevalent in the south-east, north, and west.⁷⁰

Although no official projections for agricultural land use to 2050 are available, existing analyses suggest a gradual decline in agricultural land area, consistent with historical trends.^{71,72}

For estimating theoretical CDR potential, this study assumes that **~8.8 Mha of agricultural land could be available for carbon sequestration by 2050**. While total agricultural area may decrease, the share available for CDR could increase due to policy developments (e.g. carbon credit schemes) and growing awareness of climate targets⁷³) and growing awareness of climate targets.

Agroforestry in Poland is still at an early stage of development and currently exists only in small, scattered initiatives⁷⁴. Thanks to new financial incentives provided by the Agency for Restructuring and Modernisation of Agriculture (ARiMR) under the 2023–2027 Common Agricultural Policy, farmers can now receive support for establishing agroforestry systems, in-field tree planting, or other tree-based landscape investments. As a result, although agroforestry remains a niche today, the availability of dedicated funding creates strong potential for rapid expansion in the coming years. In the long term, it could become an important component of sustainable agriculture, biodiversity enhancement, and land-based carbon sequestration strategies.⁷⁵

To calculate the **theoretical potential** of to what extent **agroforestry** could be applied, the majority of the agricultural land was assumed to be available, thus the area available would be **~7.9 Mha in 2050**.

Afforestation potential

Afforestation consists of establishing forest on land previously outside silviculture, usually agricultural or wasteland. Afforestation can also happen because of natural succession. According to the Statistical Yearbook of Forestry⁷⁶, 859 ha of land was actively afforested or afforested by natural succession in year 2023. The rate of afforestation based on statistics have fluctuated during 2015–2023 between 620–2400 ha per year. Unfortunately, there were no official data or projections on how afforestation efforts will be conducted in the future.

For the **theoretical potential** we assumed that the goal of National Programme for Increasing Forest Cover (33% forest cover) will be met **by 2050**. This would mean afforestation rate of around **32 kha/year**.

3.3.3 Peatlands

Peatlands in Poland cover a total area of 1.5 Mha (4.8% of the country area). Historically, a significant portion of these peatlands has been drained for agricultural and forestry purposes – mainly during the 19th and 20th centuries – which has led to a drastic reduction in their natural hydrological functions. Currently, over 85% of peatlands in Poland are degraded and no longer act as net carbon sinks.⁷⁷ Based on the research of Wetlands International, only 16 % of peatlands in Poland are under conservation status and are still able to form peat.⁷⁸ From the drained peatlands, around 70% are used for agriculture, while 13.8% are not in active use (wasteland) and 11.7% are used for forestry.

During recent years there has been a shift in political environment towards the conservation of peatlands for climate and safety reasons. Climate change and the associated droughts, fires and floods are directly linked to the need for water retention in all areas. In Poland, rewetted peatlands are seen as a way to strengthen the defence on the Russian and Belarus borders. This has led to a new wetland protection strategy that was submitted for public consultation in autumn 2025.⁷⁹ This will most probably lead to significant funding of rewetting projects in the near future.

In Poland, peatlands and wetlands are supported by the “Forests for Wetlands” project, implemented by the State Forests (PGL LP) from 2024 to 2029, covering at least 10 450 ha of Natura 2000 sites and other wetland areas, including bogs, peatlands, and grasslands. The project focuses on habitat restoration through the reconstruction of weirs,

removal of invasive species, hydrological monitoring, and educational activities for employees, local communities, and decision-makers. The total project cost is PLN 117.6 million, of which PLN 100 million comes from EU co-financing.⁸⁰

Additionally, under GAEC 2 (Good Agricultural and Environmental Conditions), a set of rules applying to farmers receiving EU support through the Common Agricultural policy, Poland has from 2025 introduced measures to protect peatlands and wetlands located on agricultural land. According to the Ministry of Agriculture, peatlands are wetlands where, due to high groundwater levels, peat accumulates from partially decomposed plant material, and organic matter mineralization is limited. To safeguard the carbon stored in peat soils on agricultural land, GAEC 2 prohibits, among other activities, peat extraction, the construction of drainage ditches, and ploughing of such soils.⁸¹

Thus, GAEC 2 serves as a complementary legal instrument for the protection of peatlands and wetlands in Poland, alongside financial projects like "Forests for Wetlands."

For **theoretical potential of peatland restoration**, we have assumed that all drained peatlands would be rewetted **by 2050**, i.e. in total **~1.3 Mha**.

3.3.4 Coastal areas

Poland has a coastline of 770 km on the Baltic Sea, including the internal waters of the Szczecin Lagoon and the Vistula Lagoon, which account for 246km. The maritime border is 440 km long.⁸²

The Baltic Sea is a shallow inland sea and it is severely eutrophicated. The current surface area of the Baltic Sea is 392,000 km², with a volume of 21,000 km³. The average depth of the Baltic Sea is only 55 m, whereas the average depth of other inland seas, such as the Mediterranean, is 1,000 m, and the average depth of oceans is several kilometres. The maximum depth of the Baltic Sea is only 460 m.⁸³ Sea currents in the Baltic Sea are characterized by low intensity, which enhances eutrophication. As there are few connections to other seas, the flow of salty seawater into the Baltic Sea is minimal.



Instead, fresh water constantly flows into the Baltic Sea via rivers and rainfall. The entire Baltic Sea is a low-salinity brackish water area. The sea has been polluted by the wastewater of approximately 85 million people across the 14 states that belong to its basin, and the eight countries which share the shoreline of the Baltic Sea.

Seagrass meadows (*Zostera marina*) and salt marshes are present in the Baltic Sea, and they are both found on the Polish coast around the Hel Peninsula in the Gulf of Gdansk, while salt marshes are also found along the coastline west of Hel Peninsula⁸⁴. There is research evidence about the carbon capturing capabilities of seagrass meadows, suggesting that most of them act as carbon sinks, however the rate at which these habitats capture and store carbon dioxide will fluctuate depending on the environmental conditions⁸⁵ - for *Zostera marina* for example habitats in calm bays will store more carbon than in areas with strong erosion.^{86 87} The GEOMAR Helmholtz Centre for Ocean Research in Cologne is conducting a research project called ZOBLUC ("*Zostera marina* as a Blue Carbon Sink in the Baltic Sea"). The aim of the project is to carry out modelling that will determine the capacity of seagrass meadows to absorb carbon dioxide.

For now, there is not adequate research from Polish context to estimate the carbon dioxide capture potential of seagrass meadows or salt marshes, nor the development of the potential, and further research is needed.

As a result of the limited evidence, a theoretical potential for CDR on coastal lands has not been estimated.

3.4 Biomass feedstocks

In Poland, various biomass streams from agricultural, industrial, and forestry activities are available for CDR.

3.4.1 Forest biomass

The theoretical availability of forest biomass is closely linked to harvest levels, which determine both biomass supply and the carbon stock maintained in forests. Increasing harvests can raise biomass availability but may reduce the forest carbon sink, creating a trade-off between carbon storage in forests natural state and biomass-based CDR pathways. This analysis is based on data from the Statistical Yearbook of Forestry (GUS). The current distribution of harvested wood by type is shown in Figure 11.

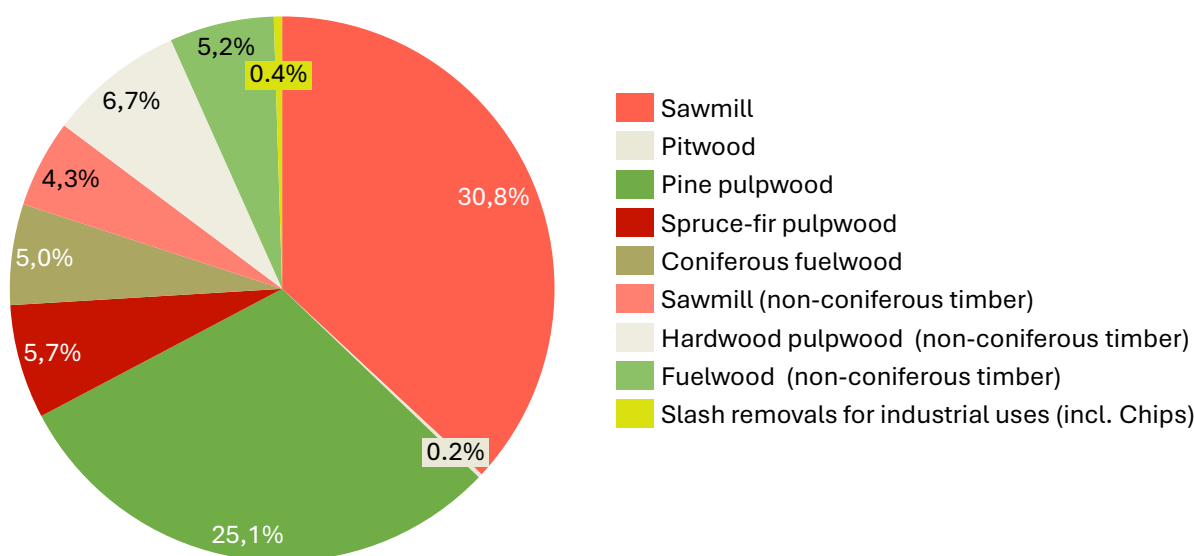


Figure 11. Share of different types of wood removed (data from 2024)⁸⁸.

Biomass stream	Description	Current total mass (t DM/year)	Projected mass in 2030 and 2050 (t DM/year)	Assumptions for availability
Energy wood	Primarily used for energy generation in industry and households.	913,951	682,625	90% theoretically available for CDR through CCS retrofitting, 10% used for households.
Sawmill wood	Large-diameter logs used for sawnwood production	3,034,763	3,049,615	From overall stream of this type of wood: 70% is product, 30% is waste from production. From product stream: 60% theoretically available for CDR Assumed that 40% will be used in non-long term storage solutions Availability for CDR: 42% of overall stream.
Pitwood	Wood used for mining support structures.	18,734	26,546	From overall stream of this type of wood: 85% is product, 15% is waste from production. From product stream: 60% theoretically available for CDR Assumed that 40% will be used in non-long term storage solutions. Availability for CDR: 51%.
Pulpwood	Small-diameter or lower-quality wood used in paper production.	1,943,599	2,106,912	0% of stream available for CDR due to higher import than export. ⁸⁹
Wood-based panels, plywood	Wood used for engineered products such as particleboard, OSB, MDF and HDF	1,295,733	1,404,608	From overall stream of this type of wood: 90% is product, 10% is waste from production. From product stream: 30% theoretically available for CDR Assumed that 70% will be used in non-long term storage solutions (lower than in other wood types due to different applications) Availability for CDR: 27% of overall stream.
Black liquor	A by-product of pulp and paper production.	777,440	842,765	100% theoretically available for CDR.
SUM		7,206,782	7,270,306	-

Table 1. Forest biomass theoretically available for CDR biomass conversion methods in 2030 and 2050⁹⁰.

Due to the lack of reliable projections for future harvest levels in Poland, this study assumes constant harvest volumes through 2030 and 2050, based on the average for 2019–2023. This is a simplifying assumption, particularly given national climate objectives to increase forest carbon sinks, which could imply reduced harvest intensity over time.

Forest biomass availability for CDR is presented in Table 1. Estimates are based on historical averages from 2019–2023 reported in the Statistical Yearbook of Forestry (GUS). Energy wood, sawmill and pitwood data were used as reported in the original data source. For pulpwood and plywood, it was assumed 60% of pine pulpwood, spruce-fir

pulpwood and hardwood pulpwood were assumed to be used for pulp and 40% of these were assumed for other usage (plywood).

Table 1 presents the projected availability of forest biomass and the assumptions used to estimate its potential for CDR. These assumptions are based on current usage patterns of different biomass streams.

Industrial residues (such as residues from boards production, sawmill and pitwood production) were not included in the flows available for CDR as it was assumed that most of these residues would be used to produce for example pellets used by private households.

In summary, **forests present significant CDR potential for Poland** both as a natural carbon sink and by forest-based biomass in other CDR value chains. Energy wood can be utilised for CDR through retrofitting existing facilities for combustion with BECCS assuming use of sustainable biomass. Resource allocation to different CDR methods is explained in chapter 4 and 7.

3.4.2 Waste Biomass

Waste-derived biomass represents a significant potential feedstock for CDR in Poland. The total **municipal waste stream amounts to over 10.6 Mt annually**,⁹¹ with a large share still collected as mixed waste (approximately 60%). Around 2.7 Mt is

incinerated with energy recovery, with an additional ~0.1 Mt incinerated without recovery⁹², while a substantial fraction continues to be landfilled. Industrial waste contributes an additional **~8 Mt annually**, with paper and cardboard **waste constituting a major share**.

Table 2 presents the breakdown of key waste biomass streams and their estimated availability for CDR. Future projections are based on extrapolation of historical trends (up to five years where available) due to the lack of official forward-looking data. Waste streams recycled were excluded from the amount available for CDR because recycling is considered a priority use.

Type of products		Current stream (t DM/year)	Projected mass in 2030 (t DM/year)	Projected mass in 2050 (t DM/year)	Assumptions for availability
Municipal waste	Paper and cardboard	517,845 ⁹³	640,570	915,100	50% currently available for CDR (based on ~42% recycling rate from 2021). It is assumed that availability will decrease to 20% by 2050 due to increasing recycling rates.
	Biowaste	456,334 ⁹⁴	689,978	1,361,348	~ 98% currently available (as per 2022, existing biogas plants have very limited treatment capacity, with 45 kt annually ⁹⁵ so overall stream has been decreased by current biogas plants capacity). Up to 100% theoretically available in future, depending on infrastructure.
	Mixed waste	6,800,000 ⁹⁶	5,950,000	4,250,000	42% is and will be available for CDR (it is part of mixed waste stream considered as biofraction).
Industrial waste*	Paper and cardboard	4,618,510 ⁹⁷	732,080	366,040	Same assumption as municipal paper; decreasing availability due to increased recycling (20% long-term).
	Sludge	946,500 ⁹⁸	1,034,844	1,161,251	10% is currently available for CDR ⁹⁹ . Up to 100% theoretically available if redirected to BECCS-type applications.
SUM		3,339,189	9,047,472	8,053,739	

Table 2. Waste theoretically available for CDR in 2030 and 2050¹⁰⁰. *Wood waste was included in the forest biomass table.

3.4.3 Agricultural feedstocks

Poland has a well-developed agricultural sector that generates substantial volumes of by-products and post-harvest residues. This analysis focuses exclusively on agricultural residues - materials arising during production rather than primary crops - including straw, crop tops (e.g. potato and sugar beet leaves), oilseed residues, grasses, and animal manure.

Currently, most of these materials are used on-site as natural fertilisers, animal feed, or are partially directed to existing biogas plants. However, their potential in CDR methods - such as BECCS combined with anaerobic digestion - remains largely untapped. In the future, it may be possible to fully utilise these resources in biogas plants, replacing raw field residues with digestate.

The transition towards more sustainable agricultural practices is supported by policy instruments such as the "Energia dla Wsi" programme, which provides grants and loans for renewable energy installations, including small-scale biogas plants using agricultural residues. This programme is recurring each year, extending the number of beneficiaries (farmers).¹⁰¹

In Poland, annual agricultural production generates substantial quantities of biomass and residues. Major crops include grain, potatoes, sugar beet, and oilseeds. These production streams generate

significant amounts of crop residues (e.g. straw, tops, stems) with potential for CDR. Manure also constitutes a significant source of biomass that could be utilized for CDR. Altogether, these streams amount to about 140 Mt of biomass currently of which a fraction could be available for CDR.

The current total available quantities of different agricultural resources are presented in Table 3. Current and projected amounts were identified based on multiple sources of data such as national statistics and data bases. The projected stream volumes were derived through extrapolation from historical data. For residue streams lacking direct data, estimates were calculated using residue-to-product ratios from literature and typical agricultural practices. These were applied to projected crop outputs to derive residue volumes. It should be noted that these estimates are subject to significant uncertainty, as residue availability depends on crop type, regional practices, moisture content, and competing uses. Where data on current utilisation were unavailable, expert assumptions were applied on availability of residues for CDR.



Type of products	Current stream	Projected mass of stream (2030)	Projected mass of stream (2050)	Assumptions for availability
Cereal production	30,567,167 ¹⁰²	34,296,000	38,583,000	Cereal production results in generation of husks and straw. Cereal processing generates husks (shells), typically accounting for 5–25% of grain mass. In this analysis, a 10% share of total grain mass is assumed as husk residue potentially available for CDR. 10% of cereal production has been assumed to calculate available amount of husks. In addition, cereal production in Poland generates approximately 35 Mt of straw annually. Only small part of it is used. 10% is left on the field¹⁰³. Based on the above it has been assumed that 10% of total mass is available as husks. Of this, half of the stream was assumed possible to be used for CDR (due to other usage like local use for farm animals). Based on this calculation 54,09% is available now and 43,27% (80% of current availability) will be available in 2050.
Stems from peas and broad bean	258,637 ¹⁰⁴	275,000	330,000	25% is assumed to be theoretically available for CDR in 2050.
Potato tops	1,152,505 ¹⁰⁵	1,033,553	565,454	
Sugar beet tops	4,135,828 ¹⁰⁶	5,770,912	8,976,365	
Straw of herbage seed crops	22,521,242 ¹⁰⁷	23,593,182	25,654,563	
Stems of oils crops (oilseeds)	3,548,880 ¹⁰⁸	4,185,000	4,836,000	
Grasses	37,839,025 ¹⁰⁹	36,750,000	44,100,000	20% is assumed to be theoretically available for CDR in 2050.
Manure	25,096,214 ¹¹⁰	30,732,106	33,857,266	50% is assumed to be theoretically available for CDR in 2050.
Hay	17,260,525 ¹¹¹	11,050,000	12,750,000	25% is assumed to be theoretically available for CDR in 2050.
SUM	142,380,023	147,685,753	169,652,647	

Table 3. Current and projected agricultural products amounts (2024, 2030, 2050). Units in dry tons/year.

Based on the available data, the total **agricultural biomass theoretically available for CDR** is estimated at **148 Mt (dry mass) in 2030** and **170 Mt in 2050**. These biomass streams can be used for example for BECCS (e.g. for the production of biogas that is already incentivised in Poland) and biochar. However, several restrictions must be noted: the amount of waste biomass is expected

to decrease due to increased recycling and circular economy measures, while agricultural biomass faces competing uses such as animal feed and soil improvement. These factors, along with logistical challenges and moisture variability, represent critical considerations for the practical implementation of CDR strategies.

3.5 Mineral feedstocks

Limestone, dolomite and other sedimentary rocks are widespread across Poland, with significant deposits in central and southeastern areas. Igneous and metamorphic rocks are instead mainly located in the southern regions, particularly in Lower Silesia, Opole, and Lesser Poland. **This study considered only primary mineral resources.** Secondary materials (e.g. industrial by-products) were excluded due to insufficient data on volumes, current uses, and their suitability for CDR applications.

Poland has substantial **limestone** resources, with total geological deposits estimated at approximately 20,000 Mt¹¹², of which around 3,000 Mt are classified as industrial reserves¹¹³. These reserves include both balance-sheet and selected off-balance resources within designated mining areas and may be exploited subject to technical, economic, and environmental constraints. Annual limestone production in Poland is approximately **16.5 Mt** of limestone (based on 2019 data), placing the country among the leading producers in Europe.¹¹⁴ Limestone is primarily used in the cement and lime industries, as well as in construction (aggregates), with a smaller share used in agriculture for soil pH regulation¹¹⁵. Current exports are relatively modest, at around 1.1–1.2 Mt/year (2023)¹¹⁶, and are expected to increase gradually to ~2 Mt/year by 2050. Production is assumed to remain broadly stable in the near term (to 2030), with a moderate increase (~0.8 Mt/year) by 2050.

Basalt is another mineral of interest for CDR, particularly for enhanced rock weathering. Poland's basalt resources are estimated at approximately 544 Mt of total deposits, with **~314 Mt** classified as industrial reserves¹¹⁷. Current production is around **7.3 Mt/year** (2024)¹¹⁸ and is expected to grow modestly by 2030 and more significantly by 2050 (by ~1.5 Mt). Exports are relatively small (around 0.1–0.2 Mt/year) but are projected to increase over time.

Dolomite production currently exceeds **2.9 Mt/year** and is projected to increase gradually (by ~0.3 Mt by 2030 and ~0.9 Mt by 2050). Export volumes are limited (~0.05 Mt/year) but are expected to grow modestly.

Olivine, a mineral with high theoretical potential for CDR, occurs in Poland (e.g. in serpentinite massifs in Lower Silesia)^{119 120 121 122}, but is not exploited at industrial scale, and no reliable production data are available. It is therefore excluded from the quantitative assessment. Similarly, there are no natural deposits of wollastonite in the country, nor is it imported from abroad¹²³.

To conclude, Poland has significant mineral resources that could support CDR pathways, particularly limestone, basalt, and dolomite. However, these materials are already extensively used in construction, industry, and metallurgy, and part of production is exported, limiting their availability.

To estimate the theoretical availability for CDR of mineral resources, this study applied the following assumptions based on expert estimates:

- **Limestone:** ~20% of production available for CDR (**~5.1 Mt/year**)
- **Basalt:** ~50% of production available (**~4.6 Mt/year**) as a consequence of both increased production and exports
- **Dolomite:** ~50% of production available (**~1.9 Mt/year**)

These assumptions represent **simplified, scenario-based estimates** and do not account for economic competition, regulatory constraints, environmental considerations, or logistical limitations.

3.6 CO₂ storage

The estimates of CO₂ storage potential presented in this section are based on preliminary, theoretical assessments by the Polish Geological Institute (PIG-PIB). These figures should be considered indicative, as they require further validation through detailed geological and geophysical studies. Until such analyses are completed, the suitability and economic viability of specific formations remain uncertain. Overall, the assessment of geological CO₂ storage in Poland is still at an early stage.

Between 2008 and 2012, Poland's National Geological Institute¹²⁴ conducted a comprehensive evaluation of the country's geological CO₂ storage potential. The results suggested that Poland has significant theoretical cumulative capacity of up to **15.62 GtCO₂**, distributed across¹²⁵:

- Saline aquifers (12,009–14,495 MtCO₂):** the largest potential, located across multiple regions (e.g. Jurassic, Triassic, Permian, Carboniferous and Cambrian formations), typically at depths >800–1,000 m. Key structures include the Poznań Trough, Budziszewice–Zaosie (Bełchatów region), and the Choszczno-Suliszewo anticlines in northwestern Poland, with some sites reaching capacities of hundreds of millions of tonnes.

- b. Depleted oil and gas fields (784-1,021 MtCO₂):** mainly in western and southeastern Poland (e.g. Wilków gas field and Nosówka oil field), offering well-characterised and relatively secure traps, but with more limited capacity compared to saline aquifers.
- c. Unmined coal seams (20-100 MtCO₂):** concentrated in the Upper Silesian Coal Basin (GZW) (e.g., the Pawłowice-Mizerów objective), with limited potential and mainly considered in combination with enhanced coalbed methane recovery.

The study conducted by Nooraiepour et al establishes an integrated assessment framework to assess geological CO₂ storage potential especially in low-maturity CCS regions. The study suggests that the total theoretical capacity estimation ranges from 8.9 Gt to 15 Gt in Poland, deep saline aquifers representing 90-93 % of this potential. The findings are more or less along the lines with those from Poland's National Geological Institute. The data from the latter was used, as the data collection for the carbon readiness assessment was conducted prior publication of the study by Nooraiepour et al.

Figure 12 shows the geographical distribution of potential geological formations suitable for CO₂ storage based on findings by Poland's National Geological Institute.

