

Public Project Description

This document is a project description made available in the Puro Registry to summarize the information available about a certified production facility. The project description is organized as follow:

1	Production Facility and Supplier information	1
2	Overview of activity, its location, and operators	2
3	Technical description of the removal activity	4
4	Application of the Puro Standard (boundary, baseline, additionality, quantification).....	7
5	Social and environmental safeguards	14
6	Other documents available in the Puro Registry	19

1 Production Facility and Supplier information

This project description corresponds to the following **Production Facility** and **CO₂ Removal supplier**, acting as registering entity of the facility.

Production Facility	
Production Facility name	Mammoth
Registration date (YYYY-MM-DD)	2024-06-27
Production Facility ID	417791
Location of facility	Suðurvellir 1, 816 Ölfus
Host Country of removal	Iceland
Has this facility been registered in another registry?	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes, additional information (registration periods):
<i>This table is filled in by the CO₂ Removal Supplier.</i>	

CO ₂ Removal Supplier	
Supplier name	Climeworks AG
Supplier address	Birchstrasse 155, 8050 Zurich, Switzerland
Business ID	CHE-115234406
KYC status	Completed
<i>This table is filled in by the CO₂ Removal Supplier.</i>	

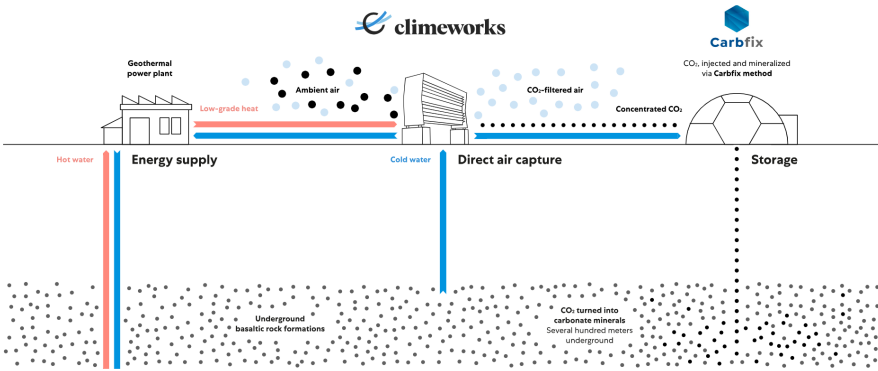
The above-mentioned production facility has undergone the following audit, during which the project description, alongside other audit documents were verified.

Facility Audit	
Type of audit	Facility Audit
General Rules version	4.0
Methodology name	Geologically Stored Carbon
Methodology edition and version	Edition: 2024 Version: 2
Date of audit completion	2024-09-19
Conclusion of audit	Qualified Positive
Auditing body	DNV Business Assurance Finland Oy Ab
Start date of crediting period	2024-06-01
End date of crediting period	2039-06-01
<i>This table is filled in by the Issuing Body.</i>	

2 Overview of activity, its location, and operators

The information in this section provides an overview of how and where carbon dioxide removal is achieved, and by whom.

2.1 Non-technical description

Instructions	<i>Please provide a non-technical description of the carbon removal activity taking place at the production facility. Word limit: 100 words.</i>
Non-technical description	<p>Project Mammoth is a Direct Air Capture (DAC) and CO₂ mineral storage project owned by Climeworks and operated by Climeworks and partner Carbfix. Mammoth was inaugurated in May 2024 at ON Power's Geothermal Park at Hellisheiði in Iceland. It has a nominal capacity of capturing and permanently removing 36,000 tons of CO₂ per year from the atmosphere. CO₂ is removed from the atmosphere using Climeworks' Direct Air Capture technology. This CO₂ is then permanently stored underground using Carbfix's in-situ CO₂ mineralization method. Both processes are supplied with energy from Hellisheiði geothermal power plant by ON Power.</p>  <p>The diagram illustrates the process of carbon removal at Project Mammoth. It shows a geothermal power plant providing energy to a direct air capture facility. Ambient air is filtered to remove CO₂, which is then concentrated and injected into the ground for storage. The diagram also shows the underground basaltic rock formations and the CO₂ being turned into carbonate minerals.</p>

This table is filled-in by the supplier and verified by the auditor.

2.2 Locations

Instructions	<i>Please provide a list of locations associated with the carbon removal activity. Additional locations or areas can refer to e.g. the location of the storage site, the spatial extent of the area of use of a carbon removal product or sourcing of a specific feedstock.</i>
Production Facility Location (as registered)	<p>Address: Hellisheiðarvirkjun, 816 Ölfus, Iceland Coordinates (WSG84, decimal format): Latitude: 64.044 Longitude: -21.41</p>
Additional location(s)	<p><i>Specify purpose, location, address, coordinates, to the extent possible, for one or multiple additional locations relevant to the removal activity.</i></p> <p>Climeworks DAC facility is located at the ON Power Geothermal Park of the Hellisheiði Geothermal Power Station</p>

This table is filled-in by the supplier and verified by the auditor.

2.3 Operators

Instructions	<i>Please provide a full list of operators or organizations that contribute to the removal activity. Add rows as necessary. For each entity, provide the name, a business ID, an address, and the role of the entity.</i>
CO₂ Removal Supplier	<i>Entity name:</i> Climeworks AG <i>Entity business ID:</i> CHE-115234406 <i>Entity address:</i> Birchstrasse 155, Zurich 8050, Switzerland <i>Role of entity:</i> DAC operator
Storage Operator	<i>Entity name:</i> Carbfix hf. <i>Entity business ID:</i> 531022-0840 <i>Entity address:</i> Höfðabakki 9D, 110 Reykjavík, Iceland <i>Role of entity:</i> Storage operator
Power Provider	<i>Entity name:</i> ON Power <i>Entity business ID:</i> 471119-0830 <i>Entity address:</i> Bæjarháls 1, Reykjavik 110, Iceland <i>Role of entity:</i> Power supplier
<i>This table is filled-in by the supplier and verified by the auditor.</i>	

3 Technical description of the removal activity

The information in this section provides more technical details about the technologies and processes deployed to achieve carbon dioxide removal.

3.1 Technical description

Instructions	<i>Please provide a technical description of the carbon removal activity taking place at the production facility. Word limit: 500 words.</i>
Technical description	<p>Project Mammoth contains four main process steps: Direct Air Capture (DAC) of atmospheric CO₂; dissolution of captured CO₂ into water; transport of CO₂-charged water via pipeline; geological storage of CO₂ through in-situ mineralization.</p> <p>CO₂ Capture</p> <p>The DAC plant is made up of 72 modular units called CO₂ Collector Containers. Each unit is composed of fans and filters and is connected to the process units. Mammoth captures atmospheric CO₂ by applying a cyclic vacuum-temperature-swing adsorption and desorption process. Air is drawn into the plant using fans and the CO₂ within the air is chemically bound to the sorbent, a highly selective solid filter material. Once sorbent is saturated, it is heated under vacuum to ~100°C using hot water from nearby Hellisheiði geothermal power plant. The CO₂ is thereby released from the filter and collected as a concentrated gas (for dissolution), and the continuous cycle begins again.</p> <p>CO₂ Dissolution in Water</p> <p>CO₂ is dissolved in water in an on-site absorption tower using water sourced from local wells and the power plant. The purpose of this is to remove remaining water-insoluble air components from the CO₂ gas before injection, remove the inherent buoyancy of CO₂ prior to injection, and enhance reactions required for in-situ mineralization.</p> <p>Dissolution eliminates CO₂ buoyancy because CO₂-charged water is denser than other fluids in subsurface geological reservoirs. CO₂-charged water will therefore sink once injected, removing the capability of CO₂ to migrate upwards. This is a chemical CO₂ trapping mechanism known as solubility-trapping. CO₂ dissolution enhances mineralization reactions because CO₂-charged fluids are acidic (typically pH 3-5). This increases the release of calcium, magnesium and iron from the storage reservoir rocks, which are needed to mineralize the injected CO₂.</p> <p>CO₂ Transport</p> <p>CO₂ capture and storage facilities are located on the same site. The infrastructure required for CO₂ transport is an underground pipeline of <100m. Booster pumps, controlled and powered within the DAC facility, feed the CO₂ charged water from the absorption tower towards injection wells.</p> <p>CO₂ Storage: In-situ CO₂ Mineralization</p> <p>Permanent storage of injected CO₂ is provided through subsurface (in-situ) mineralization. CO₂-charged fluids are injected to at least 348 m depth to ensure sufficient pressure for all CO₂ to remain dissolved. Fluids enter the reservoir rocks below this depth and begin to react with minerals in the basaltic host rocks. These minerals contain calcium, magnesium and iron, which dissolve into solution upon interaction with CO₂-charged fluids. Dissolved CO₂ reacts with these elements to form stable carbonate minerals</p>