However, not all of this capacity is expected to be technically or economically viable. Accounting for geological uncertainty, infrastructure constraints, and cost considerations, the International Energy Agency (IEA) estimates Poland's **practical cumulative CO₂ storage capacity at around 2 GtCO₂**, significantly lower than the theoretical total.¹²⁶

Overall, Poland's geological formations - particularly saline aquifers and depleted hydrocarbon reservoirs - offer substantial long-term storage potential, although further site-specific assessments are required. Additional studies and international collaborations are ongoing to better characterise and validate these resources.

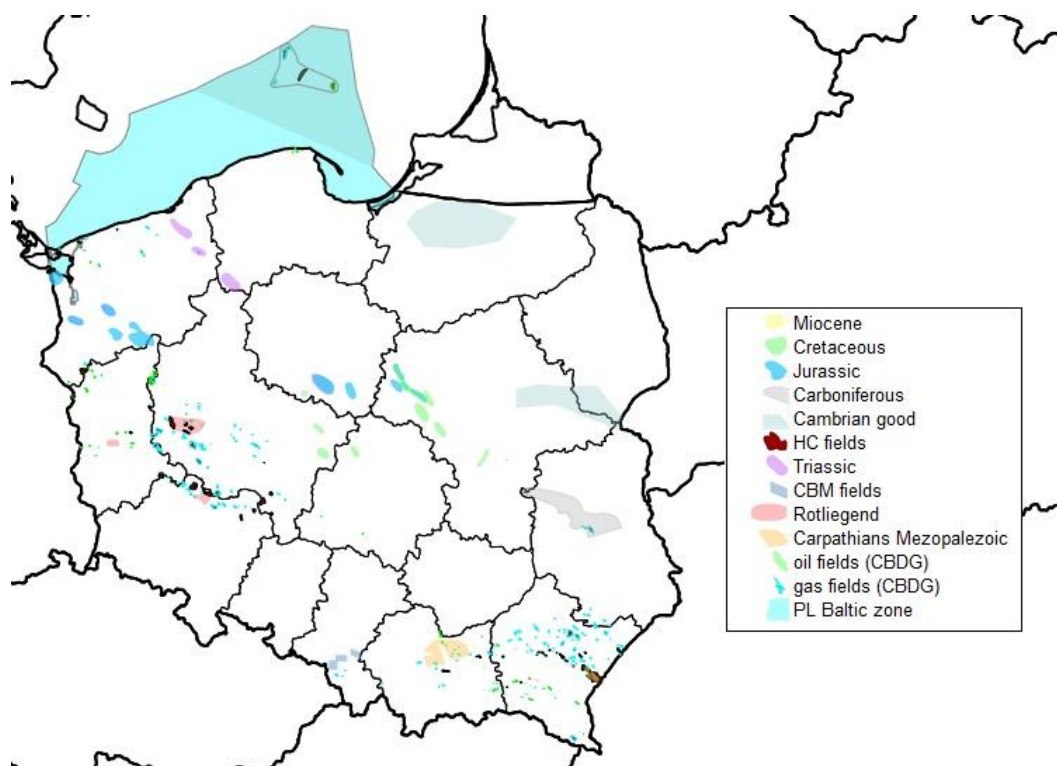


Figure 12. Geological CO₂ sequestration possibilities in Poland¹²⁷

Carbon mineralisation technologies are also emerging in Poland, although they are not yet deployed at scale. In particular, ex-situ mineralisation - where CO₂ is permanently bound into minerals or construction materials outside geological formations - is gaining interest. One example is the Heidelberg Materials cement plant in Górażdże, where a pilot carbonation reactor has been implemented under the CARBON4MINERALS project. The installation processes recycled concrete fines and binds approximately 150 kg CO₂ per tonne of material through accelerated carbonation.¹²⁸

Due to limited data availability, ex-situ mineralisation is excluded as an individual CDR method in this report, and all minerals suitable for carbon sequestration are allocated to enhanced rock weathering.

Since the 2012 national assessment, progress has been made in advancing plans for CO₂ storage deployment in Poland, with several projects under development (see next chapter).

For modelling purposes, this report assumes a total geological storage capacity of ~2 GtCO₂ by 2050, in line with the IEA estimate. Assuming deployment begins to scale from 2030 onwards and reach 2 Gt by 2050, this would correspond to a **theoretical storage rate of ~130 MtCO₂/year in 2050.**

3.7 CO₂ infrastructure

In addition to its significant geological CO₂ storage potential, Poland is a strong candidate for CCUS deployment due to both its large storage capacity and the presence of hard-to-abate industrial sectors that will likely require CCUS for decarbonisation. **Currently, Poland has no commercial-scale CCS facilities in operation, although several pilot, demonstration, and infrastructure projects are under development or feasibility assessment**¹²⁹ (Table 4). Although Poland amended the *Geological and Mining Law* in 2023 to support the implementation of CO₂ storage projects, the accompanying delegated regulations have not yet been updated. In particular, the so-called location regulation - which defines areas eligible for CO₂ storage exploration - currently restricts such activities to Poland's Exclusive Economic Zone in the Baltic Sea. As a result, the legislation still does not specify which onshore areas in Poland may be used for CO₂ storage. While amendments to allow selected onshore locations are reportedly under discussion, the absence of an updated regulatory framework has effectively delayed the practical development and implementation of onshore CO₂ storage projects in Poland.



Existing R&D installations	
Łaziska Power Plant (Tauron)	Installation completed in 2013 Project cost 8,8 mln PLN
Qemetica factory in Inowrocław	Project completed in 2023 Capacity 3.000-4.000 tons of CO ₂ /year
Góraźdże Cement Plant	Heidelbergs Materials Pilot CO ₂ capture installation implemented as part of the ACCSESS project Project completed in 2026 Total cost of the project: 18 mln EUR EU grant: 15 mln EUR
Completed projects	
Pilot of the Polish CCUS Cluster	Strategy for the Development of CO ₂ Capture, Transport, Utilisation, and Storage Technologies in Poland and the Pilot of the Polish CCUS Cluster. AGH University of Science and Technology in Kraków, the Ministry of Development and Technology (MRiT), and WiseEuropa. Project completed in 2024. Did not result in any binding strategy. Project funded by the National Center for Research and Development (10 mln PLN).
ECO ₂ CEE (previously - Studies4CCS Interconnector) link link	The project is implemented, inter alia, by ORLEN, Air Liquide Poland, Holcim Polska (the implementer of the Go4ECOPlanet project), and Gaz System. According to the current assumptions, it is divided into phases. The first phase is aligned with Holcim's plans, while the volumes attributable to the ORLEN Group are envisaged only in the second, developmental phase of the project, as focus is placed on the gradually emerging domestic storage opportunities. Preparation of feasibility studies to develop an open access terminal in Gdańsk with related CO ₂ transport infrastructure from the facilities of industrial emitters: • 1 MtCO₂ – Kujawy Cement Plant • 1 MtCO₂ – Refinery Plant Płock • 1 MtCO₂ – other companies Project completed in 2025. Connecting Europe Facility (CEF) grant: 2,5 mln EUR.
Ongoing projects	
Go4ECOPlanet	Holcim, Air Liquide CO ₂ capture and transmission infrastructure at the Kujawy Cement Plant (1 MtCO ₂) According to Holcim Polska, construction is expected to begin in 2027, with the project planned to become operational post-2030. Total cost of the project: 380 mln EUR. Innovation Fund grant: 228 mln EUR.
TGTU III (Refinery Plant Płock)	ORLEN CO ₂ capture and transmission infrastructure at the Refinery Plant Płock (1 MtCO ₂) The installation is scheduled to begin operations in 2030 Total cost of the project: 346 mln EUR.
Planned Projects	
ORLEN + Norway's Equinor collaboration agreement	Under the agreement, ORLEN and Equinor will jointly identify potential CO ₂ storage sites, considering both land-based locations and areas within the Polish section of the Baltic Sea. In the next step, the partners will assess the feasibility of joint projects based on the identified storage locations in Poland.
ORLEN Strategy	ORLEN has committed to achieving an annual carbon capture, transport, and storage capacity of 4 million tonnes by 2035.
BaltiCO₂Net PCI	Regional initiative coordinated by Equinor aiming to establish a cross-border infrastructure for the transport and permanent storage of anthropogenic and biogenic CO ₂ from the Baltic Sea region to storage sites in Denmark. BaltiCO ₂ Net includes 17 capture projects across Denmark, Germany, Latvia, Poland, and Sweden, CO ₂ collection networks, export terminals, and a receiving terminal and storage site in Kalundborg, Denmark. Operations are planned to begin before 2030.

Table 4. Summary of CO₂ infrastructure projects

To explore possibilities for collaboration within CCS, Polish energy company ORLEN signed a Memorandum of Understanding with Norwegian Equinor, which already has a number of CO₂ transport and storage projects that are either in operation, under development or planning. **ORLEN's recent update to its corporate strategy indicates that their goal is to capture, transport, and store up to 4.2 MtCO₂ annually by 2035¹³⁰.** This aligns with the EU Net-Zero Industry Act (NZIA), which requires oil and gas producers operating in the EU to contribute to the development of a collective CO₂ injection capacity target of 50 MtCO₂/year by 2030.¹³¹

A consortium including AGH University of Science and Technology, the Ministry of Development and Technology, and WiseEuropa has developed a *Strategy for the Development of CO₂ Capture, Transport, Utilisation and Storage Technologies* in Poland. This was completed in 2024 but did not result in any binding strategy. The project aimed to develop regulatory recommendations and support the creation of the first Polish CCUS cluster.¹³²

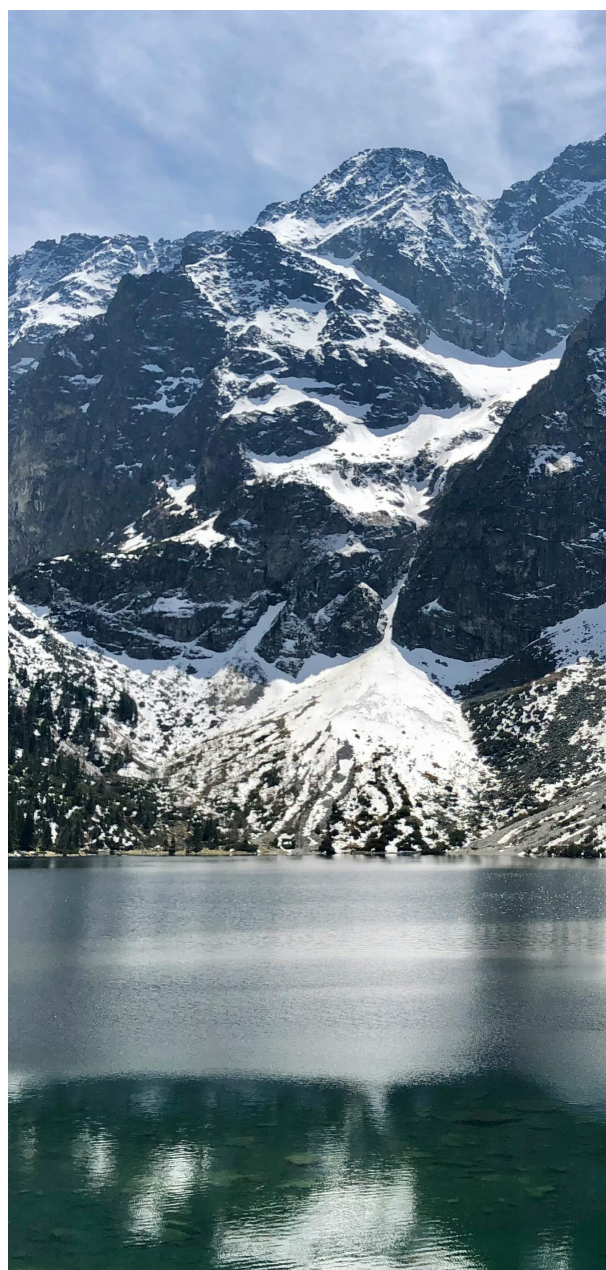
Major CCS initiative is ECO₂CEE project. The project involves construction of the first transshipment terminal in Gdańsk, enabling international transport of CO₂¹³³. The project also includes the development of a network enabling the transport of CO₂ from emitters such as the refinery in Płock and the Kujawy Cement Plant to the terminal.

In 2023 the terminal project under the name „Studies4CCS Interconnector” received 2.54 mln EUR from the EU Connecting Europe Facility (CEF) for feasibility studies regarding the management of the CO₂ logistics chain and FEED documentation¹³⁴. According to Orlen's strategy by 2035¹³⁵, planned terminal is expected to handle 4 MtCO₂/year, including approximately:

- 1.1 MtCO₂/year from ORLENS internal demand,
- 1 MtCO₂/year from external volume,
- and 1.9 MtCO₂/year further commercial potential.

Holcim's project at the Kujawy Cement Plant called Kujawy Go4ECOPlanet includes CO₂ capture infrastructure and in the final stage - connection to the planned transport network via the port of Gdańsk¹³⁶. Expected start of project execution is 2027, with operations planned from 2030 and a projected capture capacity of 1.2 MtCO₂/year.

Poland is also involved in the broader regional BaltiCO₂Net PCI initiative coordinated by Equinor. The project aims to establish cross-border infrastructure for the transport and permanent storage of anthropogenic and biogenic CO₂ from the Baltic Sea region to storage sites in Denmark. In addition to supporting industrial decarbonisation, the initiative seeks to accelerate the development of a wider European CO₂ transport and storage market. BaltiCO₂Net includes 17 capture projects across five EU Member States (Denmark, Germany, Latvia, Poland, and Sweden), together with CO₂ collection networks, export terminals, and a receiving terminal and storage site in Kalundborg, Denmark. Operations are planned to begin before 2030.



3.8 Natural conditions

The geographical distribution of climatic and ecological conditions is crucial for land-based CDR methods, geochemistry, and certain synthetic carbon removal techniques. To understand the climatic conditions across Poland. Generally southwestern regions of Poland are warmer than northern parts. The cold-water masses of the Southern Baltic Sea have a noticeable impact on reducing the highest temperature values, especially prominent during late spring and summer.^{137 138}

Conversely, the impact of the warming Baltic Sea is evident in the spatial distribution of the 5% minimum air temperatures (-10 , -3°C)¹³⁹, with higher values observed in the western and central parts of the Polish coastline and the coastal strip.¹⁴⁰ For this element, the gradient trends toward the southeast. The largest temperature drops occur in the Sudetes, Carpathians, and Świętokrzyskie Mountains.

Re rainfall, the average annual rainfall distribution throughout Poland, based on actual measurements from 1950-2019, shows that central Poland presents significantly lower rainfall compared to the northern and southern parts of the country. The range of average annual rainfall between 560 mm and 1400 mm^{141 142}. Relative humidity values range from 50% to 90%¹⁴³ in Poland, depending on temperature, season, pressure, and other atmospheric factors.

3.9 Restrictions

In Poland, the level of environmental protection is primarily defined by legally designated forms of nature protection. These areas are spatially distributed across the country and include a wide range of categories with varying levels of protection (Figure 13). The system comprises, among others, national parks and ecological utility areas, nature reserves and protected landscape areas, Natura 2000 sites (both bird and habitat directives), landscape parks, and nature-landscape complexes. Together, these designations form a dense and overlapping network of protected areas, although individual natural monuments are typically not included in nationwide spatial datasets. Due to data limitations and the calculation method used, these areas were not deducted individually from the land potentially suitable for CDR, but were considered when estimating the realistic potential, particularly where forest-use restrictions, wetland protection, or peatland conservation may limit biomass supply or agricultural land availability.



Figure 13. Forms of nature protection in Poland¹⁴⁴

The green colour indicates Ecological Utility Areas and National Parks, the orange colour represents Nature Reserves and Protected Landscape Areas, the blue colour marks Natura 2000 bird areas, the red colour indicates Natura 2000 habitat areas, the yellow colour shows Landscape Parks, and the pink colour represents Nature and Landscape Complexes. The attached map does not account for Nature Monuments.

Agricultural land use is widespread across Poland and varies according to soil conditions and crop types. Spatial data show a mosaic of arable land uses, including cereals (such as wheat, rye, and triticale), fodder crops, permanent grasslands, and mountain farming areas. Some areas remain unclassified. This distribution reflects both environmental conditions and regional agricultural practices.¹⁴⁵

From a biodiversity perspective, Poland's 23 national parks play a key role. These parks include zones with different protection regimes, ranging from strictly protected core areas to actively managed and buffer zones. The variation in protection categories reflects differing conservation objectives and management approaches within each park.¹⁴⁶

4. CDR theoretical potential (Could do)

To estimate Poland's theoretical CDR potential, this study first assessed the maximum availability of relevant resources - such as biomass, land, and energy - presented in Chapter 3 and discounted the amounts from priority uses. The theoretical CDR potential assumes full mobilisation of all suitable resources for CDR, without factoring in real-world constraints, competing demands from other sectors, or societal readiness. While not practically feasible, this upper-bound estimate serves as a benchmark for understanding what could be achieved under extraordinary circumstances, akin to a nationwide mobilisation effort to address climate change. This theoretical maximum helps frame the more realistic estimates presented in Chapter 7.

4.1 Methodology

To assess the theoretical potential, it is necessary to estimate the resource availability of each CDR method. Most methods rely on multiple inputs – such as electricity, water or heat – and therefore compete for the same resources. The calculation of theoretical potential is based on a bottom-up approach of assessing how the physical resources (described in Chapter 3) should be used optimally to maximize overall removal potential. For each CDR method it is firstly defined what is the primary resource – or resources – needed, and resources are then allocated optimally to the different methods based on which method requires the fewest resources per net ton of CO₂. The methodology and database used for this optimisation is described in chapter 2.3. Based on this allocation, it is then calculated how much CO₂ could be used with existing resources using the portfolio of methods in the most optimal way.

In the Polish context, **the most contested and limiting resource among different CDR methods is geological storage capacity**. Additionally, various CDR methods compete for similar types of biomass particularly wood-based biomass. Alongside energy efficiency, current uses and economic feasibility were also considered in the resource allocation process to the extent reasonably possible (this was done on a qualitative level – no economic variables were factored in the calculation). For example, despite biochar's technical efficiency and BECCS' limitations (due to storage availability), allocating the majority of biomass to biochar is not justified due to limited market demand compared to other CDR pathways. For CDR methods where biomass feedstocks can be clearly assigned without competition from other

CDR methods, the CDR potential was calculated by applying conversion factors to translate available biomass into equivalent tons of CO₂.

The theoretical CDR potential was calculated through a bottom-up assessment, quantifying the amount of carbon dioxide that Poland could remove by mobilising available resources across various CDR pathways.

4.2 Maximum theoretical CDR potential in Poland

The theoretical CDR potential for Poland in 2050 is **~362 Mt CO₂**. **This potential is dominated by agroforestry (~124 Mt CO₂)**, electrochemical DACCS (~106 Mt CO₂) and BECCS with anaerobic digestion (~30 Mt CO₂) (see Table 5 for a full breakdown of CDR methods).

This potential represents a **purely theoretical estimate**, based exclusively on availability of natural resources without considering political, economic, social and technological constraints. It is achieved if for instance, all biomass available in Poland after allocation to priority uses is assigned to CDR methods. A key driver of the overall potential is the assumption of sufficient CO₂ storage capacity, both domestically and through exports.

Geological storage is assumed to be available with injection capacity of 140 MtCO₂ per year, comprising 130 Mt CO₂ of domestic capacity and 10 MtCO₂ available for export. The latter reflects a theoretical high-ambition CDR scenario; in practice, exports from Poland are expected to be unlikely and limited, given domestic storage potential. Storage allocation prioritises BECCS over DACCS, reflecting the higher efficiency of capturing CO₂ from flue gases compared to direct air capture. Even after allocating storage to BECCS, sufficient capacity remains for DACCS deployment. However, DACCS ultimately utilises the remaining storage in a way that leaves part of the available electricity for CDR unused. As a result, geological storage capacity - not energy availability - emerges as the primary limiting factor in this scenario.

CDR method	CDR potential by 2050 (MtCO ₂ /year)	Notes
Agroforestry	124	Assumes that nearly all agricultural land (7.9 Mha) could be converted to agroforestry. This likely overestimates potential, as agroforestry may overlap with other carbon removal methods, and the applied conversion factor may not fully reflect Polish agricultural conditions.
Electrochemical DACCS	106	The CO ₂ storage left after BECCS, 106 Mt, was fully deployed to DACCS. Availability of electrical or thermal energy is not limiting the deployment of electrochemical DACCS. Instead, the storage potential becomes the limiting factor.
BECCS with anaerobic digestion	30	Based on the current total volumes of biomasses suitable for BECCS with anaerobic digestion, after biomass has been allocated to priority uses.
Cropland management	18	Assuming all cropland (7.7 Mha) in 2050 could be deployed for CDR.
Peatland restoration	10	Assuming all drained peatlands (1.2 Mha, 85% of the total peatland area) would be rewetted.
Afforestation	9	Assuming 0.87 Mha is available for afforestation, based on the assumption that the forest cover target is achieved by 2050.
Biochar	7	Assuming 20% of wood can be diverted to biochar production and that 20% of the agricultural residues most technically suitable for biochar were also directed to biochar.
Pasture management	5	Assuming all pasture lands in 2050 (1.2 Mha) could be deployed towards CDR.
BECCS with combustion	4	The figure is based on the current total volumes of biomass that is combusted. The potential of BECCS with combustion is much lower than BECCS with anaerobic digestion because of low availability of suitable wood for BECCS with combustion.
Mineral ocean alkalinity enhancement	4	Assuming 50% of projected volumes of dolomite and 20% of projected volumes of limestone are used for CDR. Thermal energy was a limiting factor, so the remaining amounts of dolomite and limestone were then allocated to ERW.
Improved forest management	3	Assuming all state-owned forests currently outside of FSC certification can be certified, along with 50% of other forests, for a total of 6.5 Mha.
Enhanced rock weathering	1.3	Assuming 50% of the projected volume of basalt is available for CDR by 2050. A small share of dolomite and limestone was also allocated to ERW as thermal energy constraints limit their use in Mineral OAE.
Durable bio-based products	0.4	Based on current total volumes of wood-based biomass already used for these products, and an assumption about the extent to which this could be increased.
Reforestation	0.3	Based historical restoration trends and adjusted for increasing forest damage, consistent with projections of around 24% rise in weather-related forest fire risk in Europe by 2050 compared to historical levels, implying greater reforestation needs ¹⁴⁷ .
Forest natural carbon sink (based on assumed harvesting levels)	40	The estimate is aligned with the 2023 forest sink, assuming stable harvesting and sink levels. Although this likely underestimates the theoretical maximum, data limitations prevent a more integrated assessment of sinks, harvesting, and biomass use. Increases in forest sink through forest management and reforestation are assessed separately.
Total (without natural sink)	322	The most limiting factor for technical methods was geological CO₂ storage capacity and thermal energy.
Total (with natural sink)	362	

Table 5. Poland's theoretical CDR potential by 2050.

5. Existing policy

This chapter explores how CDR is reflected in Poland's emissions trends, climate targets, and policy framework. It analyses Poland's role within EU climate commitments, reviews the political and legal context shaping national climate action, and identifies existing support mechanisms relevant for CDR and CCUS deployment. It also highlights key actors and upcoming policy developments that could influence the future role of CDR in Poland.

Poland has not adopted a legally binding national climate neutrality target or dedicated climate law, and current energy policy still foresees coal use continuing into the late 2040s, with the final coal mines expected to close by 2049¹⁴⁸. However, it is bound by the European Climate Law and other EU legislation requiring Member States to reduce GHG emissions across multiple sectors.¹⁴⁹ While CDR has so far played only a limited role in national policy, Poland's updated draft National Energy and Climate Plan (NECP) includes references to CCUS, BECCS and potentially DACCS. In parallel, several emerging CCUS-related policies and infrastructure initiatives could also support future deployment of CDR methods.¹⁵⁰

5.1 CDR within the Poland's climate strategy

As an EU Member State, Poland is legally bound by the European Climate Law, which sets the Union-wide objective of achieving climate neutrality by 2050¹⁵¹. However, Poland has not yet incorporated this target into national legislation, nor does it have a dedicated climate law or strategy outlining how it intends to meet this goal domestically¹⁵². This is due to its heavy reliance on coal, concerns about economic costs and energy security, and political resistance to EU-driven decarbonisation. As an EU Member State, Poland is covered by the European Union's collective Nationally Determined Contribution (NDC) submitted to the UNFCCC, rather than submitting an individual national NDC.¹⁵³ Poland submitted its first Biennial Transparency Report (BTR1) to the UNFCCC by the end of 2024. The report, prepared by the National Centre for Emissions Balancing and Management (KOBiZE) under the Ministry of Climate and Environment, provides a comprehensive overview of national greenhouse gas emissions, climate policies, and progress toward achieving EU climate targets.¹⁵⁴

Under the EU Governance Regulation (Regulation (EU) 2018/1999), Poland is required to prepare, submit, and regularly update its **National Energy and Climate Plan (NECP)**, which serves as a key

document defining how EU Member States will achieve their 2030 targets, including GHG emission reductions. The first Polish NECP for the years 2021–2030 was submitted to the European Commission on 30 December 2019. In July 2025, the Ministry of Climate and Environment approved a revised version of Poland's NECP covering the period up to 2030, with a strategic outlook to 2040, and presenting two scenarios:

- **WEM (With Existing Measures):** a continuation of existing policies (business as usual);
- **WAM (With Additional Measures):** a more ambitious scenario with active transition measures on climate and energy, where Poland aims to reduce GHG emissions by 53.9% by 2030 and 75.8% by 2040, compared to 1990 levels.

At the time of publication (May 2026), the revised NECP (aKPEiK) remains in the final stages of the national approval process.¹⁵⁵ Following its publication by the Ministry of Climate and Environment in July 2025, responsibility for the document was transferred to the newly established Ministry of Energy after the government reshuffle in August 2025. The Ministry is currently conducting inter-ministerial consultations and reviews with key advisory bodies, including the Joint Commission of the Government and Local Government, the Council for Social Dialogue, and the Public Benefit Activity Council. Once the document is endorsed by the national Council of Ministers, it will be formally submitted to the European Commission in line with EU governance requirements.¹⁵⁶

While carbon removal is already integrated into the Polish NECP draft scenarios mainly through the LULUCF sector, technological solutions like DACCS are presented only as options for the more distant future, with no specific measures for their immediate deployment detailed in the current plan. The document also recognizes the potential of BECCS (bio-CCS) as a decarbonization instrument within the power sector, particularly for biomass- and biomethane-based generation. Furthermore, the plan addresses the cascading use of biomass—prioritizing material applications over energy use—and announces the development of a national strategy for CCS/CCU technologies.

Poland's emissions profile shows a steady decline across most sectors, reflecting significant progress in decarbonisation, particularly within the energy and heating industries. Between 1990 and 2030, total emissions excluding LULUCF are projected to decrease by about 47%, with further reductions

of up to 70% expected by 2040. When LULUCF absorption is considered, total net emissions are projected to decline by approximately 54% by 2030 and 78% by 2040 compared to 1990 levels. Figure 14 illustrates that energy generation remains the dominant source of emissions. The LULUCF sector (Land Use, Land Use Change and Forestry) plays a crucial compensatory role, acting as a carbon sink that offsets part of Poland's total emissions. Its net absorption potential is estimated at around 46.8 MtCO₂ equivalent in 2030 and 35.6 MtCO₂ in 2040, supporting both climate mitigation and forest adaptation objectives¹⁵⁷.

5.1.1 Cost estimates for Poland's climate action

Under the WAM scenario, total investment needs in Poland over 2021–2040 **are estimated at approximately** PLN 3.64 trillion (about EUR 790–860 billion, depending on exchange rate assumptions), around 15–16% higher than under the WEM scenario. **The largest increases are expected in the** energy sector, particularly electricity generation and grids, as well as in district heating and mining, reflecting the need to modernise energy infrastructure and improve system efficiency.¹⁵⁸

Investment growth in other sectors is more moderate, with limited differences between scenarios. Notably, current plans do not explicitly allocate funding for carbon dioxide removal (CDR). This may constrain dedicated CDR deployment, although some planned investments – such as in CCUS, biomass, and energy infrastructure – could indirectly support it.

The Ministry of Climate and Environment has estimated that the average annual investment cost for the WAM scenario in the years 2026–2030 will amount to approximately PLN 216 billion. By comparison, the cost of inaction – linked to continued reliance on fossil fuels and delayed transition – has been estimated at up to PLN 266 billion per year (based on 2022–2023 data). **This includes:**

- PLN 140 billion in fuel import costs
- PLN 100 billion in air pollution-related health and environmental impacts
- PLN 20 billion in emission allowance costs
- PLN 6 billion from extreme weather events

Policy measures place particular emphasis on industry, including electrification, digitalisation of industrial processes, and reducing emissions in hard-to-decarbonise sectors such as cement through CCUS.¹⁵⁹

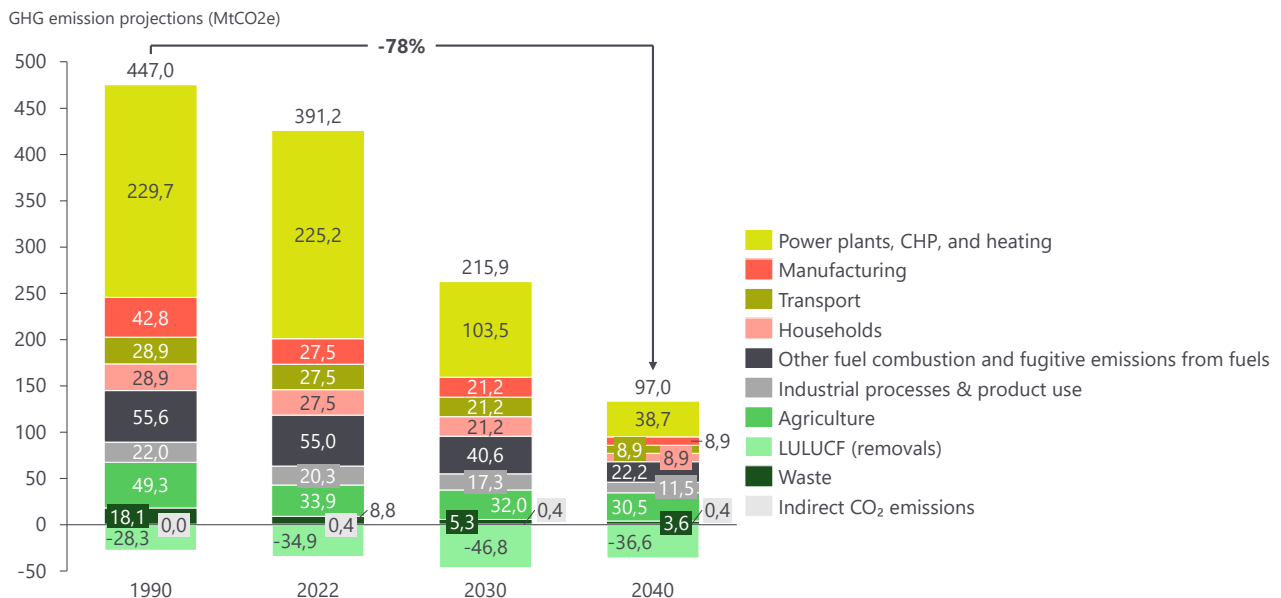


Figure 14. GHG emission projections in (MtCO₂e) for 2030 and 2040 under the WAM scenario, compared with 1990 and 2022 levels.¹⁶⁰ In the original source, the first five categories (power plants, CHP and heating; manufacturing; transport; households; and other fuel combustion and fugitive emissions) are grouped under the energy sector, consistent with IPCC definitions. This includes emissions from fuel combustion across sectors and fugitive emissions from fuels. The “industrial processes and product use” sector covers process-related emissions from mineral production, chemicals, and metals, excluding emissions from fuel combustion for energy generation.

5.2 Legal frameworks relevant to CDR

Poland's regulatory landscape for CDR is shaped by a combination of EU-level obligations, such as the CCS Directive, Industrial Emissions Directive (IED), the Net-Zero Industry Act (NZIA), Waste/Water/Nature Directives, and EU ETS, as well as national legislation, such as the Environmental Protection Law, Geological and Mining Law, Waste Act, Nature Conservation Act, and Environmental Impact Assessment/Strategic Environmental Assessment (EIA/SEA).

The CCS Directive¹⁶¹ is a key EU law for enabling CDR, as it sets rules for the safe capture, transport, and permanent geological storage of CO₂. In Poland, the Directive has been transposed mainly through the **Geological and Mining Law, which provides the fundamental legal basis for CCS projects**. Recent amendments to this law (2023/2024) have eased previous restrictions on geological CO₂ storage and created a more enabling framework for CCUS deployment. In October 2023, the Law of 16 June 2023 amending the *Geological and Mining Law and certain other laws* (Dz.U. 2023 item 2029)¹⁶² removed the previous limitation that allowed CO₂ storage only for demonstration projects, enabling industrial-scale storage. These changes primarily supported CCUS deployment, with indirect relevance for CDR pathways that depend on geological storage, such as BECCS and DACCS. A non-exhaustive list of changes includes:

- **Location ordinance remains the main legal bottleneck.** Polish law requires a regulation specifying the areas where underground CO₂ storage complexes may be located. The currently applicable framework has historically allowed storage only in limited offshore areas, while onshore storage remains constrained until an updated "location ordinance" is adopted. A draft regulation identifying new potential storage areas, including onshore locations, was put forward in late 2025, but industry stakeholders continue to identify its final adoption as essential for unlocking storage development.¹⁶³
- **Removal of the demonstration-project restriction.** The amendments removed previous limits that restricted geological CO₂ storage to demonstration projects only, opening the possibility for commercial CCS deployment.
- **Direct transport to storage sites.** CO₂ may be transported directly from capture facilities to geological storage sites where transport is functionally linked to storage operations, without necessarily relying on a dedicated transmission network.

- **Simplified early-stage exploration.** At the investment planning stage, identifying and assessing potential CO₂ storage locations no longer requires a full concession. Investors must instead prepare a geological works project and obtain approval from the Chief State Geologist.
- **Small-scale exemption.** Small-scale installations storing less than 100 ktCO₂ may benefit from simplified licensing requirements.

Poland has also not yet ratified the 2009 amendment to Article 6 of the **London Protocol**, which would formally allow cross-border export of CO₂ for sub-seabed geological storage. Although a provisional application is possible under the 2019 IMO resolution, this still requires appropriate international arrangements and notifications, meaning cross-border offshore storage remains legally more complex than domestic storage¹⁶⁴.

The regulation of the Minister of Development and Technology dated 29 September 2023, specifies the conditions for granting public aid for the implementation of investment projects of strategic importance for transitioning to a net-zero emission economy¹⁶⁵. Under this regulation, entrepreneurs can apply for support for investments related to the production of clean technologies, including equipment for capturing and storing CO₂. As of 2025, this aid has been granted to a new copper foil production plant, offshore wind-related projects and two battery material plants¹⁶⁶.

5.3 Support for R&D and Innovation

A key objective of Poland's national research and innovation (RDI) policy is to support the green economy through the development of a Green Innovation Hub, and support for activities aiming at achieving a zero-emission economy. The overarching RDI strategy focuses on creating an innovation-friendly environment, boosting employment in innovative sectors, and increasing R&D intensity. Poland is classified as an Emerging Innovator in the European Innovation Scoreboard.

While Poland does not yet have dedicated R&D programmes specifically targeting CDR, several **ongoing initiatives support** technologies and infrastructure relevant to both CCUS and future CDR deployment. Research and innovation efforts currently focus primarily on CCUS rather than on carbon removal technologies directly. Key organisations and institutions relevant to CDR and CCUS development in Poland include:

- **Governmental bodies** that set key regulations and develop strategies supporting CDR, including the Ministry of Climate and Environment, the Ministry of Development and Technology, the Ministry of Energy (established after the dissolution of the Ministry of Industry), and the Ministry of Education and Science.
- **Research organisations and universities**, particularly the Central Mining Institute (Główny Instytut Górnictwa, GIG), AGH University of Science and Technology (Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie), the National Centre for Emissions Management (Krajowy Ośrodek Bilansowania i Zarządzania Emisjami), operating as part of the National Institute of Environmental Protection – National Research Institute.
- **Private and non-governmental organisations** (enterprises, technology transfer organisations, business associations, foundations, technology parks, etc.), such as the Warsaw Institute for Economic and European Studies Foundation (Fundacja Warszawski Instytut Studiów Ekonomicznych i Europejskich), UNEP/GRID-Warsaw.
- **The National Centre for Research and Development (NCBR)**¹⁶⁷, Poland's main public R&D funding agency supporting innovation in both the public and private sectors, and acting as the National Contact Point for Horizon Europe, provides an important enabling environment for emerging climate technologies, including CDR. Although its funding is not dedicated specifically to CDR, the scale of its activities demonstrates significant capacity to support related research and innovation. In 2020 alone, NCBR launched 73 calls for proposals with a total budget of PLN 6.9 billion across research and innovation sectors.

In addition, the **EEA and Norway Grants** have become an increasingly relevant source of support for green transition and CCUS-related activities in Poland. Under the 2021–2028 funding period, Poland is the largest beneficiary of the programme, with dedicated funding streams supporting climate action, innovation, and CCUS project development, including under the “Green Transition” programme.¹⁶⁸

The research program **Strategy for the Development of CO₂ Capture, Transport, Utilization, and Storage Technologies in Poland and the Pilot of the Polish CCUS Cluster**¹⁶⁹ implemented between 2021 and 2024 aimed to foster Poland's climate neutrality in line with the Paris Agreement by formulating the country's first CCUS development strategy, preparing comprehensive

legal regulations to support sustainable CCUS technology development, whilst taking into account Poland's economic, environmental, social, and industrial interests. Although the programme did not result in a legally binding national strategy, it contributed to the ongoing development of Poland's CCUS policy framework, which could support the development of BECCS and DACCS170. Co-funded by the National Centre for Research and Development (NCBR), this project aligned with the “Societal and Economic Development of Poland under Globalising Markets” program (GOSPOSTRATEG III), with a total project value of PLN 9,973,862.75.

The Innovation Fund, a program for the deployment of net-zero and innovative technologies funded by the EU Emissions Trading System (EU ETS), is the EU's primary climate policy funding instrument. It aims to support the EU's transition to climate neutrality while fostering competitiveness. Funding for innovative projects focuses, among others, on CCU and CCS¹⁷¹. One of the flagship projects financed under the Innovation Fund is the **Go4ECOPlanet initiative** implemented by Holcim Polska S.A. (formerly Lafarge Cement S.A.) at the Kujawy Cement Plant. The project received approximately €228 million in EU funding to develop and deploy a CCS installation capable of capturing 100% of CO₂ emissions from clinker production, one of the most emission-intensive industrial processes.¹⁷² Another relevant project is **HuCCSar**, led by Heidelberg Materials' Polish affiliate Góraźdże, aiming to develop Poland's first onshore CCS value chain by validating CO₂ storage potential in central Poland and supporting the deployment of transport and storage infrastructure for industrial decarbonisation.¹⁷³

5.4 On the horizon

While Poland's national focus in its climate work for the coming years and decades will be on decarbonising the energy sector, industrial transformation, and the transport sector - and while society as a whole is not yet fully on board with large-scale climate reforms - there are still opportunities to accelerate CDR deployment.

As the deadlines for the EU's carbon neutrality and emission-reduction targets draw nearer, Poland will need to include CDR in its toolbox, as its current decarbonisation efforts are progressing more slowly than required to meet these goals.

Strengths

- The updated National Energy and Climate Plan (NECP) for 2030, with a perspective to 2040, is currently in the final stage of adoption and outlines Poland's pathway towards a lower-emission economy, including initial references to CCUS and CDR-related technologies. However, the plan remains relatively limited in ambition and detail regarding CDR deployment.
- Rapid development of renewable energy sources - installed capacity in RES increased by over 10 GW within two years. In 2024, 42 TWh of electricity was generated from renewable sources (25% of total electricity production).

Weaknesses

- No specific plans for the development of CDR in Poland (only initial studies on storage capacity and individual developments from big companies).
- Fossil fuel-based generation sources currently produce 72% of the total electricity in the power system¹⁷⁴.
- Numerous regulations for new investments could extend the construction time of CCUS/CDR technology¹⁷⁵.

Opportunities

- Several emerging policy initiatives supporting CCUS deployment could also facilitate the future development of CDR, as many CDR methods rely on similar technologies and shared CO₂ transport and storage infrastructure.
- Progress in achieving the EU's climate goals according to e.g. the National Energy and Climate Plan¹⁷⁶.
- Public funding schemes already support technologies relevant to CDR. For example, ARiMR (the Agency for Restructuring and Modernisation of Agriculture) provides support for agroforestry¹⁷⁷ and biogas projects (which could also support deployment of BECCS), while programmes such as "Energy for Rural Areas"¹⁷⁸, the FEnKS programme, and the Modernisation Fund¹⁷⁹ support biogas, renewable gas, and high-efficiency cogeneration projects that could also facilitate future BECCS deployment.

Threats

- Difficulties in the administrative process, including obtaining permits for CO₂ storage¹⁸⁰.
- Limited public awareness and support for CCUS¹⁸¹ may also hinder broader acceptance of CDR technologies relying on CO₂ transport and storage, given Poland's reliance on onshore storage.
- Lack of coherent national climate targets.

Table 6. SWOT analysis of Polish climate policy.

Potential reductions in EU ETS prices could lower electricity costs for energy-intensive CDR methods such as DACCS. However, lower carbon prices may also weaken the overall economic incentive for CDR deployment by reducing the value of avoided or removed emissions. As a result, the net effect on CDR investment is uncertain and could be negative in the absence of dedicated support mechanisms for carbon removals.

In the context of updating climate policy plans in Poland, there are currently no specific projects dedicated to developing new strategic documents. All new updates are expected to be published on the government's website¹⁸². The **draft NECP** addresses technologies related to the capture, storage, and removal of carbon dioxide. In this document, CCUS is identified as a key factor for decarbonising industry, particularly in sectors that are difficult to decarbonise or electrify, such as cement, steel, and chemicals.^{183 184} Planned actions and policies regarding CCUS that could also benefit potential CDR deployment include:

- Support for commercial projects, including financial instruments and regulations to promote wider use of CCS and CCU in processes where other decarbonisation pathways are not feasible.
- Development of legal and organisational frameworks for CCS/CCU, including enabling CO₂ storage both onshore and offshore.
- Identification of potential CO₂ storage sites and transport infrastructure, including via a national geological mapping program.
- Establishment of legal frameworks for CO₂ transport network operators and storage operators.
- Conducting R&D and pilot projects.
- Public information campaigns to raise awareness of the safety of onshore CO₂ storage.
- In the cement industry, CCS deployment is considered a key solution to enable decarbonisation and avoid EU ETS costs, with implementation expected by 2030.
- Other industrial sectors, such as the chemical industry, which also face significant hard-to-abate emissions, are expected to adopt CCUS technologies.
- Investment decisions in CCS/CCU will depend on factors such as emission allowance prices, fuel and electricity costs, and the availability of alternative emission-reduction solutions.

From the perspective of Polish legislation and CCUS/CDR sector developments, it should be noted that on 5 March 2025, a **letter of intent** was signed at the Ministry of Climate and Environment, initiating the development of CCUS technologies in Poland¹⁸⁵. The document was signed by representatives of energy and industrial sectors, the scientific community, research institutions, and civil society organisations. The letter is open, meaning additional entities interested in deploying CDR technologies may join. The main goals of the initiative include:

- Developing a national CCUS strategy covering the entire value chain: capture, transport, storage, and utilisation of CO₂.
- Building technological and operational capacities at both national and local levels.
- Adapting legislation, including alignment with the EU's Net-Zero Industry Act (NZIA).
- Supporting research and innovation, including demonstration and pilot projects.
- Promoting international cooperation to enable knowledge and technology transfer and joint investments.
- Developing a communication and education strategy to increase public awareness and acceptance of CCUS technologies.

This initiative fits into the broader European efforts toward climate neutrality and may play a key role in addressing Poland's regulatory gap. It may also support the development of potential CDR hubs, which are likely to emerge around industrial clusters, particularly in Świętokrzyskie, Opolskie,, and Silesian (Śląskie) regions; coal-dependent regions undergoing transition such as Łódzkie (Łódzkie), and coastal regions with CO₂ transport and storage potential, including Pomeranian (Pomorskie) and West Pomeranian (Zachodniopomorskie), complemented by major research centres in Masovian (Mazowieckie) and Lesser Poland (Małopolskie), providing technological and operational capacity at both national and local levels.

5.4.1 CDR players

In Poland, the CDR and CCUS ecosystem is still at an early stage of development, but several relevant actors and initiatives are emerging (Figure 15). For example, **a dedicated CCUS association already coordinates activities** related to carbon capture, utilisation, and storage.

There is currently a lack of companies specialising in the professional implementation and development of CDR technologies in Poland.

The main entities currently investing in CCUS technologies in Poland are two companies operating in the fuel, refining, and cement industries. The first is **ORLEN S.A.**, which is preparing a project to capture approximately 1 Mt CO₂ annually¹⁸⁶ at its refinery site. The second major investment is the construction of a CO₂ capture and transmission installation, along with the accompanying infrastructure, at a cement plant, with **Holcim** as the investor¹⁸⁷. Heidelberg Materials' Polish affiliate, **Góraźdże Cement**, is also developing a CCUS project supported under the EU Innovation Fund, further indicating growing interest from the cement industry in CCS deployment in Poland.¹⁸⁸

Dedicated CDR start-ups remain limited, although a broader ecosystem of companies focused on emissions management and decarbonisation services is developing. Early-stage DAC and CCUS cluster initiatives are also beginning to emerge. One example is Poland's first DAC pilot project, developed by Oraquel S.A. in cooperation with the city of Kielce, targeting the capture of around 500 tCO₂/year.¹⁸⁹

According to an analysis by the Polish Economic Institute, the energy sector - including electricity producers - has the greatest potential for implementing CCUS/CDR technology in Poland in the coming years¹⁹⁰.