	<p>such as calcite (CaCO_3), magnesite (MgCO_3) and siderite (FeCO_3). The reservoir monitoring well, and groundwater monitoring wells located downstream of the injection well are used with reservoir models to track the fate of CO_2 and verify storage is occurring as described. Field demonstrations have shown that in-situ CO_2 mineralization can occur within months of injection. Once mineralized, CO_2 is immobilized in the subsurface, a process known as mineral-trapping. Carbonate minerals are stable in the subsurface for thousands of years, meaning mineral trapping provides permanent secure storage.</p>
<p><i>This table is filled-in by the supplier and verified by the auditor.</i></p>	

Illustration

Instructions	<p>Please provide up to three illustrations of the process and technologies described above (e.g. picture of equipment, flowcharts of process). Note that you must own the rights to reproduce and publish the illustration and that you also authorize puro.earth to reproduce and publish the illustration in the Puro Registry.</p>
Authorization to reproduce and publish the illustration	<p><input checked="" type="checkbox"/> Puro.earth is authorized to reproduce and publish the illustrations below, for use in the Puro Registry.</p>

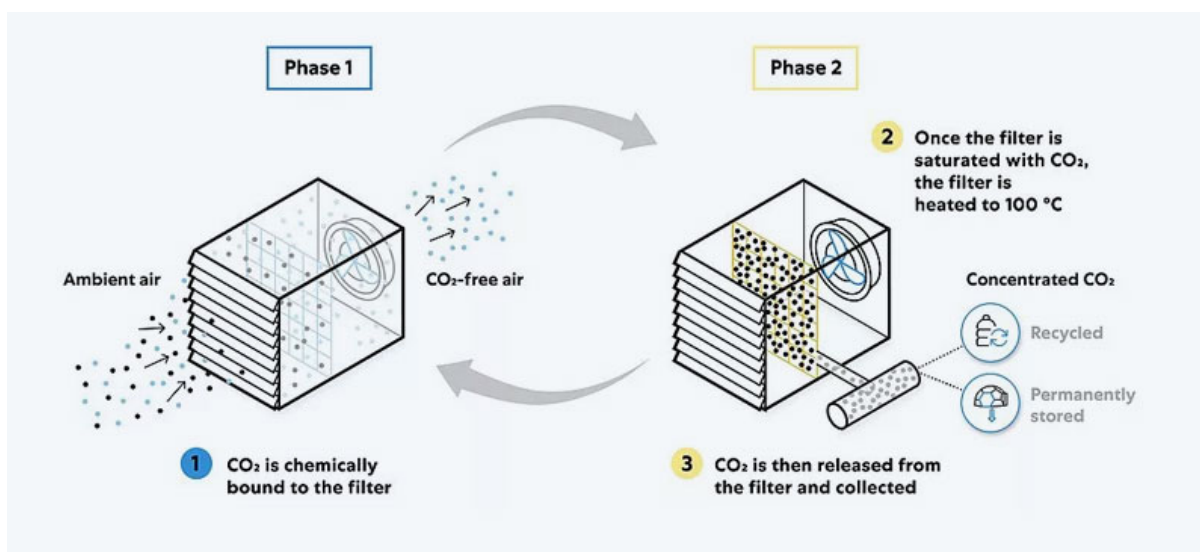


Figure 1: Working principle of Climeworks DAC technology.

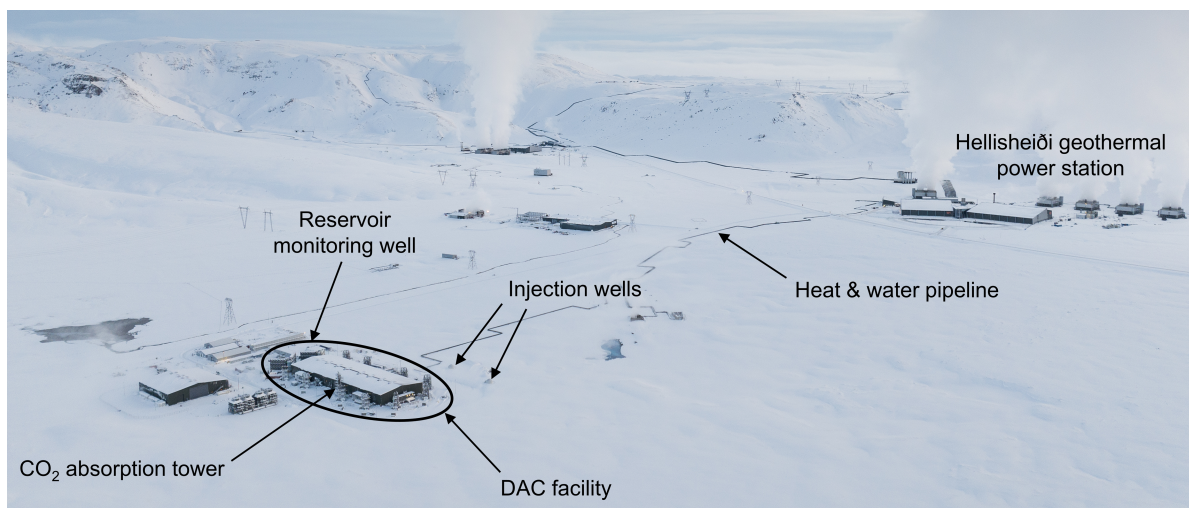


Figure 1: Aerial picture of Project Mammoth and its associated infrastructure, including the pipeline from Hellisheiði geothermal power station that supplies Mammoth with heat, water and electricity. Images faces east. Photo by Climeworks.

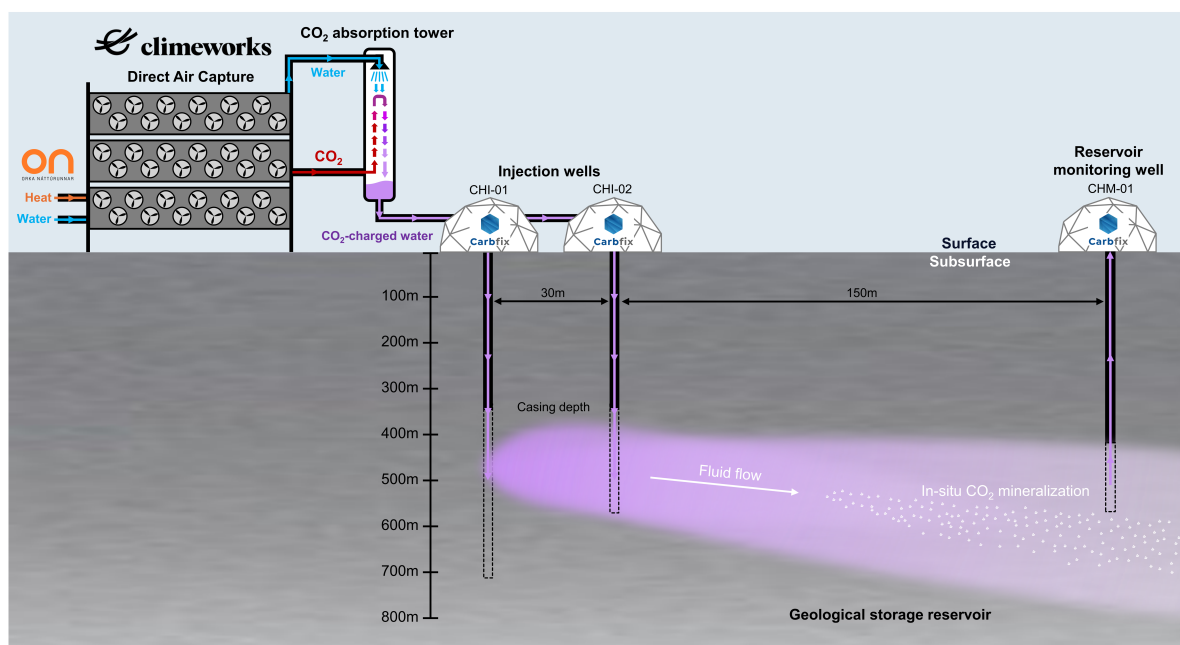


Figure 3: Schematic diagram of the CO₂ capture, dissolution, transport and storage systems at Project Mammoth. Graphic by Carbfix, C. Holdsworth.

4 Application of the Puro Standard (boundary, baseline, additionality, quantification)

4.1 Scope and project boundary

Instructions	Please provide a brief demonstration that the removal activity described above fits within the scope of the methodology and that the system boundaries of the removal activity correspond to the ones defined in the methodology. Word limit: 150 words.
Scope and system boundary	Boundaries of the project include the physical boundaries of the infrastructure and the vertical and lateral limits of the storage reservoir. The physical boundaries are such that the activities of the geothermal power plant are outside of them, and heat and electricity are simply inputs into the project boundary. Similarly, the boundary is on the interface of the atmosphere and the DAC plant, such that atmospheric air is an input and output, and is not a reservoir included in the project. Figure 3 below shows a schematic of CO ₂ flow in Project Mammoth with the step and project boundaries identified. CO ₂ moves from capture in (step 1) to the transport (step 2) and geological storage (step 3).
This table is filled-in by the supplier and verified by the auditor.	