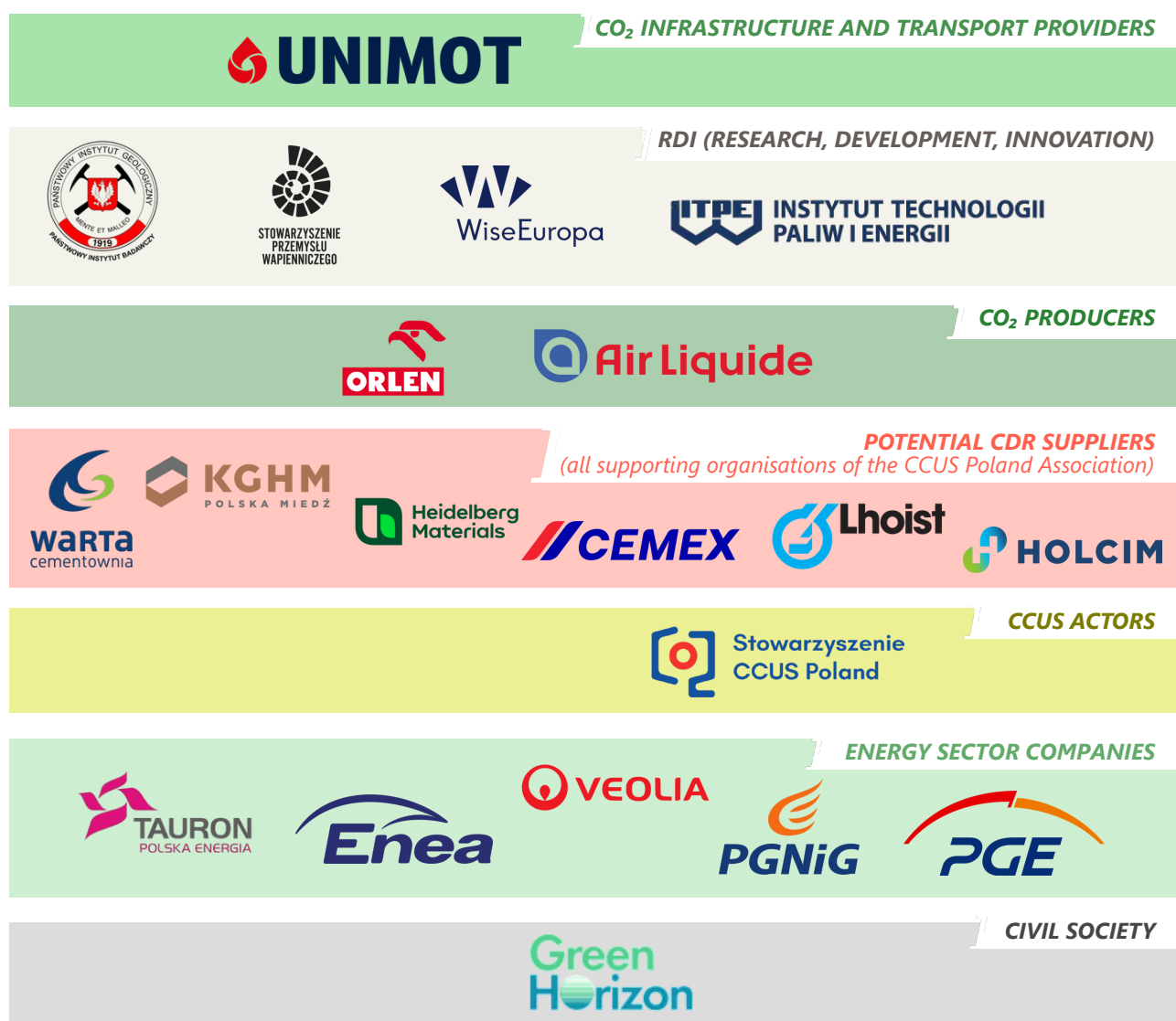


Figure 15. Current main actors in the Polish CDR ecosystem.

6. Poland's social geography

Poland's social landscape presents a unique blend of opportunities and challenges for the deployment of CDR technologies. As the country navigates its path towards sustainability, various social, economic, and political factors come into play. On one hand, growing public awareness of climate issues and increasing support from the government and educational institutions offer a promising foundation for CDR initiatives. On the other hand, Poland's industrial dependence on fossil fuels, economic priorities, and mixed public opinion serve as significant barriers that must be addressed. With access to EU funding, Poland has the potential to overcome these limitations and lead innovative efforts in contributing meaningfully to global climate goals.

6.1 Overview

This section provides a description of Poland's economic and political context, human resources, and current industrial structure, and examines how these elements could be leveraged for CRD deployment. It is then followed by the description of results from the stakeholder interviews and the citizen panel.

6.1.1 Economy

The latest macroeconomic forecast from the European Commission¹⁹¹ for Poland indicates solid growth in 2025 and 2026, driven by private consumption and investment, although net exports are expected to weigh on growth. Inflation, which eased in 2024, is projected to continue decreasing in 2026, although fiscal pressures remain elevated and geopolitical pressures might cause an increase in 2027. Real GDP growth was 3.2% in 2025, with the forecast for 2026 increased slightly at 3.5%, while inflation is expected to decline from 3.4% in 2025 to 2.9% in 2026.

GDP (billion USD, 2024)	917.77 ¹⁹²
Growth (2024)	2.9% ¹⁹³
Productivity	54,06 USD per hour worked ¹⁹⁴
Unemployment	2,9% (of population aged from 15 to 74 years) ¹⁹⁵
Main Sectors	Poland's economy remains heavily industrialised (57,51% Services, 30,06% Industry) relative to many EU Member States, with strong manufacturing sectors including automotive, machinery, chemicals, metals, food processing, and construction materials. ¹⁹⁶
Trends	• Growth slowdown: Industrial output weakened due to high inflation, rising interest rates, and lower investment. • High energy costs: Energy-intensive industries struggled, pushing the need for green transition. • Supply chain issues: Delays and shortages impacted manufacturing, particularly in the tech and automotive sectors. • Labor shortages: Skilled workers in industry remain difficult to find, limiting production capacity. • EU funding needed: Reforms and digital investments are essential to boosting competitiveness.¹⁹⁷
Carbon intensity	High: 0,66 kg/per€ (greenhouse gas emissions intensity of gross value added) ¹⁹⁸
GDP per head (Current USD, 2024)	22,056.7 ¹⁹⁹
HDI (2022)	0,881 ²⁰⁰
CO₂ emissions (megatons) in 2023	320 ²⁰¹

Table 7. Poland's economic key numbers.

6.1.2 Political and public landscape

Poland is a democratic parliamentary republic with a dual executive: the President of the Republic of Poland and the Council of Ministers, chaired by the Prime Minister as head of government. Since August 6, 2025, the President of the Republic of Poland has been Karol Nawrocki, elected in the second round of the presidential election on 1 June 2025 with 50.89% of the vote. Although formally unaffiliated, he was a candidate supported by Law and Justice (PiS), a right-wing political party.

The Prime Minister remains Donald Tusk, who took office after forming a government in December 2023. The government was established following the victory of the democratic opposition in the parliamentary elections of 15 October 2023. The coalition consists of three parties: Civic Coalition (centre-right, liberal), Third Way (centrist, Christian-democratic), and the Left (centre-left, social-democratic). Internal differences among the governing parties directly affect the effectiveness of governance. The next parliamentary elections are scheduled for autumn 2027, in line with the four-year term of the Sejm (lower house of the bicameral parliament of Poland).

Poland has been a member of the European Union since 1 May 2004, and of the North Atlantic Treaty Organization (NATO) since 12 March 1999.

The shape of Poland's political landscape is strongly influenced by the opposition between the Head of State – the President of the Republic of Poland – and the government led by the Prime Minister. Although the coalition partners are not fully aligned on climate and energy transition issues, they support the development of renewable energy, the unblocking of onshore wind energy, the development of nuclear energy, and the implementation of EU climate policy. A strong emphasis is also placed on the gradual phasing out of coal and improving energy efficiency.

In opposition to the governing coalition stands Law and Justice (PiS), under whose support Karol Nawrocki won the presidential election. PiS – a conservative-national party – supports the development of nuclear energy and offshore wind power, while defending coal's role in the energy mix until 2040. The party takes a critical stance toward the EU ETS and the Fit for 55 package.²⁰²

Nationalist parties, including Konfederacja, are playing an increasingly important role in Poland's political landscape. This trend is clearly visible in recent presidential elections. In the 2025 presidential race, two nationalist-associated candidates ranked

among the top five representing a notable increase compared to the 2020 election, when only one nationalist candidate appeared among the top five, with just under 7% of the votes^{203 204}. Although they currently hold no governing majority, their influence is growing. Their positions on climate transition are sceptical, marked by opposition to bearing the costs of change. They also strongly oppose EU climate policy, advocating for cheap energy and minimal state intervention.

CDR does not currently appear in the programmes of any major political party in Poland. Similarly, CCUS/CCS technologies in Poland are mainly addressed at the governmental level and in strategic documents, rather than as a clear priority in party programmes. The development of technologies related to biogas and biomethane – which can be partly linked to the CCUS agenda – is mentioned more frequently in the programmes of pro-environment and left-wing parties²⁰⁵. This absence may be attributed to a general lack of understanding of the issue among political actors, as well as limited public awareness, which reduces its political traction. Nevertheless, left-wing parties tend to be more receptive to climate-related changes. The current government's signing of the *Letter of Intent on the Development of CO₂ Capture, Storage and Utilization Technologies* indicates a gradual shift towards recognising CDR-related initiatives, as described in section 5.4.

In summary, at the time of writing (end of 2025), political consensus exists around nuclear power and offshore wind as pillars of energy security. Key disputes concern the pace of decarbonisation, the role of coal after 2030, transition costs, and the implementation of EU climate policy.²⁰⁶

6.1.3 Relationship to ecology

Public attitudes toward ecology in Poland vary by political orientation, level of education, and place of residence. According to a Centre for Public Opinion Research (Centrum Badania Opinii Publicznej, CBOS) survey from April 2023, only 38% of respondents supported achieving climate neutrality by 2050, a decline from 2021, while 21% favoured achieving the goal earlier. **Over half** (55%, up 12 percentage points compared to nearly two years earlier) **believe Poland should pursue climate neutrality at its own pace, even if this means achieving it after 2050**²⁰⁷.

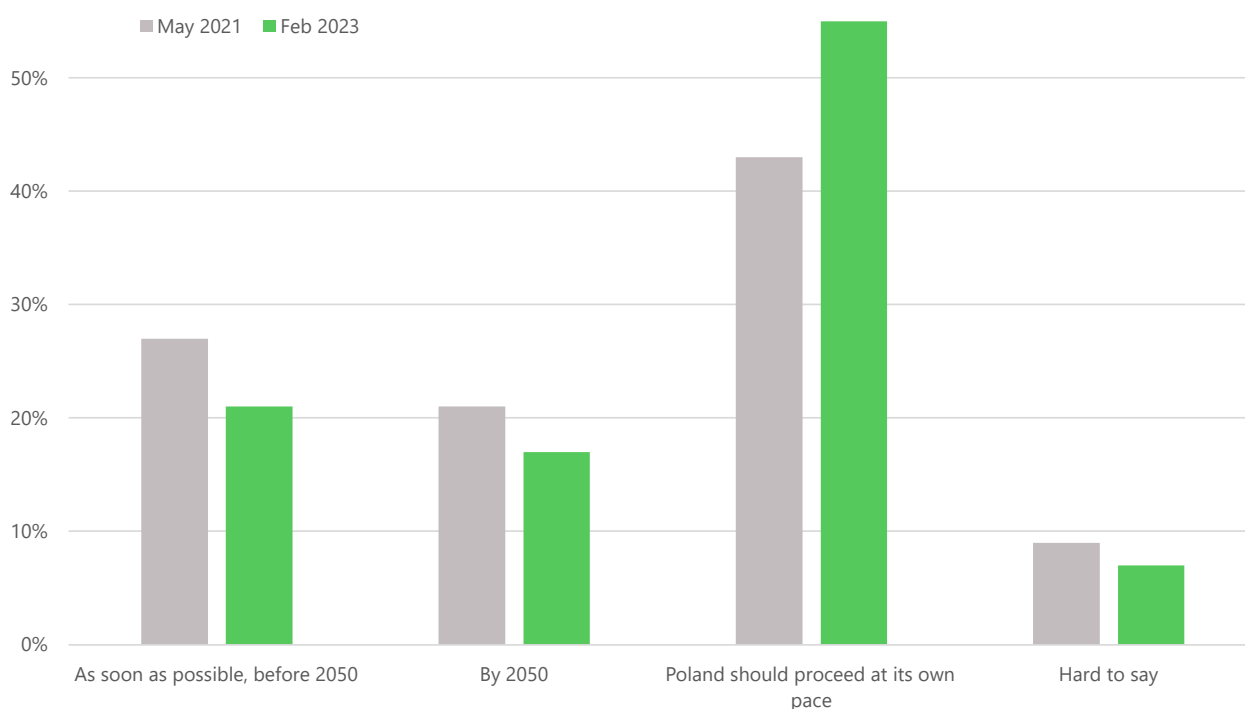


Figure 16. By 2050, European Union countries are to achieve climate neutrality: reduce emissions of greenhouse gases that contribute to global warming, including carbon dioxide. In your opinion, should Poland strive to achieve this goal²⁰⁸

Views differ strongly by political preference. Supporters of the Civic Coalition – a political grouping of centrist to left-leaning parties and the largest in the current Polish government – 65% prioritise environmental and climate benefits (65%), while 56% also consider the cost of energy as important. In contrast, 82% of Confederation voters – a far-right party – prioritise energy prices, with only 42% emphasising environmental benefits²⁰⁹. A report by the Pole Dialogu Foundation indicates the **presence of climate change denial**, particularly in coal regions such as Silesia, where climate narratives have become highly polarised and vulnerable to misinformation.

Since 2018, the **youth movement Fridays for Future** has organised climate protests in major cities, mobilising society to act on reducing GHG emissions. NGOs such as Greenpeace Poland actively campaign against coal and gas investments and in defence of the Białowieża Forest, emphasising the importance of biodiversity conservation. Judicial action, including climate lawsuits (e.g. by ClientEarth²¹⁰ against the Polish state for failing to take adequate measures to reduce emissions), has also become an important advocacy tool.

These developments demonstrate increasing civic engagement, although stronger incentives and anti-disinformation measures remain necessary.^{211 212 213 214}

6.1.4 Human Resources

Poland is a highly educated country, with strong learning outcomes at school level. In the 2022 PISA assessment, Poland ranked fifth among European Union countries, performing above the EU average in mathematics, reading and science, reflecting a solid foundation of human capital relevant for advanced technical and environmental fields²¹⁵. However, recent demographic and systemic trends indicate a gradual decline in participation in higher education, driven by population ageing and shrinking youth cohorts.

From the perspective of human resources for **CDR** and broader climate transition pathways, **labour availability and skills shortages are already emerging as a key constraint**. According to an OECD analysis of green labour markets, Poland experiences significantly higher shortages in green jobs than in the average occupation. Specifically, there are 34% more vacancies per employed person in green jobs than in the average job in Poland, compared to 29% across the OECD, indicating above-average labour market tightness²¹⁶.

Green jobs encompass employment in energy efficiency, the circular economy, sustainable transport, environmental services and agriculture, and extend well beyond traditional energy roles to include occupations with substantial environmental impact across multiple sectors. Because of this diversity, comprehensive and comparable statistics on all green jobs remain limited. However, renewable energy (OZE – odnawialne źródła energii, including wind, solar, biomass and related installations and services) remains the best-quantified green subsector in Poland, with the **renewable energy sector currently employing over 212,000 people, mainly across installation, manufacturing, operations and maintenance**²¹⁷.

Looking ahead, World Bank-linked analyses of Poland's energy and industrial transition suggest that **up to 300,000 new jobs could be created** in high-potential sectors such as renewable energy, nuclear power, electromobility, electricity grids and building renovation, as investment accelerates under long-term decarbonisation strategies²¹⁸.

In terms of the education pipeline, around 1.28 million students were enrolled in higher education institutions in Poland in the 2024-2025 academic year, according to official data from Statistics Poland (GUS)²¹⁹. Among graduates in the 2023/24 academic year in Poland, students in Engineering, Industry and Construction represented approximately 13.3% of all graduates, while Natural Sciences, Mathematics and Statistics accounted for around 3.5%, and Agriculture for about 1.7% of the total graduate cohort, providing a foundation for future green and CDR-relevant employment²²⁰.

Finally, **labour shortages in green sectors could be partially addressed by workers transitioning from declining carbon-intensive industries**, particularly coal mining and coal-based power generation. Poland still employs tens of thousands of workers in coal mining, with recent estimates placing direct employment at approximately 85,000 workers²²¹, many of whom possess technical, mechanical and safety-critical skills that are transferable to renewables, grid infrastructure and industrial decarbonisation with appropriate upskilling. Existing retraining programmes already demonstrate pathways for former miners to move into roles such as wind turbine operation, maintenance and energy infrastructure services, supporting a just transition while helping to close green labour gaps²²². Similar reskilling and upskilling model could also play an important role in enabling the deployment of CDR technologies.

6.1.5 Industrial integration

Several sectors offer opportunities for integration with CDR methods in Poland. Construction, wastewater management, mining and minerals, agriculture and forestry, generate resources such as alkaline residues, biomass streams, and concentrated CO₂ that are suitable for CDR methods including mineralisation, biochar, and BECCS. In addition, the country's geology, particularly its large salt deposits and extensive mineral resources, combined with a sizeable industrial base, could provide favourable conditions for CDR integration, provided that regulatory, economic, and other barriers, such as insufficient CO₂ transport and storage infrastructure, are addressed.

Fuel combustion is the dominant source of CO₂ emissions in Poland, accounting for over 90% of total emissions. This includes energy production, transport, manufacturing, and construction. Among these, the energy sector is the largest contributor, with power generation alone responsible for around 48% of national CO₂ emissions. Regionally, the Upper Silesian Industrial Region stands out as a major emissions hotspot. Its concentration of heavy industry - including metal production (e.g. KGHM), coal mining, machinery, and automotive manufacturing - makes it one of the country's most significant sources of CO₂. The next sections lay out an overview and examples of the main synergies between existing, ongoing industrial activities and CDR.

Building, concrete and demolition

Poland produces on the order of ~18–20 Mt of cement per year, and its construction sector generates substantial volumes of construction and demolition (C&D) mineral waste, a significant share of which is already recovered. EU and national data²²³ indicate that mineral C&D waste flows are in the low millions of tonnes annually (e.g. ~3.5 Mt reported in 2012), with more recent datasets pointing to continued large and technically recoverable streams. These materials - including demolition rubble, cement and concrete fines, and industrial slags - represent important feedstocks for carbon dioxide removal. They are well suited to mineralisation-based CDR pathways, where CO₂ is permanently bound into materials. The reuse of carbonated fines in construction could enable product-integrated carbon storage.

Water treatment

Poland has a well-developed, centralised wastewater treatment system that generates steady streams of sewage sludge and sludge ash. These waste streams offer promising feedstocks for processes that can improve waste management while contributing to CDR.

Hydrothermal carbonisation (HTC) is an emerging technology gaining traction in Poland. It converts organic waste – such as sewage sludge and biowaste – into a carbon-rich material known as hydrochar. This process can reduce disposal costs and enhance resource recovery for wastewater utilities. In March 2024, Poland's first pilot HTC installation was commissioned, with a capacity of around 2,000 tonnes of sewage sludge per year²²⁴. Hydrochar has multiple applications, including as a coal substitute, soil amendment, or input for biogas and fertilisers²²⁵. Its stable carbon structure also enables long-term carbon sequestration in soil and can additionally support storing CO₂²²⁶.

Mining & mineral processing

Poland's geology supports strong synergies between mining, mineral processing, and carbon removal. Extensive salt deposits in the Zechstein basin and significant metal and industrial mineral resources underpin a mature mining sector, with resource data maintained by the Polish Geological Institute (PIGPIB). Mining and mineral-processing activities generate alkaline and metal-rich tailings, waste rock, and slags that are well suited for mineral-based CDR approaches such as enhanced rock weathering. Salt and potash deposits are extensive in the Zechstein basin, offering brine resources that may be relevant for brine-based electrochemical carbon capture or mineralisation chemistries²²⁷.

Agriculture and forestry

Poland has a large agricultural and forestry sector, with forests and timber products playing an important role in the economy and trade. Agricultural residues (e.g. crop straw, manure) and forestry by-products could provide suitable feedstocks for biochar. Biochar is already being researched and deployed at small scale in Poland, with several emerging initiatives and companies. When combined with improved soil management or enhanced rock weathering on agricultural land, biochar can deliver measurable CDR at regional scale, provided that sustainable sourcing is maintained²²⁸.

The first fundamental obstacle is the low level of awareness among farmers. According to research done by BNP Paribas in 2022, only 8% of farmers knew about carbon credits. Secondly, a majority of farmers either do not want or do not plan to switch to carbon farming. But then again, one-third of the respondents claimed they already use many of practices recognised by the European Commission as part of carbon farming²²⁹, indicating untapped potential. Overall, while R&D and pilot projects are underway, scaling will depend on stronger market demand and targeted incentives for carbon removals and soil carbon practices²³⁰.

6.1.6 Cultural, aesthetic, religious and ethical considerations

The implementation of climate solutions in Poland is strongly conditioned by cultural, ethical, and social factors. Although most Poles recognise climate change as a serious threat, their concerns seem to be decreasing: in 2024, only 46% identified climate as a primary risk (a drop of 12 percentage points since 2019). Growing fears related to war and migration overshadow long-term environmental threats. Young people increasingly feel powerless and indifferent – 57% of those aged 18–35 believe the situation requires immediate action.²³¹

The level of climate knowledge remains low, and trust in institutions and science is weakened by misinformation and greenwashing. Poles are more likely to take pro-environmental actions if they bring financial benefits, such as energy savings through subsidy schemes for prosumers (e.g. "My Electricity" government support for household photovoltaic installations²³², or the "Clean Air" programme supporting the replacement of inefficient heating systems and home energy retrofitting²³³) such as energy savins rather than for ethical reasons. Only 20% report reducing meat consumption, despite its impact on the climate²³⁴.

Poland's coal infrastructure has historically been socially accepted not only because it provided jobs, but because it became embedded in regional identity and industrial heritage – an advantage that new low-carbon technologies do not share. To date, no studies could be identified that specifically examine public perceptions of the visual or landscape impacts of CDR installations. In the absence of such evidence, insights can be cautiously drawn from experiences with other large-scale low-carbon infrastructure, particularly onshore wind power²³⁵. Despite local aesthetic concerns and occasional opposition, **wind turbines have enjoyed broad public support** in Poland, suggesting that when tangible benefits are perceived, aesthetic considerations tend to play a secondary role.

At present, there is no empirical evidence that clearly links levels of religiosity with attitudes toward CCS, CDR, or, more broadly, with perceptions of the relationship between faith and nature. Nevertheless, broader sociological trends provide useful contextual insight. Although Catholicism remains the declared religion of most Poles – approximately 89% according to recent surveys²³⁶ conducted by Public Opinion Research Center (Centrum Badania Opinii Społecznej, CBOS) these same studies indicate a steady decline in institutional religious engagement. In particular, a growing share of the

population, especially among younger cohorts, does not identify with the Catholic Church and is increasingly unwilling to participate in confessional Catholic religious education²³⁷. These trends suggest that public attitudes toward emerging technologies such as CDR are likely to be shaped less by religious beliefs or doctrine than in previous decades, and more by secular considerations such as perceived social, economic, and environmental benefits.

According to the Capturing Public Trust analysis, Polish communities are not yet consistently included in meaningful decision-making processes for CCS projects, with **current public engagement and consultation mechanisms underdeveloped**²³⁸. Absence of transparent dialogue increases the risk of opposition. Public protests or scepticism, especially when local concerns are ignored, can delay or even halt technically viable CCS/CCUS/CDR projects, and without an early and genuine social license, projects may not proceed despite formal permits. Similar dynamics have been observed in other Polish climate programmes, such as the "Clean Air" (Czyste Powietrze) scheme²³⁹, where beneficiaries criticised complex procedures and long waiting times, suggesting that **opaque implementation can generate local distrust and undermine support for well-intended policies**.

Important social groups in Poland include miners and farmers, who have historically been among the most privileged groups in the country. **Mining has received substantial state subsidies for decades**²⁴⁰ and attempts to close unprofitable mines regularly ended in protests and strikes to protect jobs²⁴¹. **Similarly, farmers benefit from an extensive system of subsidies and tax reliefs, and any attempts to limit these privileges – such as changes in the Agricultural Social Insurance Fund (KRUS) or protests against the Green Deal – meet strong resistance**²⁴². Both groups are highly conservative, attached to established patterns and hard-won rights, making them particularly difficult to reform.