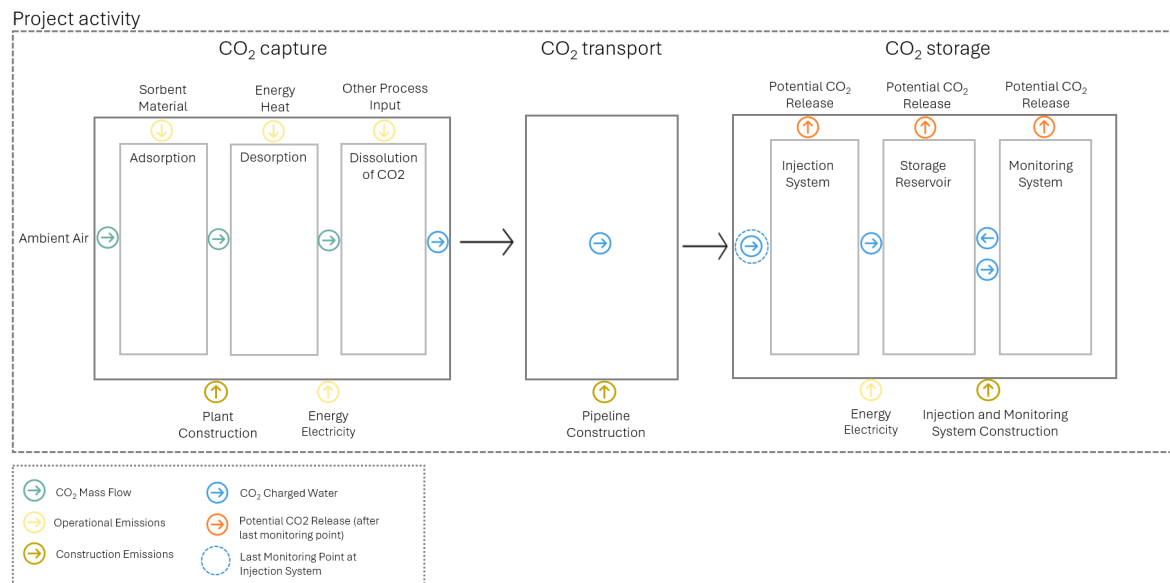


Figure 4: Project Mammoth boundary overview, showing the CO₂ flow, emissions and storage of CO₂. Graphic by Climeworks, D. Brun.

4.2 Baseline scenario

The information in this section provides a summary of the project-specific **baseline scenario**.

Instructions	<i>Please provide a summary of the project-specific baseline scenario. The summary shall be based on the additionality questionnaire (available separately). Word limit: 150 words.</i>
Summary of the project-specific baseline scenario	
<p>Project Mammoth runs under the baseline called 'DACCS New build'. Prior to the construction of Mammoth, no carbon capture facility, transport infrastructure or storage site were built. Furthermore, project Mammoth is constructed within the industrial area of the geothermal energy park. This area is categorized as non-arable land and reserved for industrial activities. For these reasons, the baseline is set as zero for all evaluations.</p>	
<i>This table is filled-in by the supplier and verified by the auditor.</i>	

Further information on the baseline scenario:

Instructions	<i>If the methodology explicitly defines one or several possible baseline scenarios for the removal activity, please specify which ones was selected:</i>
Selected baseline scenario	DACCS New build
<i>This table is filled-in by the supplier and verified by the auditor.</i>	

4.3 Demonstration of additionality

The information in this section provides a summary of the project-specific **additionality assessment**.

Instructions	Please provide a summary of the project-specific additionality assessment, considering baseline removal, regulatory and financial additionality. The summary shall be based on the additionality questionnaire (available separately). Word limit: 150 words.
Summary of additionality assessment	
<p>Project Mammoth is neither required by existing laws, regulations nor any other binding policy obligations. With CO₂ removals as the only product stemming from Mammoth operations, it relies on the revenues generated via carbon finance, stemming from the voluntary carbon market. Carbon Finance is essential to ramp up capture capacity significantly. Mammoth required a multi-million investment without any subsidies and is incurring continuous operating costs related to energy, land lease, plant operations and maintenance. Hence all investment would be lost without carbon credit revenues. As the second of its kind plant operating globally, Mammoth can be understood as a logical next step in Climeworks' roadmap to removing climate relevant amounts of carbon from the atmosphere to contribute to the substantial challenge of achieving CO₂ removals compatible with science-based assessments of achieving global net-zero CO₂ by mid-century.¹ To this end, Mammoth further relies on substantial equity investments made directly by Climeworks.</p> <p>¹ E.g. see: Smith, S. M., Geden, O., Gidden, M. J., Lamb, W. F., Nemet, G. F., Minx, J. C., Buck, H., Burke, J., Cox, E., Edwards, M. R., Fuss, S., Johnstone, I., Müller-Hansen, F., Pongratz, J., Probst, B. S., Roe, S., Schenuit, F., Schulte, I., Vaughan, N. E. (eds.) The State of Carbon Dioxide Removal 2024 - 2nd Edition. DOI 10.17605/OSF.IO/F85QJ (2024)</p>	
This table is filled-in by the supplier and verified by the auditor.	

The following files are further made available in the Puro Registry.

Additionality questionnaire (required)	Filename	Puro Additionality_Mammoth_final
	Description	Additionality questionnaire signed and audited, used to determine the additionality of the project following the Puro requirements for additionality.
Additional file (optional)	Filename	-
	Description	-
Additional file (optional)	Filename	-
	Description	-
Add rows as necessary, following same template as for additional file. The filename shall be the exact filename as provided in the audit documentation. The description shall be at most a 3-line summary of what the file contains. This table is filled-in by the supplier and verified by the auditor.		

4.4 Quantification of net carbon dioxide removal

The information in this section provides a description of how **quantification of net carbon dioxide removal removals** is achieved, including **monitoring** of the removal activity, and calculation of **supply-chain emissions**.

Quantification implementation

Instructions	<i>Please describe how the quantification of net carbon dioxide removal, as described in the methodology (see CORC equation), is implemented by the supplier. Word limit: 200 words.</i>
Description of quantification implementation	
<p>The quantification of net carbon dioxide removal in the Project Mammoth is implemented using the CORC (CO₂ Removal Certificate) equation. The equation calculates the net CO₂ removal by subtracting project emissions (E_{project}), CO₂ leakage (E_{leakage}), and CO₂ reversal (E_{reversal}) from the gross amount of CO₂ stored (C_{stored}). The project's lifecycle emissions, including operational and embodied emissions, are quantified using industry standards and life cycle assessments. Additionally, potential CO₂ leakage and reversal events are monitored and deducted from the stored CO₂ amount, if applicable. This comprehensive approach ensures accurate tracking of the net CO₂ removed by the project, meeting the standards set by Puro.earth.</p>	
<i>This table is filled-in by the supplier and verified by the auditor.</i>	

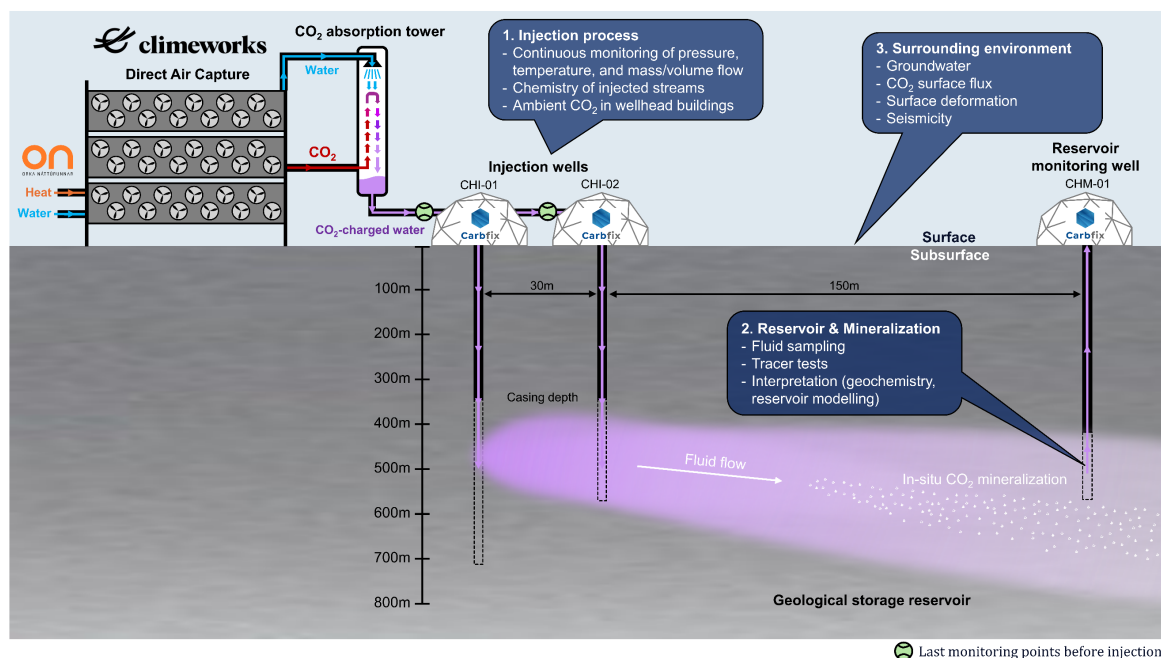
Monitoring and reporting

Instructions	<i>Please provide a summary of the monitoring procedures and monitoring plan which are in place at the production facility to ensure i) the safety of the removal activity, ii) the eligibility of the removal activity, and iii) the precise quantification of CORCs. The summary shall be project-specific and based on related evidence pieces that were submitted in the audit documentation. Word limit: 500 words.</i>
Summary of monitoring and reporting plan	
<p>The monitoring plan for Project Mammoth ensures effective and safe CO₂ capture, transport, and storage, aligning with Puro Methodology, Icelandic regulations, and the EU Directive 2009/31.</p>	
<p>QA/QC Procedures for Measurement Devices</p> <p>QA/QC procedures include regular calibration of measurement devices, following manufacturer guidelines, to ensure accuracy within $\pm 5\%$. Backup systems and regular uncertainty assessments maintain data integrity, ensuring reliable monitoring throughout the project.</p>	
<p>Data Management</p> <p>A secure data management system supports all monitoring activities, facilitating data acquisition, storage, processing, and retrieval. The system integrates data from multiple sources, ensuring comprehensive analysis and accurate Carbon Removal Certificates (CORC) generation, while safeguarding data integrity.</p>	
<p>Monitoring of CO₂ Capture</p> <p>CO₂ capture is quantified using a mass balance approach of the CO₂ absorption system. Sorbent fills and refills are also monitored, as is the sorbent consumption rate (SCR).</p>	
<p>Mineral Storage Site Characterization</p> <p>The Hellisheiði storage site has undergone extensive characterization as required by national (Icelandic regulation 1430/2022) and European (EU Directive 2009/31) requirements for geological storage of CO₂. Geological, geophysical and hydrogeological surveys were conducted to</p>	

assess the site's suitability for long-term CO₂ storage and estimate its storage capacity. Static and dynamic models of the subsurface reservoir have been developed, predicting the behaviour of stored CO₂ over time and ensuring it remains securely trapped. These models incorporate data from seismic surveys, core sample analyses, and reservoir simulations, providing a comprehensive understanding of the site's properties. Detailed geochemical studies confirm the reactive capacity of the basalt formations at Hellisheiði, and the site's porosity, permeability, and fluid pathways have been analysed to optimize CO₂ injection strategies, ensuring efficient and permanent storage. Environmental Impact Assessments have also been conducted to evaluate potential risks, with mitigation strategies in place to address any identified concerns (see section 5.3 for further details).

Monitoring of Mineral Storage

The storage monitoring strategy builds on the experience of Carbfix demonstration injections at Hellisheiði and is guided by national and European guidelines on CO₂ storage, groundwater protection and subsurface fluid injection. It includes monitoring of CO₂ injection, the storage reservoir, and the surrounding environment:



Injection of CO₂-charged water is monitored to confirm complete dissolution of solubility trapping of CO₂ in water. Continuous measurements of pressure, temperature, mass/volume flow and dissolved inorganic carbon (DIC) are taken for this purpose to calculate the bubble point pressure of the injection fluid. Fluid sampling and tracer tests are used to track the migration of CO₂-charged water and verify the conversion of CO₂ into stable carbonate minerals. Geochemical analysis of reservoir fluids provides ongoing confirmation of the occurrence and extent of mineralization through use in mass balance calculations and reservoir models. Groundwater quality assessments and CO₂ surface flux measurements are performed to detect any leakage or impact to the surrounding environment. Surface deformation and seismic monitoring are also conducted to ensure the integrity of the storage site.

Post-Closure Monitoring

Post-closure monitoring will monitor relevant parameters at reduced frequency for a period of no less than 20 years, unless it can be demonstrated earlier that all data indicate that CO₂ will be permanently stored by solubility trapping and in-situ CO₂ mineralization. This includes continued reservoir & mineralization monitoring, groundwater monitoring, and surface flux campaigns.

This table is filled-in by the supplier and verified by the auditor.

Optionally, the following documents may be made available in the Puro Registry once the facility has completed its first Output Audit:

Can the monitoring plan and procedures be made available in the Puro Registry?	
Answer	<input type="checkbox"/> Yes, entirely. <input type="checkbox"/> Yes, in a redacted version. <input checked="" type="checkbox"/> No. If no, please provide a reason: Contains confidential information
Filename(s) to be made public	
This table is filled-in by the supplier.	

Supply-chain emissions

The determination of the supply-chain emissions of the removal activity shall be based on a project-specific life cycle assessment, made of a report and calculations. Calculations are updated at least annually, during the Output Audits, with data captured through above-described monitoring.

Instructions	Please provide a summary or an abstract of the LCA performed. Word limit: 500 words.
Summary of life cycle assessment Climeworks' DAC technology captures CO ₂ from ambient air. However, the construction, operation, maintenance and decommissioning of a DACCS plant such as Mammoth generates CO _{2e} emissions, or grey emissions. Monitoring these emissions is key to determining the net CO _{2e} removal or carbon efficiency of Mammoth. Whether internally conducted or externally commissioned, the life cycle assessments (LCAs) for Climeworks' and Carbfix' operations follow ISO 14040 Environmental management — Life cycle assessment (ISO, 2006) and Puro.earth Geologically Stored Carbon Methodology for CO ₂ Removal (Puro, 2024) and are further guided by Best Practices for LCA of Direct Air Capture with Storage (US DOE, 2022). The main contributors to grey emissions are summarized below.	
Filter material: In Mammoth, the filter material which separates the CO ₂ from the ambient air is a specially designed sorbent material. As existing LCA databases do not provide an emission factor for such a material, Climeworks has specially commissioned a cradle-to-grave life cycle analysis for the sorbent. This analysis covers energy and material inputs, any waste arising during production, transport, packaging and end-of-life treatment of the sorbent. Currently just one sorbent material is employed in Mammoth. However, specially commissioned LCAs for any alternative sorbent materials which may be used throughout the lifetime of the plant will be conducted before they are introduced to Mammoth.	
Energy: The thermal and electrical energy requirements at Mammoth are provided by Hellisheiði Geothermal Power Plant – a combined heat and power plant. Although geothermal energy is a low-carbon form of energy, there is nonetheless a CO _{2e} emission factor for each kWh of energy. Using the exergy-based allocation method and an LCA conducted specifically for Hellisheiði Geothermal Power Plant (Karlsdottir et al, 2020), emission factors for heat and electricity have been calculated. These emission factors are updated annually to take account of minor changes in ambient temperature or the overall output of Hellisheiði power plant.	
Project emissions: Project emissions refer to emissions associated with building, maintaining and decommissioning the physical infrastructure of the Mammoth plant. Steel, concrete and piping are the most obvious, visible contributors to project emissions. Emission factors for these inputs have been derived from	

ecoinvent, a Swiss-based LCA database. Collector containers and associated equipment are inputs specific to the capture process of Climeworks' DAC technology. Emissions for these have been derived from manufacturers' inventory of materials and ecoinvent. Also included in project emissions are transport of key materials to the site in Iceland, end-of-life treatment of materials, fuel use during construction and an appropriate contingency for repairs and maintenance. Emissions associated with construction, maintenance and decommissioning of CO₂ injection and storage monitoring facilities have been calculated by an external LCA.

This table is filled-in by the supplier and verified by the auditor.

Optionally, the following documents may be made available in the Puro Registry once the facility has completed its first Output Audit:

Can the LCA report be made available in the Puro Registry?	
Answer	<input type="checkbox"/> Yes, entirely. <input type="checkbox"/> Yes, in a redacted version. <input checked="" type="checkbox"/> No. If no, please provide a reason:
Filename(s) to be made public	Deutz, S., Bardow, A. Life-cycle assessment of an industrial direct air capture process based on temperature–vacuum swing adsorption. <i>Nat Energy</i> 6 , 203–213 (2021). The research article can be downloaded here: https://doi.org/10.1038/s41560-020-00771-9
<i>This table is filled-in by the supplier.</i>	

5 Social and environmental safeguards

The information in this section provides a summary of the project-specific measures taken to avoid and minimize negative social and environmental effects, as well as maximize positive impacts contributing to the sustainable development goals (SDGs).