Implementing CDR methods can bring economic benefits, but their implementation requires social acceptance. This, in turn, depends on the explicit integration of cultural and sociological factors into policy design, as well as on sustained public education and the active involvement of local communities throughout the planning and implementation process. Creating a credible and inclusive narrative around the energy transition and CDR is therefore not only a communication challenge, but a core condition for success.

6.2 Stakeholder interviews

This section summarises the insights gathered from interviews with 15 stakeholders representing academic, political, advocacy, and industry perspectives in the field of CDR and climate policy. The interviews were conducted between April and June 2025 over a total of 17 Hours, and explored three core categories:

- **Government and Public Institutions connected with the energy and industry sectors:** 4 interviews
- **Independent experts and NGOs:** 4 interviews
- **Research units, academic institutions, and business representatives:** 7 interviews

The interviewed organisations are not named in this report. The interviews were semi-structured and qualitative in nature.

6.2.1 Awareness and views of stakeholders on Poland's existing climate policy

Most interviewees were aware that Poland – in line with EU commitments – is aiming to achieve climate neutrality by 2050. However, the level of knowledge about the details of this policy, as well as its assessment, varied.

All stakeholders recognised early signs of positive developments in climate policy. There was growing interest in hydrogen technologies, improved energy efficiency in industry, and an increasing number of investments in prosumer photovoltaics. One of the most frequently mentioned challenges was **the lack of a comprehensive, long-term climate strategy that clearly outlines Poland's path to climate neutrality**. Interviewees stressed that **actions are often fragmented, uncoordinated, and dependent on changing political conditions**. **Poland still relies heavily on coal and natural gas, which poses a significant barrier to rapid decarbonization**. Interviewees observed that the energy transition is progressing too slowly, and investments in renewables are often hindered by administrative barriers and the lack of stable legal frameworks.

Limited access to financing for new technologies, including CDR solutions, was also noted, as well as the absence of mechanisms to support pilots, testing, and scaling of innovative solutions, both technological and nature-based. A major issue raised by many stakeholders was the low level of climate education and the lack of understanding of the need for transformation. In regions dependent on heavy industry and mining, such as Upper Silesia,

the Dąbrowa Basin, the Bełchatów area, and Eastern Greater Poland (Konin-Turek region), the transition to a low-carbon economy poses significant socio-economic challenges related to employment transition, workforce reskilling, regional economic restructuring, and public acceptance of the transformation.

Some interviewees, particularly those connected to energy and industry sectors, expressed **concerns that delays in the transition could lead to Poland's marginalisation in EU decision-making processes and the loss of access to funds supporting the green transition.**

Over half of the interviewees expect that **regulatory pressure from the EU and rising CO₂ emission costs will accelerate the energy transition and more active climate action in Poland.** This perspective was shared across stakeholder groups and emerged as a common theme in the interviews.

A smaller number of stakeholders pointed to the increasingly **important role of the private sector as a dynamic driver of climate action**, emphasising that parts of business already perceive the transition as an opportunity rather than a cost. These views were voiced mainly by individual representatives from the scientific community and NGOs, who also anticipated further development of green certificate and compensation mechanisms, as well as a growing role of CDR technologies in public policy.

A small number of interviewees - representing senior and influential figures closely connected to industry - noted that **Poland could play a significant role in the development and implementation of CDR technologies in the Central and Eastern European region.** In their view, this role would most likely emerge in selected sectors where Poland already has strong industrial capacity and experience, such as the cement industry, as well as in technologies related to CO₂ capture and storage. They emphasised that while Poland's climate ambitions are likely to increase over time, the pace of this transition may be constrained, making it particularly important to identify niche areas in which the country could position itself as a regional leader. They also stressed the need for better dialogue between government, science, business, and civil society. The importance of a just transition was highlighted, especially in coal-dependent regions.

Government and Public Institutions connected with the energy and industry sectors expressed a moderately positive assessment, reflecting a moderate level of progress in Poland's climate transition, with policies broadly aligned with EU goals but lacking effective implementation coordination

and a long-term strategic approach, particularly a detailed CDR implementation strategy with clearly defined targets and supporting legislation, as highlighted by over half of the interviewees. Identified underutilization of public institutions' potential and the need for stable legal and financial frameworks. Better integration with industrial and energy policy is necessary.

Experts and NGOs expressed a critical stance, primarily concerning the slow pace and limited advancement of Poland's climate policy framework, which they viewed as a necessary foundation for effective CDR deployment. They pointed to the lack of coherent CDR strategy, marginalisation of the topic in government documents, and to reactive climate actions driven by EU pressure. Lack of transparency, poor implementation quality, and no dialogue with private sector or society. All interviewees expressed concern over the absence of institutional leadership and emphasized that actions are scattered and uncoordinated.

Academic, research and business institutions noted the growing importance of the topic in Poland, while emphasising the continued lack of coherence, strategic direction, and strong incentives for CDR, and pointing out that the current regulatory framework does not adequately support technology development. Lack of integration between climate, industrial, and energy policies and poor inter-ministerial coordination. Need for stable financial frameworks. All seven interviewees noted the absence of a CCUS strategy and the marginal role of CDR in public debate.

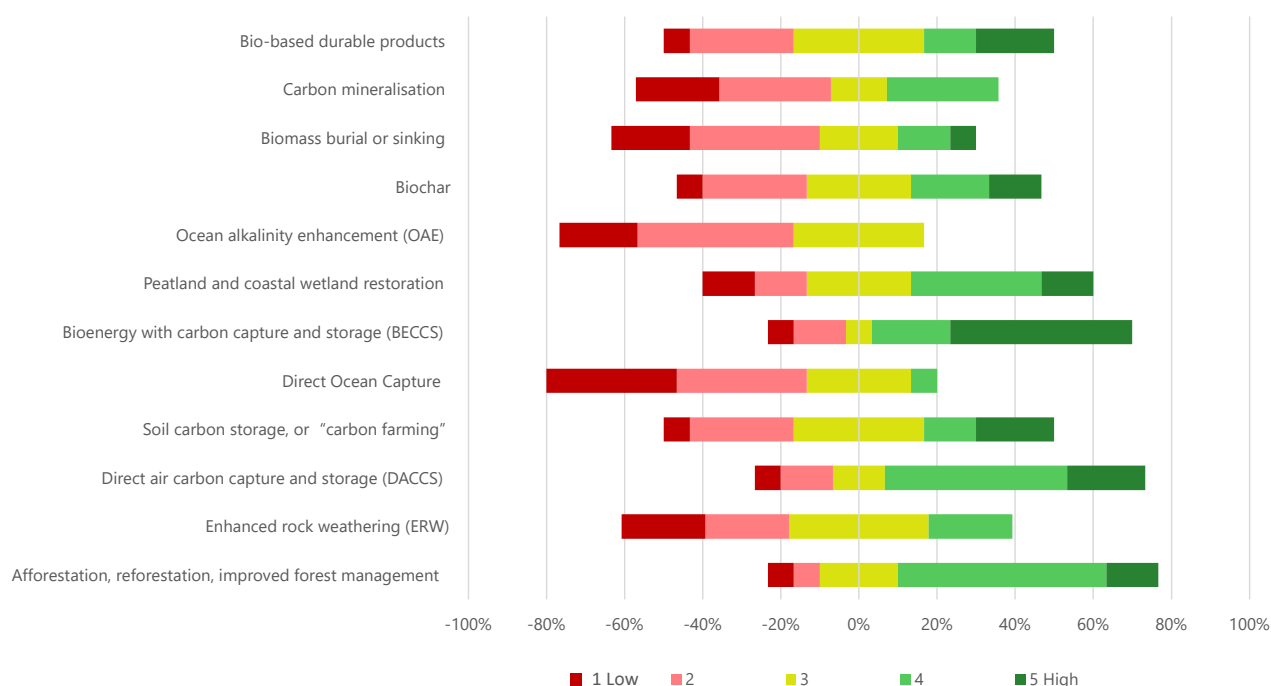


Figure 17. Pre interview survey: "How well the interviewed stakeholders knew the various methods". There was quite a bit of variance between the methods and there were many methods that were mostly unfamiliar with the interviewed organisations.

6.2.2 Awareness and knowledge of CDR and the different methods

Based on the pre-interview survey and stakeholder interviews, many of the assessed CDR methods appear to remain relatively unfamiliar across all stakeholder groups in Poland. The level of acceptance and trust in specific methods varied across sectors. **BECCS and DACCS were among the most recognised methods, alongside more familiar land-based methods** such as afforestation, reforestation, and improved forest management. In contrast, **ocean alkalinity enhancement (OAE) was unfamiliar to all interviewed organisations.**

Government and Public Institutions connected with the energy and industry sectors demonstrated a good understanding of technological CDR methods (BECCS, DAC, mineralisation), especially in the context of hard-to-abate emissions (e.g., cement, energy sectors). Natural methods were recognised but viewed as less durable and harder to certify. Emphasis was placed on monitoring and data.

Experts and NGOs demonstrated high awareness of all methods: natural methods such as afforestation, peatlands, carbon farming were seen as

environmentally positive but not durable and hard to measure; technological (BECCS, DACCS) were seen as promising but costly and technologically immature. There was an emphasis on the need for education, certification, and integration with sectoral policies.

Academic, research and business institutions showed high awareness of the full range of methods both technological (DACCS, biochar, mineralisation, BECCS) and biological (afforestation, carbon farming). They emphasised the need for further research, integration with industrial infrastructure, and environmental analysis. Natural methods were appreciated for their awareness-raising and adaptive value, but issues with durability and certification were noted.

In table 9, the main points on each presented CDR method are analysed based on whether the method was mostly preferred or not or if the method was not brought up by the interviewed organisations in either positive or negative light.

Preferred methods		
Method	Why Preferred	Limitations
Bioenergy with Carbon Capture and Storage (BECCS)	- Enables simultaneous energy production and permanent CO₂ removal (negative emissions). - Can be integrated with existing infrastructure (e.g., combined heat and power plants, cement plants). - Supports the circular economy – use of agricultural and industrial waste.	- High investment costs and lack of CO₂ storage infrastructure in Poland. - Risk of competition for biomass with the food and forestry sectors.
Peatland and Coastal Wetland Restoration	- High climate efficiency – prevents emissions from drained peatlands. - Additional benefits: water retention, biodiversity protection, microclimate cooling. - Alignment with EU policies and potential synergies with paludiculture (wetland agriculture).	- Operational challenges: need for water access, fragmented land ownership. - Low public awareness and lack of systemic incentives for landowners.
Soil Carbon Storage / Carbon Farming	- Can be integrated with existing agricultural practices without changing land use. - Benefits for farmers: improved soil quality, water retention, access to financing (e.g., carbon credits). - High social acceptance, especially among farmers and local communities.	- Difficulty in measuring and certifying sequestration outcomes. - Impermanence – changes in farming practices may lead to re-emissions.
Afforestation, Reforestation, Improved Forest Management	- Natural and intuitive – high public acceptance. - Additional benefits: improved air quality, biodiversity, land restoration. - Potential for local implementation at low cost, especially by municipalities and NGOs.	- Impermanence – risk of CO₂ emissions due to fires, disease, or logging. - Limited capacity – one-time effect, competition for land with agriculture and infrastructure.
Biochar	- Long-term carbon storage in soil (hundreds of years). - Improves soil quality, increases water retention, reduces need for fertilizers. - Potential for local implementation and integration with agriculture and waste management.	- High production costs and lack of deployment scale in Poland. - Competition for biomass and absence of support and certification systems.
Moderately preferred methods		
Method	Concerns in the Polish Context	Perceived Advantages
Direct Air Capture & Storage (DACCS)	- Very high investment and operational costs, making the technology currently unprofitable without strong public support. - High energy consumption, which – given Poland's still significant reliance on coal – may lead to net emissions. - Lack of CO₂ storage infrastructure and absence of pilot projects in Poland. - Low public and political awareness, hindering acceptance and implementation.	- Precise control and measurability of outcomes – the technology allows for accurate quantification of removed CO₂. - Future potential, especially for decarbonizing the industrial and energy sectors.
Enhanced Rock Weathering	- Lack of local research and demonstration projects – aside from a few early 2000s examples, the technology has not been extensively studied in Poland. - Uncertainty about environmental impacts, e.g., effects on soil and groundwater. - Logistical and scaling challenges – requires large volumes of material and suitable geochemical conditions. - Absence of legal frameworks and certification systems. - High energy intensity.	- Permanent CO₂ binding in mineral form, making the method potentially very effective. - Possibility of using industrial waste, such as ash or slag, which could support a circular economy.

Ocean Alkalinity Enhancement	• No applicability in Poland – lack of access to open oceans. • High risk of disrupting the chemical and biological balance of ocean ecosystems. • Lack of data and research – the method remains largely conceptual.	• Potentially large global CO₂ sequestration capacity. • Possibility of supporting plankton growth and natural CO₂ absorption processes (in theory).
Direct Ocean Capture	• No applicability in Poland – lack of access to open oceans. • Very low awareness and no implementation – the method is considered abstract. • Concerns about impacts on marine ecosystems and lack of data on effectiveness.	• Theoretically high potential – oceans are the largest natural CO₂ sink. • Possibility of enhancing CO₂ absorption efficiency by seawater.
Carbon mineralisation	• High uncertainty and low recognition of the technology – it is little known among decision-makers, administration, and the public. • High energy demand, which in Polish conditions may limit cost-effectiveness and generate secondary emissions.	• Long-term and stable CO₂ removal through binding carbon in mineral form. • Possibility of using industrial waste (ashes, slags, construction materials) as feedstock. • Potential for integration with the construction materials sector (e.g., concrete or building blocks).
Moderately preferred methods		
Method	Why Less Preferred	Identified Potential Advantages
Carbon & Biobased Products	• Lack of a consistent definition – it is unclear what exactly this category includes (e.g., wood, composites, CO₂-based concrete). • Difficulty in assessing permanence – risk of CO₂ re-emission through combustion or product degradation. • Low level of awareness and interest among public administration and industry.	• Alignment with the circular economy – use of organic waste materials.
Biomass Sinking and Burial	• Perceived as impractical and inefficient under Polish conditions. This is primarily due to competition for biomass, which makes sinking or burying it economically unattractive, as the same biomass has existing applications. • High logistical and environmental costs (transport, storage, risk of methane emissions). • Lack of infrastructure and public acceptance.	• Theoretical possibility of permanent CO₂ removal by isolating biomass from oxygen. • Potential use of agricultural and forestry residues.

Table 9. Preferred CDR methods (green), moderately preferred methods, methods considered unsuitable or rarely discussed (yellow), and less preferred methods (red) in Poland based on stakeholder interviews.

6.2.3 Views on deployment of CDR in Poland and its use to fight climate change

Stakeholders consistently identified key barriers to CDR deployment in Poland, notably the absence of a coherent national strategy, unclear allocation of responsibilities across ministries, and a lack of certification systems and incentives. Additional challenges include low public awareness, high costs, inadequate infrastructure, and insufficient data – particularly for emissions linked to technological methods.

There was broad agreement on priority actions needed to enable deployment:

- financial incentives (e.g. subsidies, tax relief, contracts for difference),
- development of CO₂ transport and storage infrastructure,
- robust certification frameworks and integration into the EU ETS (especially highlighted by business representatives),
- and pilot programmes, particularly for technological methods.

There was a fairly consistent belief that CDR should complement, not replace, emission reductions. CDR was seen as a necessary tool for achieving climate neutrality, especially in the context of hard-to-abate emissions. At the same time, some - especially NGOs - highlighted the need for greater transparency and public acceptance, noting ongoing concerns around credibility and misuse.

In terms of preferred approaches, nature-based solutions (afforestation, peatland restoration, regenerative agriculture) were viewed most favourably. Biochar was also widely supported due to its perceived practicality and co-benefits. More advanced methods such as BECCS are seen as promising but costly, requiring greater collaboration among stakeholders, and still largely confined to research and industrial contexts.

Perspectives varied by stakeholder group: public and research institutions stressed the need for R&D and policy frameworks; industry focussed on financial viability and investment risk, while NGOs raised concerns about environmental impacts and the risk of CDR being used as a "license to emit."

Overall, the most frequently cited barriers included the lack of a national strategy, fragmented governance, and low political prioritisation, alongside concerns about costs, measurement challenges, and social acceptance. Specifically:

- The **lack of a CDR strategy or coherent climate policy** was mentioned in over 85% of all responses, appearing in 13 out of 15 statements, and was raised across all groups (public, NGOs, academia).
- **Fragmentation of efforts and lack of institutional coordination** were highlighted in 20% of all responses (3 statements), mainly by NGOs and academic experts.
- **Low political ambition and marginalisation of CDR** as a topic were noted in approximately 30% of responses (4 statements), especially among NGOs and academic institutions.
- **Unclear legal frameworks regulations** were discussed by a key stakeholder within the public group (1 out of 4 responses),

Concerns also related to high costs, difficulties in measuring outcomes, and the risk of social resistance. The main findings per interviewed stakeholder group are presented below.

Government and Public Institutions connected with the energy and industry sectors see CDR technologies as necessary for hard-to-abate sectors but require support (e.g., contracts for difference,

EU funds). CO₂ infrastructure and development of national competencies are needed. Biological methods are seen as less scalable and riskier (instrumentalization). Key is integration with industrial policy and ensuring stable investment conditions (indicated by representatives of businesses in public institutions).

Experts and NGOs placed strong emphasis on the fact that CDR must not replace emissions reductions – only complement it. Concerns about "alibi for status quo." For biological methods – need for reform of agricultural and forestry policies and financial incentives. Technologies require pilots, public support, and infrastructure. Success depends on education, public trust, and cross-sector cooperation.

Academic, research and business institutions demonstrated consensus that CDR should complement, not replace, emission reductions. Technological methods are considered key to climate neutrality – requiring pilots, support, and CO₂ infrastructure development. Emphasis on developing competencies, certification systems, and monitoring – essential for effective collaboration with business. Natural methods are important locally, but insufficient at industrial scale.

Several potential benefits of CDR implementation were mentioned, depending on the sector:

- Industry: competitiveness, new business models, access to financing.
- Environment: improved soil quality, water retention, biodiversity.
- State: achievement of climate goals, innovation, energy security.

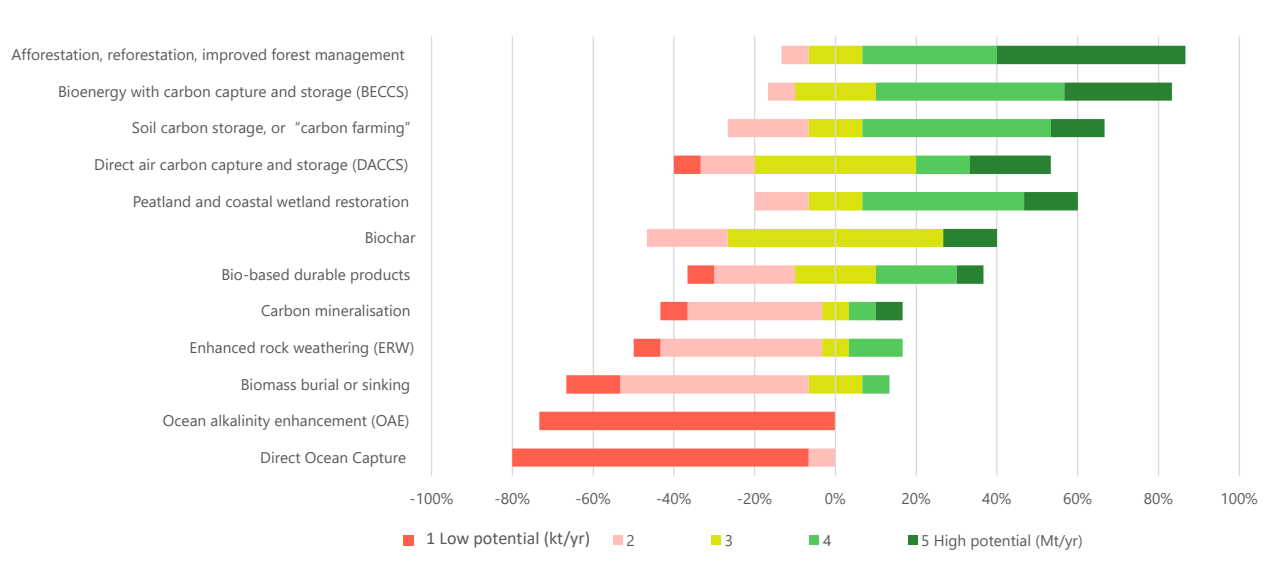


Figure 18. Interviewed organisations views on deployability of each method.

6.2.4 Conclusion on the Stakeholder Interviews

Among Polish stakeholders, the most widely supported CDR methods are those that can be implemented locally, align with EU policies, and offer additional environmental benefits. The most frequently mentioned include:

- **Soil carbon sequestration / carbon farming:** easily integrated with agricultural practices,
- **BECCS:** potential for negative emissions with integration with industry,
- **Biochar:** durable carbon sequestration and soil quality improvement,
- **Peatland restoration:** high efficiency, ecosystem benefits, and reduced emissions,
- **Afforestation and forestry:** highly rated due to their intuitive nature and broad social acceptance.

Less preferred methods, such as bio-based products or biomass sinking, raise concerns about the durability of effects, costs, and practicality in Polish conditions. **DACCS and enhanced weathering** were seen as promising but require further research, infrastructure, political and financial support. **Ocean-based methods** were considered inadequate due to Poland's lack of access to open seas and the low level of knowledge about these approaches.

6.3 Citizen panel

The Polish citizen panel was held in June 2025 in Poznań, with a total of 28 participants from diverse backgrounds taking part in the discussion. The outcomes of the panel closely aligned with insights gathered from stakeholder interviews and provided a foundation for further analysis of the realistic potential of CDR in Poland. The citizen panel should be considered as a singular qualitative data point from a group discussion and not a statistically significant representation of national sentiment.

Before the panel, participants received one-page summaries outlining each CDR method, including their advantages and drawbacks, as well as the broader context of CDR, including its definition and relevance. This material was provided in both written and webinar formats, which could be either attended live or viewed later as an on-demand recording. Participants completed a pre-panel survey capturing their initial views on the methods; the graphs presented in this chapter are based on those responses. The three-hour live panel featured small-group discussions followed by a plenary session. Citizen panel participants were encouraged to share their perspectives openly and request additional information as needed. The dialogue was structured method-by-method, beginning with perceived benefits and concerns, and culminating in a synthesis of preferred CDR approaches for Poland.

Participants in **Polish citizen panel** were younger and more highly educated than the national average

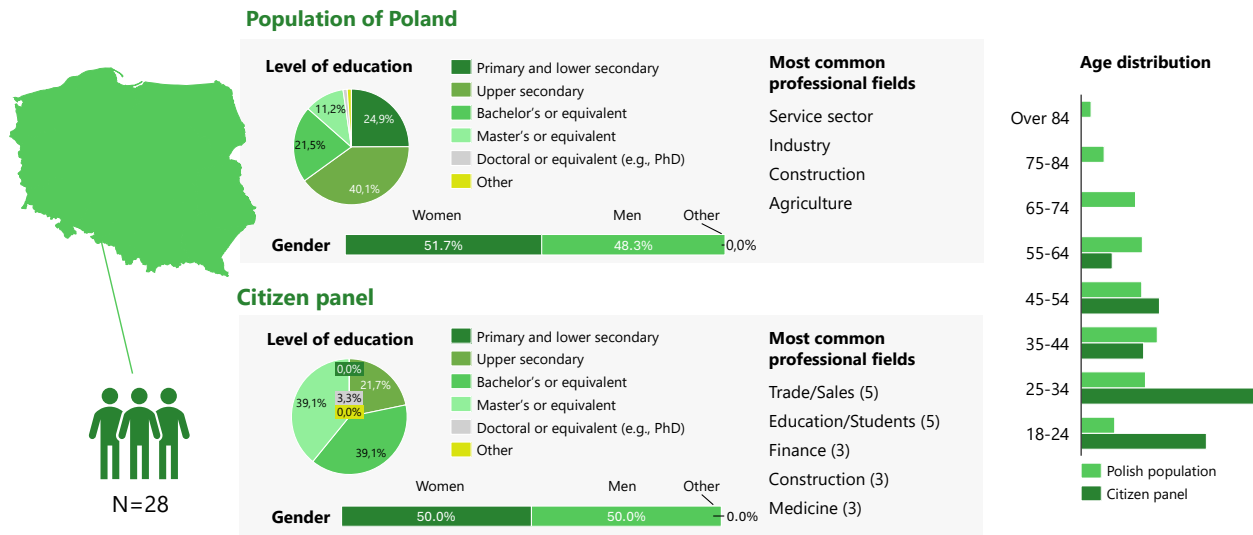


Figure 19. Poland's Citizen Panel composition.