5.1 Stakeholder engagement

In line with the Puro General Rules, the CO₂ Removal Supplier must have conducted a stakeholder engagement process and reported its outcome in a written format.

Instructions	Please reproduce the summary of the stakeholder engagement report. Word limit: 500 words.
Summary of stakeholder engagement	
A public consultation was conducted well before an application for the approval under the Puro Standard was filed. Therefore, the separately provided stakeholder report describes:	
<ul style="list-style-type: none"> • How Stakeholders were identified and invited; • The information Stakeholders were provided with; • A description of the means of conducting the consultation; • A description of how feedback from the consultations have been considered and how issues were resolved. 	
This table is filled-in by the supplier and verified by the auditor.	

In addition, the following documents are made available in the Puro Registry once the facility has completed its first Output Audit:

Stakeholder Engagement Report (required)	Filename	Puro Stakeholder Engagement Report_final
	Description	Stakeholder engagement report completed and audited, following the Puro requirements for stakeholder engagement.
The filename shall be the exact filename as provided in the audit documentation. This table is filled-in by the supplier.		

5.2 Environmental and social safeguards

In line with the Puro General Rules, the CO₂ Removal Supplier must ensure that environmental and social safeguards are in place.

Instructions	<i>Please summarize the environmental and social impacts relevant to the project, based on the answers provided to the corresponding questionnaire in the audit documentation. Word limit: 500 words.</i>
Summary of environmental and social safeguards questionnaire	
<p>Climeworks' project team and all Climeworks' contractors are committed to the principle that all occupational injuries and illnesses are preventable, and the overall environmental impact is to be avoided with an effective HSE management plan.</p> <p>The project is carried out in a manner that complies with all applicable HSE laws and regulations. On top of that, we have our own HSE process in place. Climeworks has developed a ten-point guide, called Zero Harm Behaviors, to ensure that all employees are held accountable to the highest possible HSE standard. The Zero Harm Behaviors were developed to highlight the high-risk activities that are part of daily work and the importance of following the risk control measures we have in place to manage them.</p> <p>All Climeworks and Carbfix contractors must ensure that all staff are aware of Climeworks' Zero Harm Behaviors rules and that these rules are always adhered to. If non-conformities are identified at any time during the project, the contractors must have remedial measures in place to promptly address any identified deficiencies. All Climeworks and Carbfix contractors have standards, processes, procedures and/or systems in place that meet or exceed the minimum requirements and the relevant Climeworks policies, procedures, standards, and specifications. All Climeworks and Carbfix contractors must be prepared to impose disciplinary action on work site personnel who violate the Zero Harm Behaviors guide, up to and including removal from the work site. Additionally, all Climeworks personnel are empowered with stop work orders and as owner can, and have the obligation to, prevent the presence of unsafe practices, including those who cause the unsafe practice.</p> <p>HSE Management Organization</p> <p>The project manager is responsible for implementing the HSE plan with assistance of the HSE manager. The HSE manager supports the project manager in ensuring that all necessary precautions are taken during design, construction, commissioning and operation of the plant. The HSE manager also assists the project manager in monitoring the HSE performance of the projects, including site inspections, accident reports, sick leave, hours worked, near miss and incident reports, documentation of introductory meetings and toolbox talks. The HSE manager analyses this information, determines corrective and preventive actions where necessary and follows up on their implementation.</p> <p>HSE Management Framework</p> <p>Climeworks operates under the Plan, Do, Check, Act (PDCA) approach of Safety Management. This aligns with our ISO 9001 Quality Management System, ISO 45001 Occupational Health & Safety and ISO 1400 Environmental Management System. The HSE management system is additionally supported by the Safety Management Plan (SMP) which describes the key tasks, responsibilities and requirements related to HSE and emergency management and is an integral part of the Construction Safety Manual. While Climeworks does not specifically reference a stand-alone Construction Safety Manual, the compilation of several processes and associated documents fulfils the general purpose of a Construction Safety Manual.</p> <p>Carbfix operates under the ISO 45001 Occupational Health & Safety standards. Work practices pertaining to safety and the wellbeing of Carbfix employees and contractors during day to day</p>	

work, health promotion, response to accidents and emergency response plans are detailed in the Reykjavik Energy Safety Handbook. In addition, all activities at the injection and monitoring sites strictly follow the Carbfix Mammoth Safety Manual, which is based on an extensive risk assessment.

This table is filled-in by the supplier and verified by the auditor.

In addition, the following document is made available in the Puro Registry once the facility has completed its first Output Audit:

Stakeholder Engagement Report (required)	Filename	Puro Environmental and Social Safeguard_final
	Description	Questionnaire based on a template provided by Puro, to ensure compliance with the Puro General Rules, regarding social and environmental safeguards.

The filename shall be the exact filename as provided in the audit documentation. This table is filled-in by the supplier.

5.3 Permits, risk assessments and impact assessments

Depending on the nature and scale of the removal activity, the CO₂ Removal Supplier may have obtained permits or conducted specific environmental assessments (e.g. Environmental and Social Impact Assessment, Environmental Risk Assessment) for compliance with local laws and regulations.

Were the obtention of one or several construction or environmental permits required for the removal activity, for compliance with local laws and regulations?	
Answer	<input checked="" type="checkbox"/> Yes, permits were required and successfully obtained. <input type="checkbox"/> No, permits were not required.
Permits obtained	<p>Name of permit: Building permit ID of permit: 228936 Issuer of permit: Municipal of Ölfus Date of issuance: 31.05.2022 Permit file (.pdf): Building permit approval (IS)</p> <p>Name of (permit): Notice of start of operation ID of permit: 5304221350 Issuer: Administration of Occupational Safety and Health Vinnueftirlitið Date of issuance: 15.05.2024 Permit file (.pdf): Notice of start of operation (IS) Vinnueftirlitið</p> <p><i>Storage permit application based on the CCS Directive has been submitted by Carbfix and is currently being processed by the authorities. At the time of writing (August 2024), the EFTA Surveillance Authority has issued their opinion on the draft permit from the Icelandic Environment Agency. Until the final issuance of the permit, the injection operations are exempt from it based on Article 2 of the CCS Directive.</i></p>
If several permits were obtained, provide the information for each of them. This table is filled-in by the supplier and verified by the auditor.	

Was an environmental and social impact assessment study (EIA) conducted?	
Answer	<input checked="" type="checkbox"/> Yes, an EIA was legally required and thereby conducted. <input type="checkbox"/> Yes, an EIA was not legally required but conducted voluntarily. <input type="checkbox"/> No, an EIA was not legally required and not conducted.
EIA Report (if conducted)	<p>Title of study: Niðurdæling CO₂ til geymslu í jörðu á Hellisheiði (Injection of CO₂ for geological storage at Hellisheiði) Filename of report: EIA for Hellisheiði - Report Submitted by Carbfix - Jan 2023 (Icelandic).pdf Can the report be published in the Puro Registry: Yes</p>
This table is filled-in by the supplier and verified by the auditor.	

Was an environmental risk assessment study (ERA) conducted?	
Answer	<input type="checkbox"/> Yes, an ERA was legally required and thereby conducted. <input type="checkbox"/> Yes, an ERA was not legally required but conducted voluntarily. <input checked="" type="checkbox"/> No, an ERA was not legally required and not conducted.
ERA Report (if conducted)	<p>Title of study: Filename of report: Can the report be published in the Puro Registry: Yes/No</p>
This table is filled-in by the supplier and verified by the auditor.	

5.4 Positive impacts on SDGs

Depending on the nature of the removal activity, the activity may have positive impacts on the UN Sustainable Development Goals (SDGs).

Instructions	Please provide a summary of the positive impacts on the SDGs that the removal activity has or plans to have. This summary shall be project-specific and based on related evidence pieces that were submitted in the audit documentation (SDG Reporting files). Word limit: 150 words.
Summary	Direct Air Capture of CO ₂ from the atmosphere and permanent storage through in-situ carbon mineralization resulting in CO ₂ removals to durable geological storage. The climate benefit SDG 13 resulting from carbon removal is quantified and certified as CO ₂ Removal Certificates (CORCs). Climeworks considers providing additional evidence as to the quantifiability of the positive impacts when available.
This table is filled-in by the supplier and verified by the auditor.	

In addition, the following document is made available in the Puro Registry once the facility has completed its first Output Audit:

SDG Reporting (required)	Filename	n/a
	Description	SDG Reporting based on a template provided by Puro, disclosing with SDG indicators are reported and how they are or will be demonstrated.
The filename shall be the exact filename as provided in the audit documentation. This table is filled-in by the supplier.		

6 Other documents available in the Puro Registry

Alongside this project description, several other documents are made available in the Puro Registry for more details.

The documents referenced in this project description are compiled in the following table:

Instructions		To finalize the project description, please list the names of all the public documents to be made available in the Puro Registry, in the order they appear, specifying the number of pages of each document. Add rows as necessary.
#	Document names	No of pages
1	Puro Additionality_Mammoth_final	9
2	Puro Stakeholder Engagement Report_final	7
3	Puro Environmental and Social Safeguard_final	11
4		
5		
6		
7		
8		
9		
10		
<i>This table is filled-in by the supplier.</i>		

Besides the documents referenced in this project description, the 3rd-party auditor has reviewed a complete audit package containing numerous documents, performed a site visit, and prepared an audit report and statement.

The facility described here will further be audited annually, in Output Audits, to verify the performance of the removal activity, resulting in the issuance of CORCs. All audits lead to audit reports and statements, which will be available in the Puro Registry, alongside further details on CORC quantification for each monitoring period.

Baseline and Additionality Assessment

The baseline and additionality assessment is a requirement for eligibility under the Puro Standard. The assessment is made by the CO₂ Removal Supplier and verified by the independent 3rd party auditor. **The assessment made in this document will be publicly available in the Puro Registry.**

The Puro Standard only certifies durable carbon removals from the atmosphere that are net-negative and does not certify emissions reductions or avoidance. The CORCs (Carbon dioxide removal certificates), issued therefore represent a net carbon removal (1 tCO₂eq. net) from the atmosphere to a durable storage of minimum 100 years, and for mineralization and geological storage minimum 1000 years. Net carbon removal is determined from stored gross CO₂ volume by subtracting supply-chain emissions from the project, any re-emissions over the guaranteed storage time, any baseline removals taking place in a baseline scenario, and any negative indirect leakage effects relative to the baseline scenario.

The CO₂ Removal Supplier must in this assessment:

- **Define** and quantify all reasonable **baseline alternatives** to the proposed project activity to remove carbon with carbon financing. A baseline is a scenario that reasonably represents the natural and anthropogenic carbon removals to a permanent storage (storage durability over 100 or 1000 years) in the absence of the carbon removal activity proposed by the CO₂ Removal Supplier. Although anthropogenic emissions may take place in the baseline scenarios, these emissions do not constitute a reference point for the quantification of CORCs (only the baseline removals do).
- Demonstrate **carbon additionality to the baseline**, meaning that the project must convincingly demonstrate that it is resulting to higher volumes of carbon removals than the likely baseline alternatives (question A1 and A2.).
- Demonstrate **regulatory additionality**, meaning that the project is not required by existing laws, regulations, or other binding obligations (question A4.).
- Demonstrate **prior consideration of carbon credits** through documentation demonstrating that the time period between the commitment date and production facility audit is max. 3 years. (question A5)
- Demonstrate **financial additionality**, meaning that the CO₂ removals achieved are a result of carbon finance. This means that the CO₂ Removal Supplier must show that the carbon credits were needed to secure the investment or to overcome specific barriers to the investment.
- To support the claim the of financial additionality, the project activity cannot already be *common practice* without carbon finance (question A6).

Reference documents: [Puro Standard general Rules v4.0](#), section 6.5 and [Additionality Assessment requirements v2.0](#).

1. General questions to all CO₂ Removal Suppliers

A1. Baseline Determination			
Activity name	Activity description	Removals to storage (100+ yr) due to project activity (human activity)	Natural removals to storage (100+ yr), not man-made
Baseline	The baseline scenario is no Carbon Dioxide Removal and Storage	None	None /
Project activity: Mammoth Carbon Dioxide Removal with Direct Air Capture + Storage	Project activity is additional, removing Carbon Dioxide from the air.	Mammoth was designed with a CDR capacity of 33kt per year	None

A2. Does the project lead to higher volumes of durable carbon removal than the baseline?	Yes / No
Every ton of carbon dioxide removed from the air by Mammoth is a ton immediately not contributing to global warming	Yes

A3. Is the project scenario aligned with net-zero transition? The following activities are considered not to be aligned with net-zero transition: a) directly leading to an increase in the extraction of fossil fuels, b) relating to coal-fired electricity generation, or c) involving other unabated fossil fuel-powered electricity generation, other than new gas-fired generation that is part of increased zero-emissions generation capacity in support of national low carbon energy transitions	Yes / No
Mammoth presents the second CDR plant operated by Climeworks. An overview of the role of direct air capture in mitigation of climate change is presented by Beuttler et al. 2019 . The specific Mammoth set-up mitigates any risks as mentioned above in categories a) b) and c).	Yes

A4. Is the project required by existing laws, regulations, or other binding obligations?	Yes / No
The Mammoth DAC plant was not required by existing laws, regulations or other binding obligations	No

A5. What was the Commitment Date of this facility? Commitment Date is defined as "The calendar date on which the CO ₂ Removal Supplier committed to implementing the CO ₂ Removal activity (e.g., the date when contracts for the purchase or installation of equipment required for the mitigation activity were signed). In the case where a mitigation activity does not involve capital expenditure, it refers to the date when the first physical actions were taken to implement the mitigation activity." If an exception listed in clause 2.1.3 of the Additionality Assessment Requirement applies, describe the situation here.	Date
First contract with storage provider signed.	23.05.2022

A6. Is the Technological Readiness Level of the Methodology 8 or 9?	Yes/No
Technology readiness levels of Puro methodologies as defined by IPCC. In line with IEA 2022.	No

If the answer to question A6 is Yes, please answer question A6.1 to A6.3. Questions A6.2 and A6.3 are different based on whether you are applying a distributed technology (such as enhanced rock weathering) or more centralized technology based on plants/factories producing something. See clauses 3.2.5 and 3.2.6 in the Puro Additionality Assessment Requirements with references for more information.

A6.1. Please define the region being considered and explain why it is relevant level of aggregation for the assessment if different from the host country.

n/a

A6.2. Market size or current installations

Distributed technology: What is your estimate for a realistic target market size and what constraints to the market size growth have you identified?

Centralized technology (plants): What projects have you identified that fulfil the criteria in Additionality Assessment Requirements clause 3.2.6?

- a) output range of +/- 50% of the project,
- b) located in the same region,
- c) applying the same measure,
- d) produce comparable goods or services in terms of quality, properties, and applications,
- e) started commercial operation before the proposed start date of the project, and
- f) are not registered in a carbon crediting program.

How many of them apply a different technology?

Please mention or link to any sources you have.

n/a

A6.3. Market penetration rate

Distributed technology: What is your estimate of the market penetration rate of the activity? How common or widespread is the project activity or similar activities in the relevant sector and region, and what is the trend of adoption over time?

Centralized technology (plants): Provide your calculation of market penetration rate based on the formula in clause 3.2.6 in Additionality Assessment Requirements.

n/a

A7. Does the carbon removal project have other income sources besides carbon finance? Include also information about any subsidies you receive or expect to receive. Please describe your business model here, in a short answer (max. 100 words).

Yes / No

Mammoth is solely relying on Carbon Financing from pioneering companies and individuals that have entered long-term commitments to remove carbon dioxide from the air and help rapidly scale up this much-needed climate technology in the years to come. Carbon Finance is essential to ramp up capture capacity significantly, as will be required to meet the strong market demand for carbon dioxide removals. Mammoth required a multi-million investment without any subsidies and is incurring continuous operating costs related to energy, land lease, plant operations and maintenance. Hence all investment would be lost without carbon credit revenues.

No

Please note: Questions under headings '2. Simple cost analysis', '3. Investment analysis', and '4. Barrier Analysis' are mutually exclusive options.

2. Simple cost analysis or investment analysis

Some projects may demonstrate additionality through simple cost analysis: this is applicable for projects that have no other source of income besides carbon finance or where ex-ante investment analysis is not applicable, because capital expenditure (capex) is modest compared to operating expenditure (opex). This can include e.g. enhanced rock weathering projects.

B1. Describe how the criteria above applies to your project

As one the first industrial scale direct air capture and storage plants, Mammoth is enabling the sale of Carbon Dioxide Removal Services to pioneering customers, which is required to scale up the technology and provide Climeworks with the field experience necessary to lower costs in the future and maximize the volume of tons of CO₂ removed from the atmosphere. As one of the first-of-its-kind investments there is particularly high uncertainty to the returns, linked to the actual operating costs and CO₂ output.