6.3.1 Awareness and views of citizen panel participants on the existing climate policy

Most panel participants entered the discussion with limited knowledge of CDR, often only realising the difference between CDR and emission reduction during the webinar and subsequent panel discussion. Almost all participants were highly enthusiastic and eager to take part in the conversation, willing to share ideas. A few individuals demonstrated greater familiarity with the topic, but they were exceptions. Engagement in the conversations was high, even though the topic - especially technological CDR methods - was new and initially met with some resistance. Those with more knowledge acted as helpful representatives, motivating others to join the discussion.

Initial opinions indicated a need for broad public consultations before implementing CDR solutions on a larger scale. Some participants suggested starting actions earlier, before they become mandatory, to avoid potential penalties from regulatory authorities if the EU or national climate targets were missed. People feared that delays in implementing CDR methods could lead to fines or stricter obligations, as well as reputational and economic consequences for businesses and local communities. Observations of the impact of climate change in Poland reinforced the sense of urgency. For example, recent severe floods such as

those in 2010, 2014, and 2022, as well as recurring summer droughts in regions like Wielkopolska, Mazovia, and Lower Silesia, highlighted the increasing risks of extreme weather events and water scarcity, strengthening the call for early action. Natural methods were seen as more beneficial due to their additional positive effects, such as improving biodiversity.

The information presented during the panel influenced the perceptions of most participants regarding the assessed CDR methods. Fourteen panellists stated that the information changed their views significantly, while ten indicated that it changed their views to some extent. Only five respondents reported that the information did not alter their perception. Overall, **the results suggest that awareness and understanding of CDR methods among stakeholders are still developing, and that targeted information-sharing can substantially influence perceptions and acceptance of different approaches.**

Younger participants generally reported higher familiarity with climate-related issues and considered access to climate information and education to be relatively good. However, they also highlighted that **the limited availability of detailed**

and reliable information on the effectiveness, risks, and practical implementation of different CDR methods remains a major barrier to more informed discussion and engagement.

Overall attitudes toward climate action and CDR methods were neutral but informed. There were no extreme positions in the group. Compared to the general public, participants seemed more open to discussing climate solutions and better informed about the context, though they still relied mostly on general impressions rather than hard data. A strong call for more concrete numerical data on the effectiveness of CDR methods and their consequences – such as water demand – was evident.

6.3.2 Awareness and knowledge of CDR and the different methods

Natural methods received significantly more support, being perceived as safer, better known, and offering additional environmental benefits. **Technological methods raised more concerns about unknown long-term consequences, aesthetic and landscape issues, and potential location conflicts.** There was also a lack of information about environmental and financial costs, as well as the actual effectiveness of individual technologies in reducing CO₂.

Participants clearly preferred natural methods, primarily because their mechanisms were easier to understand and they were seen as offering additional environmental and economic benefits. It was emphasised that these methods – not only absorbing CO₂ – also support biodiversity, improve soil quality, protect water resources, and can stimulate the local economy. In contrast, technological methods generated many questions, indicating both a high level of awareness and existing knowledge gaps. In the case of DACCS, participants raised concerns about the environmental impacts of infrastructure production and disposal, as well as potential landscape disruption. Views were mixed: some participants were discouraged by these technologies, while others were more open, arguing that such installations are initially unfamiliar but can become socially accepted over time, particularly given their potential to reduce air pollution.

Three solutions received the strongest support, two of which are nature-based:

- **Afforestation, reforestation, and improved forest management** – valued for their lasting carbon absorption effects, as well as landscape and ecological benefits.
 - **Restoration of peatlands and coastal wetlands** – appreciated for their high CO₂ absorption efficiency and additional ecological functions, with the caveat that peatlands may dry out, reducing their durability.
 - **Bioenergy with Carbon Capture and Storage (BECCS)** – perceived as an effective method that could be implemented in Polish conditions, although further analysis is needed regarding biomass availability and energy balance.
- The selection of preferred methods was based on several key criteria such as potential environmental consequences, implementation costs, efficiency (amount of CO₂ absorbed), energy intensity, and the ability to utilise and manage waste streams, such as agricultural residues, forestry residues, and biodegradable industrial by-products. Technological methods sparked interest, but participants lacked knowledge about their operation, effectiveness, and environmental impact. Questions were raised about CO₂ transport logistics, energy costs, and waste management during operation. Concerns included projects involving CO₂ storage in furniture (low durability and risk of wood combustion). Although scepticism toward technology was greater, some participants expressed willingness to accept these methods if they received reliable data on their safety, effectiveness, and actual costs.
- During the panel, clear boundaries of social acceptance emerged regarding certain CDR methods. In most cases, scepticism stemmed from insufficient information about effectiveness, costs, long-term consequences, and potential side effects.
- **Biomass sinking and burial** – participants were generally negative, citing high costs, risk of process reversibility, biomass degradation, and lack of data on effectiveness in both CO₂ storage and cost-effectiveness. It was emphasized that, from a circular economy perspective, using biomass for biogas fermentation would be more beneficial than burying or sinking it.
 - **Ocean alkalinity enhancement** – although perceived as natural and potentially safe, it was considered irrelevant in Polish conditions due to lack of ocean access. Participants expressed concerns about its impact on marine organisms and vegetation, calling for further research. A few individuals saw high potential in this technology, provided solid evidence of its safety is presented.
 - **Direct ocean capture** – similarly, the lack of ocean access limited its practical application in Poland. Additionally, high energy demand and implementation costs were noted. Environmental concerns focused on possible negative impacts on marine fauna and flora.

- **Enhanced rock weathering** – this method received moderately positive reactions but was accompanied by a lack of knowledge. Questions were raised about its impact on soil (“Will it improve aeration?”), the risk of heavy metal accumulation, and the technological process of rock grinding. Potential side applications were discussed, such as in gardening or surface hardening, although it was noted that the process is costly and may cause airborne dust emissions, leading to air quality deterioration.

6.3.3 Views on the deployment of CDR in Poland and its use to fight climate change

Participants agreed that CDR development requires active government support, including funding and legislative facilitation. However, it was noted that regardless of the support model, the costs would ultimately be borne by consumers. Most people expressed willingness to contribute to these costs on a moderate scale but emphasised that **the lack of clarity about “who and why should pay for it” raised significant concerns**. Many directly stated that major emitters should bear greater responsibility for financing CDR technologies.

During the panel, participants clearly expanded their knowledge and modified their initial opinions. Many admitted that all the information discussed was new to them, especially regarding technological CDR methods. In some cases, initial scepticism turned into support after explanations of how the methods work and their potential benefits.

Most participants expressed a generally positive attitude towards the use of CDR methods to address climate change: 12 respondents indicated they “somewhat favor” CDR, 9 stated they “favor” it, and 5 “strongly favor” it. Only two participants remained neutral, while just one expressed some opposition. No respondents reported outright opposition to CDR methods. Overall, the results suggest a generally favourable perception of CDR among participants, particularly once additional information and context were provided.

Discussions helped clarify positions as conversations progressed, the group increasingly leaned toward selecting the most effective biomass-based method, while also asking about its limitations, e.g., “won’t we run out of biomass?” Questions also arose about resource availability (“where will we get the rocks?”), energy intensity of some solutions, and the cost-benefit balance.

Group work enabled linking local realities with the technologies discussed. One example was connecting rock weathering with the availability of mining waste heaps in Poland. Another interesting thread was the consideration of ocean-based CDR methods. Even though Poland lacks direct ocean access, participants highlighted that these CDR approaches are inherently global and proposed forming international alliances to advance these solutions.

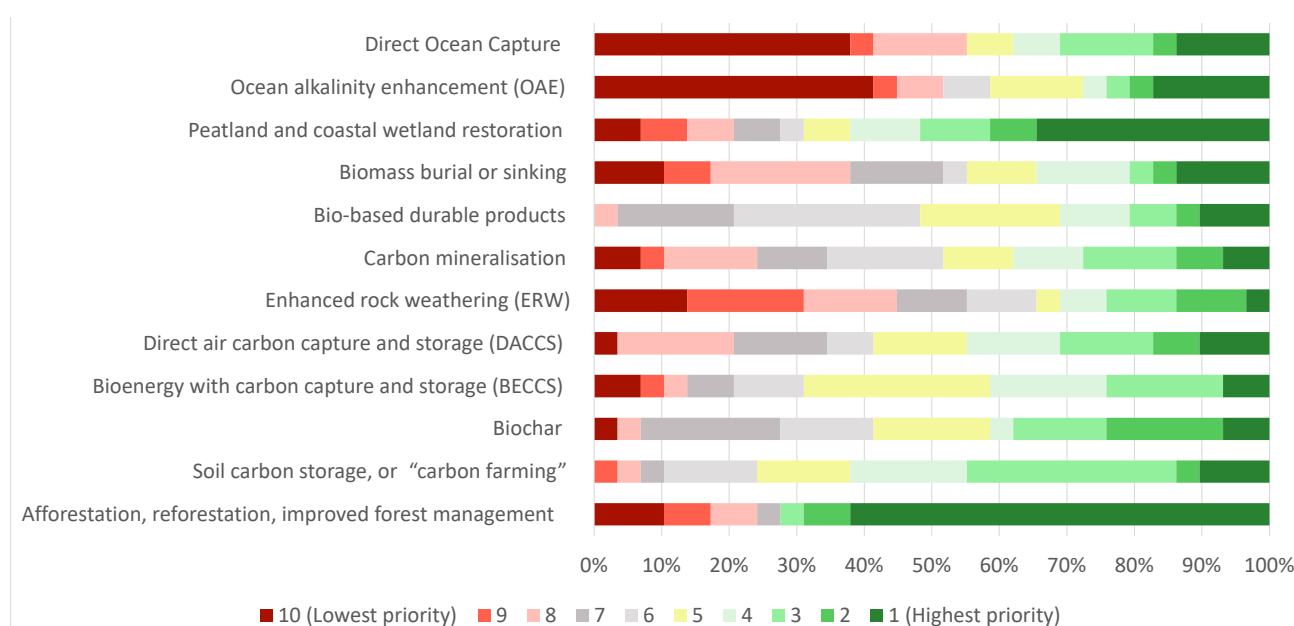


Figure 20. Pre-Pannel answers on prioritised CDR methods for Poland.

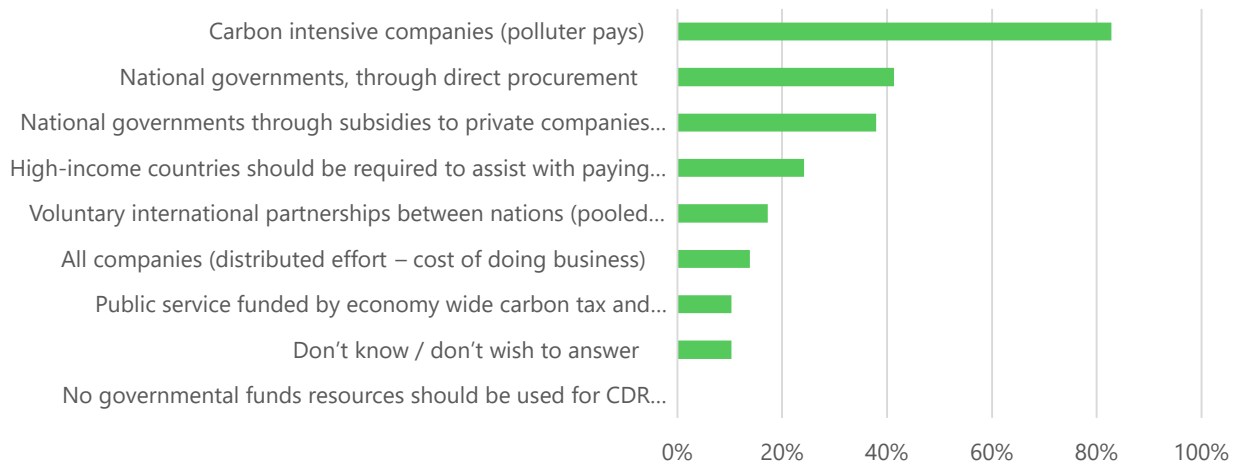
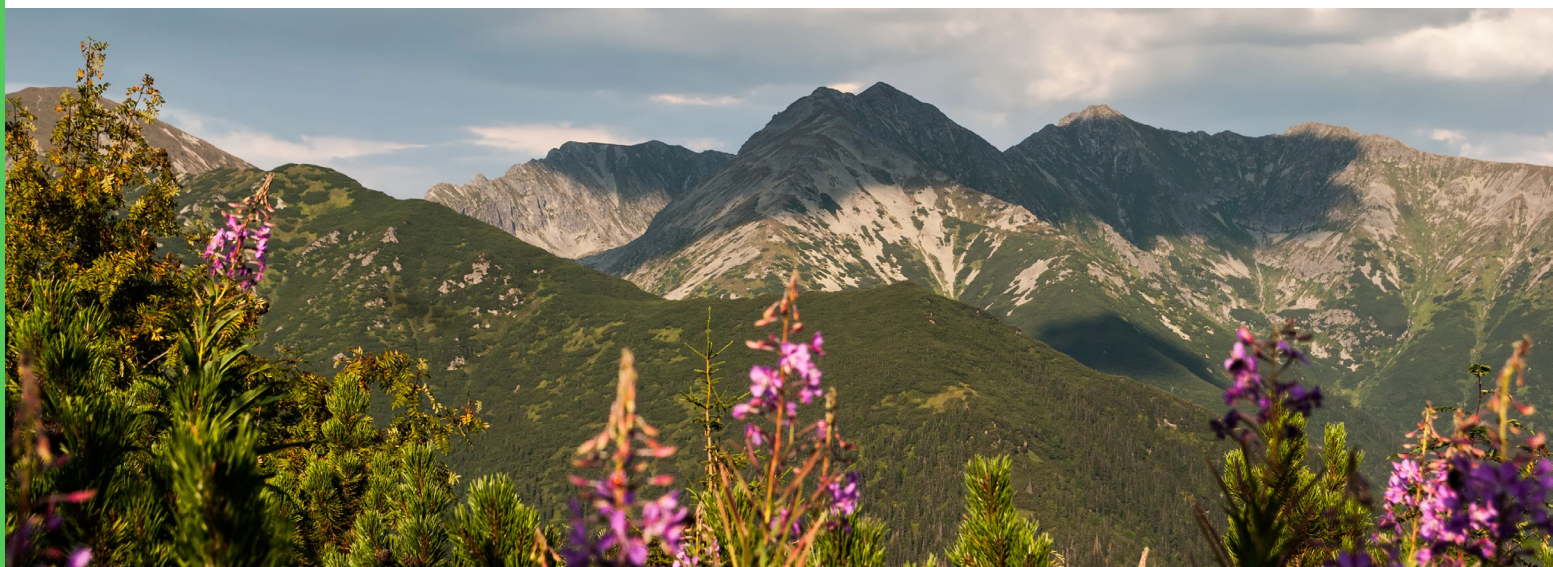


Figure 21. Citizen Panellists' views on who should pay to deploy CDR activities.

Concerns raised included land use for afforestation or peatlands, the impact of land availability on development, the durability of solutions in the face of geological changes, and the environmental costs of disposing of installations (e.g., filters used in direct air capture, DAC devices). Many questions about water use were asked, which suggests rising awareness of this problem in Poland. Discussions also touched on whether current climate actions are proportional to resource consumption, with references to the need for continued efforts in emission reduction and limiting excessive outdoor lighting (e.g., street and advertising lights), which was seen as clear evidence of resource waste, excessive energy use, and consequently higher emissions. Concrete ideas also emerged, referring to existing support programs. One example was the suggestion to implement a subsidy system for farmers maintaining CO₂-absorbing areas.

6.3.4 Conclusions on the citizen panel

The citizen panel in Poznań showed that the public is interested in climate-related topics but expects reliable information on the effectiveness, costs, and environmental impacts of CDR methods. Nature-based solutions, such as afforestation and peatland restoration, received the strongest support due to their additional benefits for biodiversity and water management. Among technological options, BECCS gained moderate acceptance, though it requires further analysis of biomass availability and energy balance. Ocean-based methods were considered impractical locally but recognised for their global potential. After in-depth discussions, it became clear that once knowledge gaps are addressed and detailed, comprehensive information on technological methods is provided, their acceptance in Poland is possible in the long term.



7. Poland's realistic potential to deploy CDR (Can do)

Building on the resource overview in chapter 3 and the theoretical CDR potential outlined in chapter 4, this chapter revises assumptions around resource availability and selected CDR methods to incorporate stakeholder perspectives, public sentiment, and the legal and socio-economic considerations discussed in chapters 5 and 6. Based on this integrated analysis, we estimate the realistic potential – defined as the volumes of CDR that can be deployed with high confidence in the foreseeable future. Within this framework, multiple scenarios remain possible, largely shaped by Poland's level of ambition. This chapter explores those pathways in detail.

7.1 Background

To contextualise Poland's realistic CDR potential and the scenarios reflecting varying levels of CDR deployment ambition, this assessment draws on the first Polish National Energy and Climate Plan (NECP) discussed in Chapter 5. The revised NECP, approved in July 2025 by the Ministry of Climate and Environment, covers the period to 2030 with a strategic outlook to 2040 and presents two scenarios:

- **WEM (With Existing Measures):** continuation of existing policies (business-as-usual);
- **WAM (With Additional Measures):** a more ambitious scenario targeting 53.9% reduction of GHG emissions by 2030 and 75.8% by 2040 compared to 1990 levels.

As an EU Member State, Poland is legally bound by the European Climate Law, which sets the Union-wide objective of achieving climate neutrality by 2050²⁴³. However, this objective has not yet been incorporated into national legislation, nor there is a dedicated climate law or strategy outlining is meant to be achieved domestically²⁴⁴. The revised NECP does not extend to 2050, nor does it include a gap analysis or quantify residual emissions at mid-century.

Independent analyses provide indicative estimates of residual emissions. Carbon Free Europe projects **30–50 MtCO₂** remaining in 2050, primarily from agriculture, waste, and industry²⁴⁵. Similarly, the Centre for Climate and Energy Analysis finds that current policies and investments are insufficient to fully decarbonise these sectors, implying a continued role for CDR. Their scenarios suggest that while the energy sector could become net-negative (e.g. through BECCS, delivering around 20 MtCO₂ of removals), other sectors would continue to emit

tens of millions of tonnes. These estimates point to a comparable range of residual emissions by 2050, driven less by inherent technological constraints and more by gaps in policy ambition and deployment²⁴⁶. Given the absence of official national projections to 2050, **this study benchmarks Poland's CDR potential against an estimated residual emissions range of 30–50 MtCO₂.**

7.2 Methodology for the realistic CDR potential

The calculation of the realistic CDR potential in Poland was carried out using the same methodology and approach as the theoretical potential presented in Chapter 4. However, it incorporates additional constraints, such as the regulatory and economic context, as well as public support. The assessment of public support is based on the views gathered through the stakeholder interviews and the citizen panel described in Chapter 6.

The estimated resource availability for CDR in the realistic potential is more conservative than in the theoretical assessment presented in Chapter 4. While the theoretical potential assumes that all available resources are allocated to CDR, the realistic potential accounts for competing demands and constraints, resulting in lower projected CDR volumes. These more cautious estimates are based on the following considerations:

- **Techno-economic feasibility:** in addition to physical constraints, resource use was evaluated in terms of what is reasonably feasible from a techno-economic perspective – particularly for resources that are contested among multiple CDR methods. However, macroeconomic variables such as GDP growth, cost levels, interest rates, and existing financial support mechanisms were not included as dynamic inputs.
- **Technological deployment:** the pace and scope of technology rollout were adjusted to reflect realistic expectations. For example, electricity production growth was modelled using a more practical scenario than assumed for theoretical potential, and adoption rates for technologies such as BECCS and DACCS were estimated for 2030 and 2050 based on plausible deployment trajectories.

- **Legislative constraints:** legal limitations were incorporated where they clearly and significantly limit the availability of certain resources.
- **Social acceptance** was assessed through public support, as determined by input from stakeholder interviews and the citizen panel.

As with the theoretical potential, a bottom-up approach was applied to most CDR methods.

7.3 Realistic CDR potential scenarios

Two realistic CDR scenarios were developed for Poland for 2030 and 2050 (Figure 22):

- **A low ambition scenario (Scenario A)** which models a business-as-usual pathway, with limited CDR deployment and no major changes to current policy frameworks. Assumptions on electricity availability for CDR are aligned with the NECP WEM scenario.
- **A high ambition scenario (Scenario B)** which reflects a more proactive pathway, with CDR deployed at greater scale through targeted and decisive actions. This may include policies designed to achieve specific outcomes (e.g. dedicated mechanisms for CDR). Assumptions on electricity availability are aligned with the NECP WAM scenario.

Differences between the scenarios also arise from assumptions on resource availability and the deployment rates of individual CDR methods (see Section 7.4).

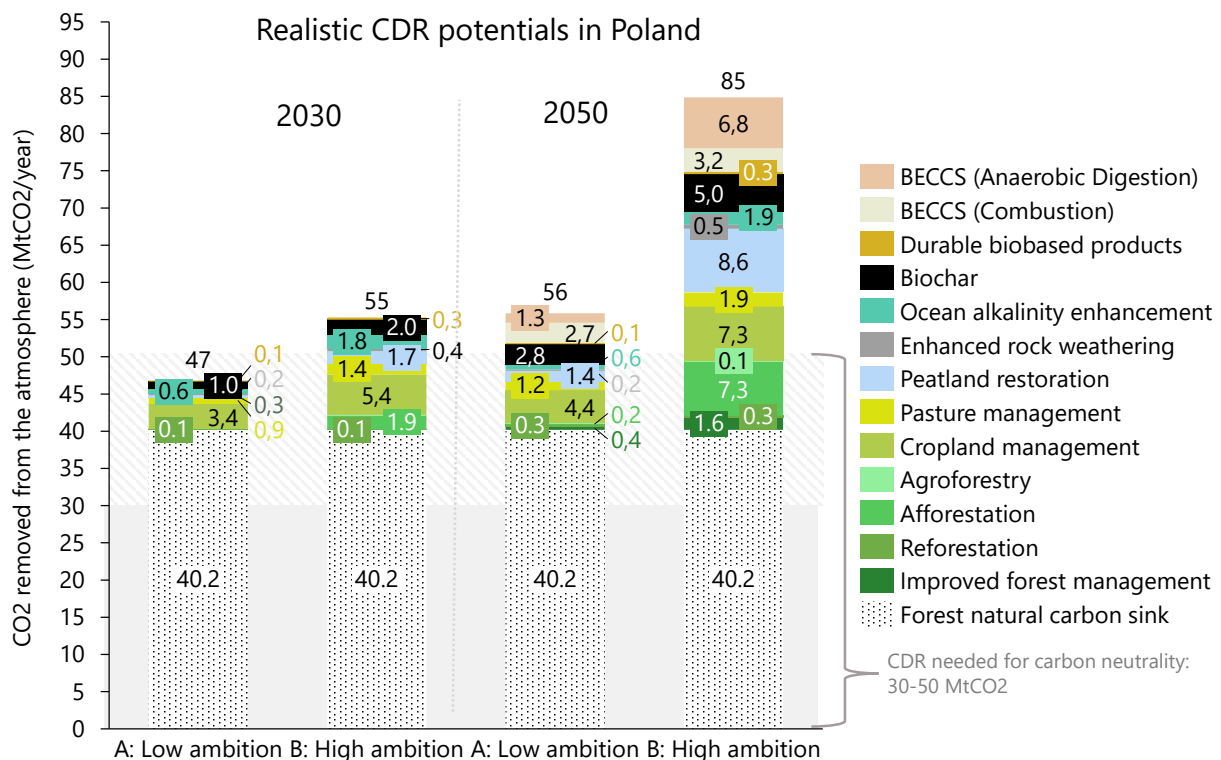


Figure 22. The Low Ambition (Scenario A) and High Ambition (Scenario B) CDR realistic potentials for Poland in 2030 and 2050.

7.3.1 Scenario A: low ambition

In Scenario A, the annual CDR potential is estimated at **~7 MtCO₂** in 2030 and **~16 MtCO₂** in 2050. Adding the projected capacity of the natural sink (40 MtCO₂/year), Poland could in total remove **~47 MtCO₂** in 2030 and **~56 MtCO₂** in 2050. The natural sink was assumed to remain constant over time due to a lack of projections on future harvesting levels.

Cropland and pasture management represent the largest CDR contribution beyond the forest sink, with a combined potential of **~4.3 MtCO₂** in 2030 and **~5.6 MtCO₂** in 2050, driven by gradual expansion of land under CDR practices. Agroforestry remains limited, growing from **~0.02 MtCO₂** to **~0.03 MtCO₂** over the same period. Among ecosystem-based methods, contributions remain modest and largely reflect historical deployment trends. **Improved forest management** is estimated to contribute **~0.4 MtCO₂/year** in 2050, while reforestation holds a potential of **~0.06 MtCO₂/year** in 2030 and **~0.3 MtCO₂/year** in 2050, and **afforestation** **~0.04 MtCO₂/year** in 2030 and **~0.2 MtCO₂/year** in 2050. **Peatland** restoration increases from **~0.3 MtCO₂/year** in 2030 to **~1.4 MtCO₂/year** in 2050, reflecting both current progress and planned expansion.

Among biomass-based pathways, **durable bio-based products** contribute **~0.15 MtCO₂/year** in 2030 and 2050, assuming stable harvesting levels and unchanged biomass allocation (due to lack of data). **Biochar** shows stronger growth, from **~1.0 MtCO₂/year** in 2030 to **~2.8 MtCO₂/year** in 2050, driven by increasing agricultural biomass available for CDR that can be used for biochar (as it is not dependent on geological storage availability). Despite using a relatively small share of biomass, biochar delivers significant removals compared to BECCS, whose deployment is instead constrained by available CO₂ storage capacity.

BECCS potential in Poland is primarily constrained by the availability of CO₂ storage rather than biomass. In the short term, storage capacity is prioritised for CCS, limiting BECCS deployment. As a result, BECCS with combustion is not expected to contribute meaningfully in 2030 due to both limited storage and constrained availability of suitable biomass. Its potential increases to **~2.7 MtCO₂/year** by 2050, driven by the expansion of domestic geological storage capacity. BECCS based on anaerobic digestion is also not expected to be deployed in 2030 due to storage constraints, reaching **~1.3 MtCO₂/year** in 2050 as more storage is expected to become available. Storage allocation favours combustion-based BECCS, as anaerobic digestion relies on more dispersed feedstocks and smaller facilities, making deployment less efficient.

Among geochemical approaches, mineral **ocean alkalinity enhancement** (OAE) using dolomite and limestone provides a potential of **~0.6 MtCO₂/year** in 2030 and **~0.65 MtCO₂/year** in 2050, based on available mineral resources. Enhanced rock weathering (ERW) with basalt contributes **~0.17 MtCO₂/year** in 2030 and **~0.2 MtCO₂/year** in 2050. In all scenarios, available mineral resources are fully utilised.

Although **DACCS** is included in the scenario, it is not deployed in Scenario A. Limited CO₂ storage capacity is instead allocated to BECCS, reflecting its higher energy efficiency relative to direct air capture.

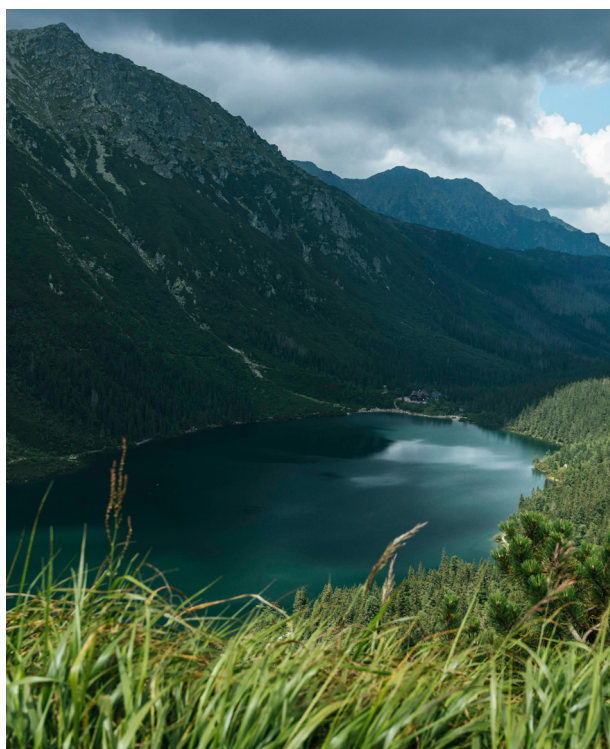


7.3.2 Scenario B: high ambition

In Scenario B, CDR potential reaches **~16 MtCO₂/year** in 2030 and **~45 MtCO₂/year** in 2050. If the natural carbon sink projections are considered (~40 MtCO₂/year), the total CDR potential is **~56 MtCO₂/year** in 2030 and **~85 MtCO₂/year** in 2050. Compared to Scenario A, the higher potential is mainly driven by expanded geological CO₂ storage and more ambitious deployment of land-based methods on arable land, afforestation and peatland restoration.

Forest-based removals show mixed dynamics. **Reforestation** remains limited, at ~0.06 MtCO₂ in 2030 and **~0.28 MtCO₂** in 2050, reflecting historical trends. In contrast, **afforestation** scales significantly, reaching ~1.9 MtCO₂ in 2030 and **~7 MtCO₂** in 2050, based on achieving national forest cover targets (33%, as described in Chapter 3). **Peatland restoration** also expands markedly, from ~1.7 MtCO₂ in 2030 to **~8.6 MtCO₂** in 2050, aligned with the current geopolitical climate, favourable public perception, and EU restoration targets. This is significantly different from Scenario A that assumes estimated pace of rewetting based on current levels.

Agricultural land-use measures remain a major contributor. **Cropland and pasture management** deliver ~6.9 MtCO₂ in 2030 and **~9.1 MtCO₂** in 2050, reflecting increased uptake of CDR methods on land. **Agroforestry** grows more gradually, from ~0.04 MtCO₂ in 2030 to **~0.1 MtCO₂** by mid-century, assuming faster adoption than current trends.



Among biomass-based pathways, **biochar** contributes ~2.0 MtCO₂ in 2030 and **~5.0 MtCO₂** in 2050, driven by greater availability and use of agricultural residues. Despite using a relatively small share of biomass, biochar outperforms BECCS in 2030 due to storage constraints. **Durable bio-based products** provide a stable contribution of **~0.3 MtCO₂/year**, assuming unchanged harvesting levels and biomass allocation due to lack of data.

In Scenario B, as in Scenario A, **BECCS** is not deployed by 2030 in Poland due to limited availability of CO₂ storage capacity. By 2050, however, geological CO₂ storage expands significantly as domestic storage capacity is developed, enabling BECCS deployment at scale. Under Scenario B, BECCS with combustion contributes an estimated **~3.2 MtCO₂/year**, while **BECCS with anaerobic digestion** contributes approximately **~6.8 MtCO₂/year by 2050**.

As in Scenario A, storage allocation prioritises combustion-based BECCS over anaerobic digestion. However, in Scenario B its deployment is more constrained by the availability of woody biomass than by CO₂ storage capacity. Therefore, after allocation of storage capacity to BECCS with combustion, there was plenty of CO₂ storage capacity available for BECCS with anaerobic digestion. This scenario therefore shows a high potential for BECCS with anaerobic digestion, also thanks to the financial support planned for biogas facilities, as presented in section 5.3.

Among geochemical methods, mineral OAE using dolomite and limestone reaches ~1.8 MtCO₂/year in both 2030 and 2050, reflecting full utilisation of available resources. ERW with basalt contributes ~0.42 MtCO₂/year in 2030 and ~0.5 MtCO₂/year in 2050.

Although **DACCS** was included in the scenario, it ultimately had no deployment potential in Scenario B due to the optimal allocation of resources. Though the Scenario B assumed larger availability of CO₂ storage capacity than scenario B, it was all prioritised for BECCS, given its higher energy efficiency relative to DACCS.

Overall, Scenario B reflects a high-ambition pathway with coordinated action across land-use and technological CDR methods. It assumes a significant scale-up of measures such as peatland restoration and the development of significant geological CO₂ storage capacity. However, much of the potential - particularly in the near term (i.e. by 2035) - would be challenging to realise under current policy and deployment trends, especially for less mature approaches such as geochemical methods.

7.4 Resource allocation

The key assumptions regarding the resource amounts available for CDR are presented in Table 10, and the more detailed assumptions per resource and scenario are explained later in this chapter after Table 11. For biomass, the assumptions are presented in Table 12. The more detailed description and background for different resources can be found in Chapter 3.

Although Table 10 presented the assumptions of the resource amounts available for CDR, not all these resources are needed if the resources are optimally allocated across different CDR methods

and resource constraints are considered. For example, the applied allocation model assumes that DACCS methods need both electricity and CO₂ storage. However, as all the storage is prioritised for and consumed by BECCS, the model showcases no potential for DACCS. As a result, the electricity available for CDR was not consumed at all. Table 11 shows the shares of resources used in the scenarios from those estimated to be available for CDR. These shares do not represent utilisation rates of the total resource amounts, which have been described in Chapter 3.

Resource	Amount available for CDR (2030)	Amount available for CDR (2050)	CDR method
Electricity	~1.8-2.2 TWh	~2-4 TWh	Assumptions on availability based on renewable energy projections as per the National Energy and Climate plan, renewable energy surplus.
Thermal energy	~1-3 TWh	~2-4 TWh	Assumptions based on the volumes and usage of waste heat. The amount was forecasted based on historical data.
Agricultural land	~1.6-2.7 Mha	~2.2-3.6 Mha	Out of the total land areas, the assumed land available for CDR was based on for example awareness levels of carbon farming, and considering the planned incentives for those, namely for agroforestry.
Forest land	0 Mha	~0.3 – 1.2 Mha	Assumed by 2030 forest management cannot be increased beyond returning to previous FSC certification levels. By 2050, 10-40% of currently non-FSC-certified forests could be managed for additional CDR.
Other land areas	48-400 kha	~230-1860 kha	The assumptions were based on historical data of afforestation and reforestation, and national targets of forest coverage, which aim to increase forest cover in Poland to 33% by 2050, corresponding to approximately 10.3 Mha of forest area ²⁴⁷ .
Areas for peatland restoration / rewetting	~38-230 kha	~190-1140 kha	The assumptions are based on the current plans of restoration projects and EU's target on peatland restoration (30% of peatlands restored by 2030).
Mineral feedstock	~1.8-4.9 Mt	~2-5.3 Mt	The assumptions are based on the projected production volumes of basalt, dolomite and limestone, and estimation of development of other, primary uses.
Storage capacity	0 Mt	4-10 Mt	Overall, it is expected that first geological storages are to be deployed 7-10 years after the research phase, thus there is no capacity available in 2030. The annual storage capacity need is expected to be prioritised for hard-to-abate fossil CO₂ until 2050, with a modest allocation for CDR. In Scenario A in 2050 the capacity available for CDR is assumed to be 4 Mt out of total capacity of 40 Mt (based on annual increase of ~2 Mt from 2030 onwards). In Scenario B, in 2050 the capacity available for CDR is assumed to be 10 MtCO₂ out of total capacity of 80 MtCO₂ (based on annual increase of ~4 MtCO₂ from 2030 onwards). In Scenario A and B, the export capacity is expected to be 0 MtCO₂ in 2030, as all the exported volumes are assumed to be fossil CO₂. In 2050 in both scenarios there is no export capacity considered, as per the assumption that Poland has scaled up its domestic geological storage capacity and have become an importer of CO₂.

Table 10. Key assumptions of the resource amounts that could be realistically available for CDR.

	2030		2050	
Resources	A	B	A	B
Mineral feedstock				
Basalt	100 %	100 %	100 %	100 %
Others incl. limestone and dolomite	100 %	100 %	100 %	100 %
Biomass	10 %	13 %	41 %	53 %
Land				
Arable land	100 %	100 %	100 %	100 %
Unspecified land (afforestation, reforestation)	100 %	100 %	100 %	100 %
Energy				
Electrical energy	not material	not material	not material	not material
Thermal energy	90 %	86 %	90 %	85 %
CO₂ storage				
Domestic storage	Not available	Not available	100 %	100 %
Exports	Not available	Not available	not material	not material

Table 11. Share of available resources used for CDR methods in each scenario. All resources available for CDR are used at their maximum except biomass and energy, that are constrained by insufficient CO₂ storage capacity.

7.4.1 Allocation of energy sources

The assessment of electricity availability is based on the National Energy and Climate Plan (NECP) published in summer 2025, which projects the development of Poland's power sector (see Chapter 3). Electricity available for CDR was assumed to scale with the growth of renewable energy sources. Availability for CDR was estimated based on volumes of renewable electricity that could not be injected into the grid due to network and system constraints. In 2024, approximately 940 GWh²⁴⁸ of solar PV generation and 731 GWh²⁴⁹ of wind generation were curtailed in Poland, corresponding to a total of ~1.67 TWh of unused renewable electricity. Available electricity for 2030 and 2050 was then projected proportionally to the expected growth in RES generation under the NECP WEM scenario. As NECP projections extend only to 2040, values for 2050 were estimated using linear extrapolation.

This assumption represents an upper bound. In practice, a share of curtailed renewable generation - particularly from distributed sources - may not be

accessible for CDR. Curtailment in Poland is partly driven by distributed generation (e.g. rooftop PV), which is not easily coupled with large-scale CDR facilities. In addition, grid access constraints may limit the extent to which curtailment scales with RES deployment. Therefore, the estimated energy availability should be interpreted as a technical upper bound rather than a fully deployable resource.

In **Scenario A**, the available electricity for CDR was assumed to be **1.7 TWh in 2030** and **2 TWh in 2050**. In **Scenario B**, the available electricity for CDR was assumed to be **2.2 TWh in 2030** and **4.4 TWh in 2050**. In the realistic scenarios, **thermal energy** availability for CDR was assumed to be limited to waste heat (**low grade only**). It was assumed that in 2030 10-30% waste heat generated could be directed to CDR and in 2050 10-30% depending on the ambition level. The ambition level is increasing towards 2050 but as the generation of waste heat declines, the total availability is assumed to remain on the same level.

The results indicate that **neither electricity nor heat constitutes a limiting factor for CDR potential**. Instead, broader deployment of electricity- and heat- consuming CDR methods like DACCS would require significant expansion of the available CO₂ storage capacity. As a result, not all projected energy resources available for CDR were consumed in the scenarios. In the resource allocation model applied, electricity consumption is considered only for DACCS (electricity required to deploy BECCS in combustion power plants is covered with additional biomass consumption). **Since there was no storage capacity left for DACCS after BECCS was deployed, none of the available electricity for CDR was consumed. Thermal energy was used in both scenarios for ocean alkalinity enhancement**, and about 85-90% of the available heat was consumed, as mineral resources (dolomite and limestone) limited the potential of the method first.

7.4.2 Allocation of land

To assess the availability of agricultural land for the realistic potential of CDR, the analysis primarily considered the availability of agricultural land that could be used for cropland and pasture management and the current rate of changes in its area. Based on a resource allocation model, it was found that land-based CDR methods compete for the same areas. Long-term national strategies, such as the *Koncepcja Rozwoju Kraju 2050*, published in July 2025²⁵⁰, assume increasing agricultural efficiency, allowing food production to be maintained with less land. This means that although the area of arable land may decrease (e.g., due to peatland restoration), the **percentage of land available for CDR is expected to increase**, as agriculture will require less space.

In **Scenario A**, it was assumed that **15% of the total agricultural land** (1.64 Mha) in 2030 with the share growing to **20%** (2.16 Mha) in 2050 would be available for CDR. No exact data was found on how carbon removal methods are applied in agriculture nowadays in Poland, so this is to large extent an expert assumption based on, for example, low awareness levels of CDR methods among Polish farmers (discussed in section 6.1.5), slow adaption rates of farmers to different methods and ways of working, as well as views gathered in the stakeholder interviews. These areas were allocated for the management of croplands and pastureland. In addition, it was assumed that **~800 ha in 2030** and **~2000 ha in 2050** would be available for **agroforestry**.

In the more ambitious **Scenario B**, it was assumed that **25% of agricultural land** (2.65 Mha) in 2030 and **40%** (3.55 Mha) in 2050, **would be available for the management of croplands and pastureland**. In addition, it was assumed that **~2600 ha in 2030** and **~7000 ha in 2050** would be available for **agroforestry**.

For areas suitable for **afforestation**: for the realistic scenarios we assumed that in **Scenario A** the average historical rate (around 700 ha/year) would be continued and in **Scenario B** it was assumed 80% of the theoretical scenario would be reached by 2050. **Reforestation estimations** were based on both historical data and rate of reforestation, as well as the national targets related to the forest coverage.

For **peatland** areas, in the theoretical potential it was assumed that all drained peatlands areas (that are 85% of all peatland areas in Poland), i.e. ~1300 kh were rewetted. This was drastically reduced for **Scenario A** based on the current pace and existing plans for rewetting. It was assumed that 15% of drained peatlands would be rewetted, i.e. **38 kha by 2030** and **190 kha by 2050**. For **Scenario B**, it was assumed that EU's target of 90% of peatland restored²⁵¹ by 2050 would be achieved. This means **6 kha rewetted by 2030**, and **26 kha by 2050**.

For **improved forest management**, only forests that are not already certified under FSC were included to prevent double counting of forest management benefits. The FSC certification has established forest management techniques, of which some affect the natural sink,²⁵² and therefore there is limited possibility and potential to implement alternative forest management methods for CDR compared to forests that are not certified. Up until 2022, the area of FSC-certified forests was about 6 Mha but this area dropped to about 2 Mha in 2024 when state-owned forests left the certification.²⁵³ As of 2024, Poland has reinstated cooperation with the FSC certification and for the 2030 realistic potential, it was assumed that all forests previously under the FSC certification would return to it and that no additional forest area for forest management would be available. The areas returning to the FSC certification were not counted towards the forest management category because it was assumed that any forest sink benefits resulting from them would still be visible in the natural forest sink value for Poland for 2023. Therefore, the land area available for forest management in 2030 was assumed to be 0. For **2050**, it was assumed that in **Scenario A**, 10% (**0.3 Mha**) of non-certified forests would be available for forest management, while in **Scenario B** these would be 40% (**1.2 Mha**).

7.4.3 Allocation of biomass resources

For the realistic CDR potential, the availability of biomass resources was estimated to be lower than in the theoretical potential due to competing uses and practical and financial feasibility constraints. Across all scenarios, **geological CO₂ storage was prioritised for BECCS with combustion while still ensuring a storage allocation of at least 10% to BECCS with anaerobic digestion**. The biomass feedstocks allocated to combustion are all energy wood intended for combustion regardless of BECCS and therefore based on retrofits to existing facilities. However, a significant portion of the non-forest biomass allocated to CDR is currently unused and its utilisation for BECCS would require construction of new anaerobic digestion facilities with BECCS. Therefore, implementing BECCS for combustion is the more resource-efficient option. Furthermore, because biogas facilities are typically smaller and more scattered than industrial wood combustion facilities, the CDR potential is in general higher in wood combustion facilities.

Biochar is a new, less established CDR method in Poland, and therefore its deployment is difficult to predict. Resource allocations to biochar should be considered a plausible estimate that could be increased even more if the appropriate infrastructure and financial incentives were in place. For now, for a short-term estimate 10% of wood and the agricultural side streams most favourable for biochar production were allocated to biochar. For 2050 this was assumed higher at 20%. Because there is existing infrastructure in place already for combustion and growing incentives for farmers to produce biogas, combustion and anaerobic digestion with BECCS, more biomass feedstock was allocated to them compared to biochar.

In **Scenario A**, the low-ambition scenario, it was assumed that only a fraction of the theoretical maximum biomass feedstock is available due to prioritization to other uses, financial and political constraints. In **Scenario B**, the high-ambition scenario, a larger portion of the theoretical maximum biomass availability is assumed for CDR. In the high-ambition scenario there is higher political and financial will to divert a larger portion of biomass to CDR and invest in CDR technologies.

Annex A lists the total biomass figures for Scenario A and Scenario B, their availability for CDR, and key assumptions.

7.4.4 Allocation of mineral feedstock

In both realistic scenarios, the available mineral feedstock was allocated to mineral ocean alkalinity enhancement and enhanced rock weathering. The included minerals were basalt, dolomite and limestone. The estimations of the current production volumes were based on historical data²⁵⁴ and projections for growth as described in Chapter 3. There was no exact data on current usages of these minerals, or plans for adopting or deploying these for CDR, so the **assumptions are largely based on the authors' expert views on what could be available for CDR after other uses**.

For dolomite, in **Scenario A** 10% of production volumes would be available for CDR, meaning ~0.31 Mt in 2030 and ~0.37 Mt in 2050. In **Scenario B** it was assumed that 25% of production volumes are available for CDR, meaning ~0.78 Mt in 2030 and ~0.92 Mt in 2050. Assuming the possibility of utilizing deposits abandoned for economic reasons (it's approx. 6% of overall balance), in practice only a limited share of resources can be mobilized for CDR.

For limestone, in **Scenario A**, 5% of production volumes would be available for CDR, meaning ~0.77 Mt in 2030 and ~0.76 Mt in 2050. In **Scenario B** it was assumed that 15% of production volumes are available for CDR, meaning ~2.27 Mt in 2030 and ~2.29 Mt in 2050. 20% of all resources of limestone are off-balance resources i.e. resources found, identified but not used due to high cost of extraction. Consequently, up to around 20% of limestone resources could be directed to CDR, but this figure appears feasible only in theory, so it was adjusted to be more realistic.

For basalt, in **Scenario A** 10% of production volumes would be available for CDR, meaning ~0.72 Mt in 2030 and ~0.86 Mt in 2050. In **Scenario B** it was assumed that 25% of production volumes are available for CDR, that is ~1.8 Mt in 2030 and ~2.2 Mt in 2050. Historically around 68% of basalt resources were classified as industrial, but for CDR realistically only a portion of this pool can be mobilised (mainly due to economic reasons).