B Simple cost analysis	Project response
B2. Please describe your cost structure here and include evidence in attachment.	<p>The largest component of a Direct Air Capture plant cost structure is linked to capital expenditure.</p> <p>In addition to Capex, the main cost buckets are as follows:</p> <ul style="list-style-type: none"> • Energy cost • Sorbent cost, Climeworks uses solid sorbents that require low-grade heat, which is easier and cheaper to obtain • Operation & maintenance (O&M) expenses • Storage cost, Climeworks outsources the storage to 3rd parties
B3. Please summarize the simple cost analysis here. Please include any public subsidies received or expected. Compare with alternative scenarios, if relevant.	N/A
B4. Please provide additional calculation spreadsheet in attachment. All formulas used in the spreadsheet shall be readable to the verifier and all relevant cells shall be viewable and unprotected. Mark confidential when needed.	A confidential spreadsheet has been provided for verification
B5. Are you willing to provide full calculation spreadsheet to be visible in Puro Registry? If yes, please specify the name of the file that has been provided. If not, please ensure that there is sufficient information provided in your answers in this document.	No
B6. Is the information shared here consistent with information presented to the company's	Yes

decision-making management, investors or lenders?	
B7. Is the information shared here consistent with the information in the audit documentation presented to Puro and its verifiers (e.g. LCA model)? If not, please explain why there are differences.	Yes

3. Investment Analysis

CO₂ Removal Suppliers can be guided by the CDM Methodological Tool 27 of the UNFCCC Clean Development Mechanism ["Investment Analysis"](#) to demonstrate financial additionality with Investment Analysis.

C. Financial Additionality – Investment analysis	Project response
C1. Describe the relevant alternative scenarios in terms of investments analysis. If the only alternative scenario is to carry out the project without CORCs, please answer the following questions: Please show your calculations to determine the benchmark rate for either equity IRR or WACC, whichever you are using. Please include documentation of how the rate is suitable for the technology and region. Please specify the currency and whether the rate is nominal or real.	N/A
C2. Please state how CORC revenues change the expected IRR or NPV of the project.	As one of the first industrial scale direct air capture and storage plants, Mammoth is enabling the sale of Carbon Dioxide Removal Services to pioneering customers, which is required to scale up the technology and provide Climeworks with the field experience necessary to lower costs in the future and maximize the volume of tons of CO ₂ removed from the atmosphere. As a first-of-its-kind investment there is particularly high uncertainty to the returns, linked to the actual operating costs and CO ₂ output. Mammoth required a multi-million investment without any subsidies and is incurring continuous operating costs related to energy, land lease, plant operations and maintenance. Hence all investment would be lost without carbon credit revenues.
C3. Please conduct a sensitivity analysis in relation to the investment analysis and summarize the results here.	N/A
C4. Is the information shared here consistent with information presented to the company's decision-making management, investors, or lenders?	Yes
C5. Is the information shared here consistent with the information in the audit documentation presented to Puro and its verifiers (e.g. LCA model)? If not, please explain why there are differences.	Yes
C6. Are you willing to provide full calculation spreadsheet to be visible in Puro Registry? If yes, please specify the name of the file that has been provided.	No
C7. If you are not willing to disclose the full spreadsheet, please provide here a summary of the confidential file that has been provided to the Auditor and Puro.earth. Please include:	A confidential spreadsheet has been provided for verification

<ul style="list-style-type: none"> • Overall description of the spreadsheet, including type of terms (real/nominal), currency, forecasting periodicity • Capital structure, if the measure is based on equity return • Information sources on main revenues and costs • Expected breakdown of income from the different sources • Expected or already received public subsidies • Growth assumptions • Model duration and a comparison with expected lifetime 	
--	--

4. Barrier Analysis

In Barrier Analysis only one barrier needs to be demonstrated but there needs to be clear, objective, and verifiable evidence to demonstrate its existence. If possible, please provide quantitative estimates for the barrier.

D. Barrier Analysis	No/yes	Project response
D1. Are there financial barriers? (e.g., financing is not accessible for the type of activity in the country due to the risks)	Yes	As one of the first-of-its-kind investments there is particularly high uncertainty of returns, linked to the actual operating costs and CO2 output. The high cost of Carbon Dioxide Removal at Mammoth implies that the cost is greater than the willingness to pay of customers for Carbon Dioxide Removal and hence the plant relies on Carbon Finance and investor financing.
D2. Are there institutional barriers? (e.g., the investor not being the beneficiary of cost savings associated with the investment)	No	
D3. Are there information barriers? (e.g., lack of awareness of the financial benefits of by-products)	No	
D4. Please explain how CORC revenues are crucial element in overcoming identified barrier(s)		As one of the first industrial scale direct air capture and storage plants, Mammoth is enabling the sale of Carbon Dioxide Removal Services to pioneering customers, which is required to scale up the technology and provide Climeworks with the field experience necessary to lower costs in the future and maximize the volume of tons of CO2 removed from the atmosphere. As a first-of-its-kind investment there is particularly high uncertainty to the returns, linked to the actual operating costs and CO2 output. Mammoth required a multi-million investment without any subsidies and is incurring continuous operating costs related to energy, land lease, plant operations and maintenance. Hence all investment would be lost without carbon credit revenues.
D5. Are there subsidies for the carbon removal activity? If yes, please explain how they are not sufficient to overcome the barrier.	No	
D6. Please attach verifiable evidence for the existence of the barrier and describe the evidence here. If the file can be included publicly in the Puro		A confidential spreadsheet has been provided for verification

registry, please specify the name of the file here. If the evidence is not public, please ensure that you describe it in sufficient detail.		
D7. Please demonstrate that at least one other alternative in baseline determination (first question) does not face any significant barriers, including the barriers faced by your project.		N/A

I hereby declare that all information provided is truthful and precise to the best of my knowledge.

Georgios Emmanouil

Georgios Emmanouil, Commercial Finance Manager, Climeworks AG

Date, Place: 16/08/2024, Zurich, Switzerland



Stakeholder Engagement Report

CO ₂ Removal Supplier	Climeworks
Production Facility	Mammoth
Production Facility ID	417791
Date of report last update (YYYY-MM-DD)	2024-08-21

Stakeholder Engagement Report

The purpose of this document is to gather results of the Stakeholder Engagement that has been conducted by the CO₂ Removal Supplier, for its Production Facility, in line with Section 6.4 of the [Puro General Rules 4.0](#) and the [Puro Stakeholder Engagement Requirements](#).

This report is divided in the following sections:

- 1 Identified stakeholders
- 2 Consultation activities and outcomes
- 3 Plans for continued consultation during crediting period
- 4 Summary

This report will be made **publicly available** in the Puro Registry. It shall not contain information about private individuals (e.g. name, personal address) for privacy reasons. Such information shall be provided separately (e.g. list of participants to consultation activity, as an appendix to the report).

1 Identified stakeholders

Provide an overview of the stakeholders that have been identified as relevant to include in the stakeholder engagement process, following the categories defined below:

Stakeholder categories	Identified stakeholders
Local Stakeholders , i.e. stakeholders in the immediate environment of the facility of the CO ₂ Removal Supplier, and most prone to experience direct or indirect effects of the respective carbon removal activity.	No stakeholders. The project is sited within the Hellisheiði geothermal park. The park on formerly unoccupied land is a platform for companies who are interested in using clean renewable resources for their vision. The area of the Geothermal park is 103 hectares, located in close proximity to the Geothermal Power plant . The area is close to natural hiking paths, therefore, ON Power, the owner, is ambitious to keep the area well maintained and attractive and to treat nature with the utmost respect as the Geothermal park takes shape.
Stakeholders with land-tenure rights within the vicinity of the project boundary	ON Power (project partner)
Representatives of relevant local authorities and relevant local politicians	Municipal authorities including Ölfus, Hveragerði and Reykjavík
Local non-governmental organizations (NGOs) or international NGOs who are active in the region and relevant to the topic	Landvernd & Ungir Umhverfissinnar ("Young Icelandic Environmentalists")
Representatives of relevant working groups or vulnerable and marginalized groups within the vicinity of the project boundary	N/A
Relevant industry experts , given there are any in the near environment	Directly involved via employment at project proponent, project partners or directly consulted in various phases of the project.

Other, please specify:	DACCS and geological storage as done within project Orca and Mammoth has received substantial international interest. Both Climeworks and Carbfix remain open to an active dialogue with this international audience and have provided avenues for insights and feedback via various formats, including site visits, conferences, academic contributions, policy positions and statements as well as general media and video documentaries.
<p><i>Answers are to be written in the second column without disclosing private information. For instance, instead of the name of a specific resident, use terminology like "local residents". Likewise, instead of naming specific public employees, prefer to mention the roles and departments.</i></p> <p><i>In case there are no identified stakeholders in a given category, provide a brief justification instead.</i></p>	

Activity directly or indirectly impacting indigenous peoples or their livelihoods, ancestral knowledge or cultural heritage:

Question	Answer
Does the list of identified stakeholders include any indigenous peoples or communities?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
If answer is "Yes" to the question above, has the free, prior and informed consent (FPIC) been obtained from those indigenous peoples or communities?	<input type="checkbox"/> Yes. Please provide evidence of the obtention of the FPIC in a separate document.
<p><i>As per rule 2.1.6 in the Puro Stakeholder Engagement Requirements, note that "FPIC is distinct from stakeholder engagement in that it is derived from indigenous peoples' right to self-determination. While stakeholder engagement involves consultation and collaboration with all parties affected by a project, FPIC goes a step further by requiring the explicit consent of indigenous peoples before proceeding with activities that impact them."</i></p>	

2 Consultation activities and outcomes

Provide an exhaustive list of all the **stakeholder consultation activities** that have been conducted. Add as many rows as necessary. The activity categories can for instance be one of the followings (but not limited to these ones): public meeting, online webinar, paper questionnaire, electronic questionnaire, interviews, focus group, site visit, door-to-door visits, etc.