In all scenarios, **dolomite and limestone were directed to mineral ocean alkalinity enhancement (OAE) whereas basalt was consumed in enhanced rock weathering**. For mineral resources, as per the resource allocation model, no other resources limited the deployment of available resources for CDR, and thus, all available resources for carbon removal were used in both scenarios.

7.4.5 Allocation of CO₂ storage resources

The most significant limiting factor in realistic scenarios is CO₂ storage capacity, allocated to BECCS and DACCS (though after allocation to BECCS, there was no storage capacity left to DACCS). Poland's geological formations, particularly saline aquifers, hydrocarbon deposits (depleted oil and gas fields), and unmined coal seams offer significant storage potential. **Although there have been research activities and the first CCUS projects are under way, none of the domestic storage capacity has been realised to date.** First geological storage is expected to be deployed 7-10 years after the research phase and conditional on removing remaining legislative roadblocks. To start with, it was assumed that the first projects have somewhat modest CO₂ capacity per year, and that the annual storage need will be higher, with priority for hard-to-abate fossil CO₂ until 2050.

In both scenarios for 2030, it was assumed that **there would be no geological CO₂ storage capacity available**. For 2050, **Scenario A** assumes an overall capacity of **40 Mt** with a handful of small projects being developed in the 2030s and then more substantial capacities being created in the 2040s. The allocation is assumed to be 90% for fossil CO₂, with only **4 MtCO₂/year allocated to CDR**. In **2050, Scenario B** assumes a total capacity of **80 Mt** (with a more ambitious deployment of larger projects in the 2040s), of which 70 Mt is needed for fossil CO₂ as per an assessment done by Clean Air Task Force²⁵⁵ and therefore with **10 Mt CO₂/year allocated to CDR**.

Assumptions about Poland's ability to export CO₂ for geological storage considered several factors: the development of storage capacity abroad, CO₂ transport infrastructure, Poland's potential share of demand for foreign storage, and prioritisation of hard-to-abate fossil emissions – and also Poland's own, vast geological storage capacity. In 2050 it was assumed that Poland has scaled up its own domestic geological storage capacity, and have become an importer of CO₂, thus no export capacity was assumed to be deployed in either of the scenarios.

In both scenarios, the entire geological CO₂ storage assumed for carbon removals is fully utilised, and the availability of geological storage limits the potential of BECCS and DACCS, even though other resources required for these methods would still be sufficient.

7.5 The estimated cost of implementing the scenarios

While this background report does not provide a full techno-economic assessment of the various CDR methods, costs were considered in the "merit order" when shaping the CDR portfolio. For example, BECCS was favoured over the generally more expensive DACCS. However, investment costs for capture, storage, and infrastructure were not estimated, as they vary widely by project, company circumstances, and other factors.

Ecosystem management CDR methods are generally cheaper per tonne of CO₂ removed than synthetic methods. Forest carbon measures – such as altering tree species or using timber in long-lived products – often cost under €50/tCO₂e²⁵⁶. According to the study by the European Scientific Advisory Board (ESAB) on Climate Change²⁵⁷, cost ranges are:

- **Afforestation:** €0-216/tCO₂. Estimates vary widely due to variations in land opportunity costs, included expenses, time horizon considered, and regional context – ranging from low-cost global cases to high-cost EU deployments on valuable agricultural land;
- **Improved forest management:** typically, less than €50/tCO₂, one study suggesting up to €113/tCO₂;
- **Soil carbon sequestration:** €-45 to 123/tCO₂ (highly context dependent, sometimes yielding cost savings);
- **Agroforestry:** €20-90/tCO₂
- **Peatland restoration:** €8-110/tCO₂

Among **biomass conversion methods**, BECCS is estimated at USD 100–200/tCO₂ removed, reflecting sustainability and infrastructure challenges. Biochar costs are projected at USD 90–120/tCO₂, though uncertainties remain due to limited large-scale deployment. The estimates are based on the European Parliament briefing on carbon dioxide removals²⁵⁸. The study by ESAB (2025) summarises that the cost of BECCS ranges from 27€ to 360€ per tCO₂, and biochar, from 10€ to over 200€/tCO₂.

For **geochemical methods**, the European Parliament has indicated that the cost of deploying enhanced rock weathering is estimated to be in the range USD 50–200/tCO₂, with ESAB reporting a wider range of ~€50–400/tCO₂ depending on rock type and source, grinding and transport costs, application method, and monitoring and verification requirements. Mineralocean alkalinity enhancement with carbonates is projected at USD 70–120/tCO₂²⁵⁹.

Lastly, **DACCS costs are estimated at USD 100-300/tCO₂** by the European Parliament briefing, while ESAB reports a wider range of €450-900/tCO₂. ESAB cautions that these figures carry significant uncertainty, with future learning rates, energy availability and costs, and infrastructure development expected to drive reductions over time.

A rough cost estimate (based largely on ESAB method-cost ranges combined with the scenario potentials) suggests an investment need of ~0.3-9 billion EUR per year by 2050 for Scenarios A and B - underscoring the need for durable market design, public procurement/finance mechanisms, and infrastructure investment to mobilise private capital.

Table 12 summarises the cost estimates for different scenarios based on the calculated CDR potential. Minimum values reflect either the lowest or average estimates (where variation is high), while maximum values use the highest estimate per method. Given the uncertainty and variance, these figures should be seen as indicative only. Detailed assumptions and data are provided in Annex B.

Based on these estimates, Scenario B is much more cost-intensive pathway, but it delivers decisive actions on carbon removals, while leveraging technical methods such as BECCS to a greater extent than Scenario A.

Scenario A (2030)	Scenario A (2050)	Scenario B (2030)	Scenario B (2050)
~0.3-1	~0.7-3.2	~0.7-2.3	~1.9-9

Table 12. Indicative costs of deploying the scenarios, in billion €.



8. Conclusions

Poland is lagging on climate action and is currently not aligning its efforts with the commitments set out in the EU Climate Law. However, the country has taken initial steps towards potential carbon dioxide removal (CDR) deployment by increasing activities related to carbon capture, utilisation, and storage (CCUS). Even though the efforts serve initially hard-to-abate fossil emissions, these investments and policies could be transferred to CDR activities, especially in case of increased societal pressure towards climate action.

This report aimed to evaluate the potential, limitations, and sociocultural implications of various CDR pathways in Poland. By examining the current state of knowledge, technological readiness, and public acceptance, the report provided an insightful overview of the prospects and challenges associated with deploying CDR methods.

In the subsequent conclusions, key findings are synthesised to provide a comprehensive understanding of what the starting point for CDR deployment in Poland is. The report highlights the main data gaps that have constrained the study's precision and scope, it identifies promising CDR pathways and potential hotspots and discusses the limitations and missing pieces crucial to effective deployment. Additionally, it considers the unique sociological factors that should guide the development of a national CDR roadmap.

To reflect this reality and enhance the relevance of the findings for decision-makers, the methodology used in this report emphasises three key dimensions:

- Comprehensive assessment of all available CDR methods and their interconnections.
- Bottom-up analysis of potential, grounded in actual resource availability.
- Consideration of Poland's unique 'social geography' - the societal, cultural, and regional factors that shape the feasibility and acceptance of CDR.

A variety of methods

Of the many existing and proposed CDR methods, this study focused on those with potential for large-scale deployment in Poland by 2050 and showcased enough technical maturity and research-based evidence of carbon removals to assess their potential. A few methods were excluded due to low level of maturity or constraints set by especially regulatory limitation specific to the Poland context or lack of research. The excluded methods were blue carbon (limited coastline), bio-oil storage, marine

biomass sinking, terrestrial biomass burial, ocean fertilisation and DOCCS (low maturity) and ex-situ carbon mineralisation (lack of data on the relevant feedstocks).

Despite these exclusions, the final portfolio of CDR methods used in the deployment scenarios encompasses all four major categories: (i) Enhanced ecosystem management, (ii) Biomass conversion/preservation, (iii) Geochemical carbon removal, and (iv) Synthetic carbon removal. Leveraging this diversity of methods is essential to accommodate the limitations on the different resources, distribute the risks, and reach meaningful levels of CDR deployed by 2050.

Two scenarios were developed to illustrate different pathways to CDR deployment in Poland:

- **Scenario A:** a low ambition CDR scenario,
- **Scenario B:** a high ambition CDR scenario

Both scenarios were modelled for the short term (2030) and the longer term (2050). The scenarios illustrate different development pathways for carbon removal, ranging from the scale of measures to deploy CDR methods to the amount of resources allocated to carbon removal.

Bottom-up analysis

The CRRA is based on a bottom-up analysis starting from the physical resources available in the country. This methodological choice makes the assessment easily auditable. It makes it easier for stakeholders to engage and use the assessment to understand where and how CDR could be deployed in their value chains, as opposed to "black box" complex models that they can only trust.

The assessment was done based on existing data, and informed assumptions derived from it. The formulation of these assumptions was partly influenced by data gaps, particularly regarding the future development of biomass and mineral resource volumes, the current use of agricultural land for carbon removal, and the projected evolution of forest sinks considering possible variations in harvesting levels. Some future projections extended only to 2040, and for these, well-founded assumptions were made about how trends would continue through 2050. In case of data gaps, the assessment was done by expert assumption based on for example the insights from stakeholder interviews.

Key conclusions

- **Poland has abundant and diversified national resources that could be utilised to deploy CDR making Poland's CDR potential relatively significant in Europe.** The availability of forests, agricultural land and peatlands provide great possibilities for nature-based CDR methods. Additionally, Poland has significant biomass feedstocks that could be deployed for CDR methods such as BECCS and biochar. Also the mineral feedstock provides opportunities to deploy geochemical carbon removal. Overall, the optimal CDR portfolio for Poland consists of variety of CDR methods.
- **In the proposed scenarios, about 80% of the CDR volumes rely on enhancing natural ecosystems,** reflecting Poland's significant natural assets. Nonetheless, this also means an **increased exposure to the risks of systemic failure of ecosystems** as already observed elsewhere in Europe. The lack of data made it hard to evaluate such risk, in particular on the natural sink. This risk should be acknowledged by policymakers and trigger both additional studies and including safety margins in CDR strategies.
- **Peatlands rewetting and conservation offer a significant potential in Poland** given the abundance of these ecosystems and their current state of degradation. Peatlands have also gained new attention as natural barriers after the Russian invasion of Ukraine giving traction to an increased effort to restore these ecosystems.
- **Poland has massive potential for geological storage of CO₂ but it is still largely underdeveloped and prioritised for emission reductions instead of CDR.** If Poland were to take full potential of its geological storage, it could provide carbon management solutions for the rest of Europe and thus increase the potential of CDR in Europe especially from 2050 onwards.
- **The lack of geologic storage combined with the relatively high availability of biomass and the high carbon intensity of electricity reduce the case for energy intensive methods like DACCS, at least before 2050.** But the decarbonisation of the power sector has already started, so the picture could be different 10 to 15 years from now subject to a fast development of storage solutions.

Readiness gaps: policy, institutions, and social license

- **Polish society is at the very starting line for CDR.** Currently, **Poland does not have national CDR targets** as it is also **lacking general climate neutrality targets** and is not progressing to comply with EU's climate law requirements. Lack of climate strategy, that would include also CDR, is one of the most significant bottlenecks hindering the progression of both emissions reductions and carbon removals in Poland. This would be needed for example to support the heavy industrial sector, with hard-to-abate emissions, to take more decisive climate action.
- **Poland has emerging activities in the CCUS space** with ongoing government investments, business clusters activities and research to support the topic. In addition to significant geological CO₂ storage, Poland has potential to become a leading country of CCUS development. Advancing CCUS in scale could support also CDR deployment in terms adaption of technologies, developing regulation and building CO₂ infrastructure. Nonetheless, the implementation of recent regulation intended to unlock this potential appear to accumulate delays eating into the already tight time window to meet EU's aligned climate objectives and amplifying uncertainty around investments that are already difficult to secure in optimal conditions.
- **Public understanding of CDR is low, but support can be built.** The citizen panel and stakeholder interviews show growing interest in CDR technologies in Poland. Although public awareness of these solutions remains low, panel participants demonstrated strong engagement and openness to discussion. Experts emphasised the need to initiate public debate to accelerate the implementation of change. Citizen panel favoured nature-based CDR methods – afforestation, peatland restoration, and carbon farming. Technologies such as BECCS and biochar sparked interest, but also raised concerns regarding costs, effectiveness, and environmental impact. Experts highlight that Poland has significant implementation potential, especially using technological methods in energy-intensive sectors. However, the development of CDR is hindered by the lack of a national strategy, regulatory frameworks, and financial support for pilot projects.

Priority actions for stakeholders and policy makers:

- **Streamline the execution of existing regulations** to unlock a pipeline of projects progressively building a CO₂ transport and storage capacity in Poland, but also to speed up the recuperation of peatlands.
- **Initiate the preparation of a national CDR strategy** with quantitative milestones to provide a direction of travel and boost investment in the projects
- **Increase ambition and speed on the development of onshore CO₂ storage** and consider prospective partnership with surrounding countries like Finland where suitable formations are not available.
- **Invest in skills, research, and coordination.** Universities, vocational institutes, and industry should coordinate to train the workforce for the green jobs for CDR design, operation, and MRV at home. A national CDR coordination body could bridge ministries, regions, regulators, and research institutions, preventing the siloed governance that currently slows action

Overall CDR is gradually entering the Polish climate discourse and has the potential to become a permanent element of the national decarbonisation strategy. However, its effective implementation requires stable regulations, strengthened climate education, better use of local resources, and for technological methods the development of national infrastructure.



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Annex A. Biomass availability for CDR in the realistic scenarios

Type of biomass	2030			2050			Allocation to CDR methods	Key assumptions
	Total projected amount in Scenario A and B	Amount available for CDR Scenario A	Amount available for CDR Scenario B	Total projected amount Scenario A and B	Amount available for CDR Scenario A	Amount available for CDR Scenario B		
Energy wood	0.683	0.369	0.491	0.683	0.369	0.491	90%/80% BECCS with combustion, 10%/20% biochar (2030/2050)	Assumed that 90% is burned in industrial plants (10% in households). Then assumed that 60% of that is burned in large units (that will be realistically available for CDR).
Sawmill wood	2.135	0.427	0.854	2.135	0.427	0.854	Products	Assumed that 70% is used for bio-based products. Then assumed that 20% of that are available for CDR as durable bio-based products.
Pitwood	0.023	0.005	0.009	0.023	0.005	0.009	90%/80% products, 10%/20% biochar (2030/2050)	Assumed that 85% of pitwood used for bio-based products. Then assumed that 20% of that is available for CDR as durable bio-based products or biochar.
Pulpwood	1.264	0.000	0.000	1.264	0.000	0.000	[-]	Import is higher than export. No CDR availability.*
Plywood	1.264	0.126	0.253	1.264	0.126	0.253	90%/80% products, 10%/20% biochar (2030/2050)	Assumed that 90% of the stream is product. Then assumed that 10% of that is available for CDR as durable bio-based products or biochar (available for CDR).
Black liquor	0.843	0.421	0.674	0.843	0.843	0.674	BECCS with combustion	Assumed that it is 40% of the stream directed to paper production (pulpwood). Assumed that 50% is available for CDR.
Forest industry byproducts	1.059	0.000	0.000	1.059	0.000	0.000	[-]	Assumed not available for CDR because used in households or small facilities
Paper and cardboard (municipal)	0.641	0.160	0.192	0.915	0.092	0.137	BECCS with combustion	Paper and cardboard are currently mostly recycled. In 2021 42% of paper and cardboard was recycled. We assume that 50% is recycled now then 50% may be used for CDR. The recycle level will grow so availability will decrease. 25% was assumed in 2030 and 10% in 2050.

*Newspaper "Gazeta Przemysłu Drzewnego 02/2025" (Newspaper of Wood Industry. 2025. Papier w nowej erze. <https://gpd24.pl/e-zine/GPD-02-2025/18/#zoom=true>

Type of biomass	2030			2050			Allocation to CDR methods	Key assumptions
	Total projected amount in Scenario A and B	Amount available for CDR Scenario A	Amount available for CDR Scenario B	Total projected amount Scenario A and B	Amount available for CDR Scenario A	Amount available for CDR Scenario B		
Paper and cardboard (industrial)	0.732	0.183	0.220	0.366	0.037	0.055	BECCS with combustion	Paper and cardboard are currently mostly recycled. In 2021 42% of paper and cardboard was recycled. We assume that 50% is recycled now then 50% may be used for CDR. The recycle level will grow so availability will decrease. 25% was assumed in 2030 and 10% in 2050.
Biowaste (municipal)	0.690	0.345	0.676	1.361	0.681	1.334	BECCS with anaerobic digestion (AD)	From the total amount of biowaste, the stream currently used in biogas plants was subtracted. 50% of what was left was assumed to be available for CDR.
Mixed waste (municipal)	5.950	1.250	1.999	4.250	0.893	1.428	BECCS with combustion	It is commonly assumed that 42% of mixed waste is biofraction. 50% of biofraction was assumed to be available for CDR.
Sludge (industrial)	1.035	0.103	0.310	1.161	0.581	0.871	BECCS with AD	Assumed BECCS can be retrofitted in anaerobic digestion facilities so that 10% of sludge is available for CDR in 2030 and 50% in 2050.
Cereal production	34.296	2.968	7.420	38.583	3.339	8.347	90%/80% BECCS with AD, 10%/20% biochar (2030/2050)	The waste is husks (shell), depending on the type its 5-10% up to 25% of the grain. It was assumed that 10% may be husks that could be used for the CDR needs. Additionally, there is approx. 35 mln tonnes of straw from cereal production in Poland. Only small part of it is used somehow. 10% is left on the field. Basing on the above it has been assumed that 10% is available husks and that we could use 35 mln tonnes of straw. Half of the stream was assumed possible due to other usage like local use for farm animals. Then 20% was assumed as available for CDR (8,65% from initial stream).
Stems from peas and broad beans	0.275	0.021	0.034	0.330	0.050	0.066	90%/80% BECCS with AD, 10%/20% biochar (2030/2050)	We assumed that 50% is used for animal food (priority) and 50% is composted or left on the field (possible to be used on CDR). 8 – 15% of total value was assumed as available for CDR.
Potato tops	1.034	0.078	0.129	0.565	0.085	0.113	BECCS with AD	We assumed that 50% is used for animal food (priority) and 50% is composted or left on the field (possible to be used on CDR). 8 – 15% of total value was assumed as available for CDR.

Type of biomass	2030			2050			Allocation to CDR methods	Key assumptions
	Total projected amount in Scenario A and B	Amount available for CDR Scenario A	Amount available for CDR Scenario B	Total projected amount Scenario A and B	Amount available for CDR Scenario A	Amount available for CDR Scenario B		
Sugar beet tops	5.771	0.433	0.721	8.976	1.346	1.795	BECCS with AD	We assumed that 50% is used for animal food (priority) and 50% is composted or left on the field (possible to be used on CDR). 8 – 15% of total value was assumed as available for CDR.
Straw of herbage seed crops	23.593	1.769	2.949	25.655	3.848	5.131	90%/80% BECCS with AD, 10%/20% biochar (2030/2050)	We assumed that 50% is used for animal food (priority) and 50% is composted or left on the field (possible to be used on CDR). 8 – 15% of total value was assumed as available for CDR.
Stems of oils crops (oilseeds)	4.185	0.314	0.523	4.836	0.725	0.967	90%/80% BECCS with AD, 10%/20% biochar (2030/2050)	We assumed that 50% is used for animal food (priority) and 50% is composted or left on the field (possible to be used on CDR). 8 – 15% of total value was assumed as available for CDR.
Grasses	36.750	1.837	3.675	44.100	2.205	4.410	BECCS with AD	We assumed that 50% is used for animal food (priority) and 50% is composted or left on the field (possible to be used on CDR). 5% of total value was assumed as available for CDR.
Manure	30.732	6.146	12.293	33.857	6.771	13.543	90%/80% BECCS with AD, 10%/20% biochar (2030/2050)	There's an idea of implementing new rules that the farmers will be responsible for emissions from not used manure (additional fees). Date of implementation is not known. Therefore we assume high usage of manure in future. 20% was assumed as available for CDR
Hay	11.050	0.829	1.326	12.750	1.913	2.550	90%/80% BECCS with AD, 10%/20% biochar (2030/2050)	We assumed that 75% is used for animal food (priority) and 25% is composted or left on the field (possible to be used on CDR). Assumed higher share of animal food usage than in other categories. 8 – 15% of total value was assumed as available for CDR.
SUM	164.004	17.784	34.750	184.977	24.333	43.029		

Table A.1. Total amounts, availability and assumptions of biomass for Scenario A and B in Mt of dry mass.

Annex B. Break-down of cost estimates for deploying the scenarios

Table B.1 showcases the detailed breakdown of cost estimates for deploying the scenarios. The columns include the potential of each method in the two scenarios, for 2030 and 2050, and the cost range of each method, as € per CO₂t removed. Most of the method-specific cost estimates are based on the sources named in chapter 7. The cost estimate was presented in USD and converted to EUR with InforEuro exchange rate on November 7th, 2025. For BECCS, the study doesn't define if the presented cost ranges are for combustion-based or anaerobic digestion, thus those are combined in the cost estimation for scenario deployment.

For afforestation and reforestation same cost estimates were used based on table 43 in ESAB's study. As the cost range started from zero, the minimum cost was defined as average of the cost range. For durable bio-based products there were no solid cost estimates to be found, so these were excluded from the cost estimation. However, that method's CDR potential is a fairly small share of overall CDR potential, the exclusion doesn't impact the scale of cost estimates or differences between the scenarios.

CDR method	Unit cost (€/tCO ₂ removed)	SCENARIO A				SCENARIO B			
		2030		2050		2030		2050	
		Amount	Cost m€	Amount	Cost m€	Amount	Cost m€	Amount	Cost m€
BECCS	27-360	-	-	4.0	108-1 440	-	-	10	270-3 600
Bio-based products	N/A	0.15	N/A	0.15	N/A	0.30	N/A	0.30	N/A
Biochar	100-223	1.03	100-230	2.8	280-614	2.04	200-450	5.0	500-1 115
Mineral OAE / Ocean liming	60.6-103.9	0.61	37-63	0.65	39-67	1.75	106-182	1.85	111-191
ERW	54-400	0.17	9-67	0.20	10-80	0.42	22-168	0.50	27-200
Peatland restoration	8-110	0.29	2.3-31	1.43	11-156	1.72	13-188	8.58	68-943
Cropland management	36-123	3.37	121-414	4.43	159-544	5.43	196-668	7.28	261-895
Pasture management	36-123	0.89	31-109	1.16	41-143	1.43	51-175	1.91	68-235
Agroforestry	20-90	0.01	0.24-1.08	0.03	0.7-2.9	0.04	0.8-3.7	0.11	2-9
Afforestation	73-216	0.04	3-9	0.18	13-39	1.89	137-407	7.28	531-1 573
Reforestation	73-216	0.06	4.7-13.8	0.28	20-59	0.06	4-13	0.28	20-59
Forest management	50-113	0	0	0.4	20-45	0	N/A	1.604	80-181
Total costs		310-940 M€		700-3200 M€		734-2284 M€		1940-9000 M€	

Table B.1. Cost assessment of Scenario A & B.



ABOUT

Carbon Gap

Carbon Gap was established to be Europe's first philanthropically funded environmental advocacy organisation, focusing exclusively on CDR. The mission is to ensure that Europe becomes a leader in developing and deploying CDR solutions at scale in a safe and equitable manner to preserve a stable climate. Carbon Gap is coordinating the delivery of the project that has produced this report.

www.carbongap.org

Sweco

Sweco is Europe's leading engineering and architecture consultancy. Sweco Finland's Strategic Sustainability Consultancy was responsible for this report.

www.sweco.fi

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