Activity categories	Activity name	Activity date (YYYY-MM-DD)
Site visit	Stakeholder visit pre project construction (Local authorities, Landvernd and Náttúruverndarsamtök Íslands)	2021-03
Meeting with public authorities & NGO	Visiting the municipalities of Ölfus and Hveragerði as well as Landvernd to discuss related plans for DAC at Hellisheiði	2022-06
Website	Website with overview of the project: https://climeworks.com/plant-mammoth	2022 onwards, continuously updated
Conference/Summit	DAC Summit 2023 – Panel on "Capturing the benefits of DAC by elevating environmental justice"	2023-06
Conference/Summit	Mineralization Summit 2023 - Panel on Environmental Justice and Social Impacts of	2023-09

	Mineralization Projects: What does responsible deployment look like?	
Site visit	Stakeholder visit prior to official launch event: - Landvernd (Chair and Director present) - Ungir Umhverfissinnar (Environmental representative present) - Town of Hveragerði (Environmental representative present) - City of Reykjavik (Chair of Environment and Planning Council of Reykjavik present)	2024-04
Launch event	Mammoth plant launch event (international audience and representation by project partners. A recording can be made available upon demand.	2024-05
Conference/Summit	Climeworks CDR summit	2024-06
Site visits	Further visits to the site include government ministers, members of Parliament, municipal health officials, Academics, Media, Press, European officials, the EFTA Surveillance Authority, Heads of States & a herd of local sheep that makes sporadic, spontaneous visits to surrounding areas including project Orca and Mammoth.	Ongoing
Exhibition	The technology is described within the geothermal exhibition area and has a dedicated section and trained staff, covering both the geothermal energy operations and the Carbfix approach, including references and information regarding DAC Projects. Geothermal Exhibition - Orka náttúrunnar	Ongoing

Provide a list of all the **stakeholder invitations** that have been sent out, grouping whenever relevant the invitations (e.g., for all local residents as one row). Add as many rows as necessary. The invitation format can be one of the followings (but not limited to these ones): postal letters, email, social media publication, public board information, telephone calls, verbal communication, etc.

Invitation format	Invitation name	Invitation date (YYYY-MM-DD)
N/A	N/A	N/A

As **supporting evidence** to this report, please provide in a separate subfolder, the following:

- Example of invitations sent out, for different consultation activities (e.g. letters, emails, website announcements).
- Lists of all stakeholders invited to the consultation activities and stakeholders participating in the consultation activities. The lists will not be made public, as they can contain private information.

In case identified relevant stakeholders (section 1) were not invited to the consultation activities, please provide clear **reasons for not inviting** them. Add as many row as necessary. Leave blank if not applicable.

Identified stakeholders	Reasons for not inviting
N/A	N/A

Provide an extensive summary of i) the **information that was provided to stakeholders** during the consultation activities, ii) the **feedback received** during the consultation activities (with a particular focus on concerns, potential issues and critiques), and iii) the **responses provided to stakeholders** about their feedback.

Summary of the feedback received during the consultation activities

Information provided to stakeholders:

Depending on the meeting, information provided ranged from i) high-level discussions around DACCS projects and the general implications for sustainable development and deployment to ii) project specific briefings and meetings where detailed assessments of the plants have been discussed prior, during and after the start of planning and operations.

Feedback received from stakeholders:

Stakeholders have questioned the Climeworks business case. Specifically, stakeholder have been inquiring around the claiming of climate benefits and respective accounting/certification frameworks. A second theme in many discussions concerns the potential mitigation deterrence caused by DACCS projects. A third theme concerns the optimal scale and respective requirements of DACCS infrastructure and the role of policy to install a responsible deployment path. Furthermore, local stakeholders have issues concerns around induced seismicity that have been taken into account and properly mitigated via Carbfix' operational experience in the Hengill area.

Responses provided to stakeholders:

Information around measurement accuracies has been provided.

Induced seismicity has been a topic in the respective EIA triggered by the Carbfix permit application and have been successfully resolved.

In case any relevant stakeholders **could not take part** in the consultation activities due to reasons such as lack of mobile access or physical disability, please describe and summarize how you engaged with them, what their specific feedback was, and how it was answered. Leave blank if not applicable.

Consultation of stakeholders that could not take part in the scheduled consultation activities

As **supporting evidence** to this report, please provide in a separate subfolder, the following:

- Materials presented during the consultation activities (e.g. presentations)
- Documentation of the feedback received (e.g. meeting notes, questionnaire answers)
- Documentation of the responses provided to stakeholders (e.g. consultation reports)

Provide an extensive description of the **changes made to the project** plans to address the concerns and issues raised during the consultation activities.

Description of the changes made to the project for addressing concerns and issues

No direct changes have been requested. Changes regarding the business model and policy frameworks supporting Mammoth and DACCS overall are ongoing.

3 Plans for continued consultation during crediting period

Provide a description of the current plans for maintaining a continued engagement of the stakeholders during the crediting period.

Description of the plans for continued consultation of stakeholders during the crediting period

In line with the stakeholder engagement plan

4 Summary

Based on all the information provided above and the evidence provided separately, write an overall summary of the stakeholder engagement. This summary must follow the structure of this report, tackling identified stakeholders, consultation activities and outcome, and plans for continued consultation. This summary is limited to 500 words. This summary must be re-used in the Project Description.

Overall summary (500-word limit)

Identified stakeholders: The general public, Municipal authorities, Commercial Partners, Domestic Media, National and municipal regulators and licensing authorities; National government (ministries); international authorities relevant to licensing and legal frameworks (e.g. EFTA Surveillance Authority or Swiss federal Minister), Academics, environmental associations and other NGO's (local and international) as well as Landowners.

Consultation activities: Inform stakeholders of the nature of the project and its implications allowing for a subsequent incorporation and/or mitigation of potential concerns.

Methods included: Websites; (open) in person meetings (on and off site); mails; verbal communications; detailed information on the Environmental Impact Assessment report; Press releases and media outreach related to project milestones; Open meeting to present the Environmental Impact Assessment (EIA) with opportunity for Q&A, Information posters and exhibitions, meetings with selected stakeholders including officials at the municipalities of Hveragerði and Ölfus. In addition, the legal process for the project's EIA, where applicable, provided a formal avenue for any and all stakeholders to submit comments on the report, voicing their concerns, which the company in turn addressed and responded to. Carbfix and Climeworks have also participated/hosted international conferences to share their approaches and learnings with international stakeholders such as academia, industries, NGO's and regulators.

Timing/frequency of stakeholder engagement

The project was introduced at meetings with the National Planning Agency in November 2021, the municipality of Ölfus in December 2021, the Environmental Agency in December 2021, the municipality of Hveragerði in January 2022, and several municipal health committees in February 2022. Prior to this the project had been introduced to numerous stakeholders in relation to the preparation of national

legislation on carbon storage. Throughout 2023, several site visits have been organized for an international audience, including heads of states and regulatory oversight bodies. Prior to officially launching the project in spring 2024, local stakeholders have again been invited on-site and been given an extensive tour of the project. Subsequently, the project has been officially inaugurated with several international visitors (including regulatory oversight bodies and energy agencies as well as local stakeholders and project participants) on site.

Outcomes:

In general, the project partners assess the local public acceptance for Mammoth to be high. Icelandic people are open to technological innovations, hosting other cutting-edge climate technology in their country. Due to the longstanding success of the geothermal industry and the deep integration of geothermal energy into everyday life, there is also greater familiarity with using the unique Icelandic geologic underground as a valuable resource. The project partners identified nature conservation and heightened energy demand as two key concerns throughout the engagements. Further concerns relate to Climeworks' business model and a potential for mitigation deterrence caused by CDR more generally. While the Mammoth project will be built on an already commercially developed and zoned area and showcases a very low land surface/t of CO₂ removed ratio, the Mammoth project partners made certain that no additional energy resources would be required for Mammoth. The project partners also continue extensive advocacy work towards setting robust frameworks for CDR ([Example 1](#), [Example 2](#)).



Environmental and Social Safeguards Questionnaire

The purpose of this document is to provide a **public** summary of how the CO₂ Removal Supplier complies with the environmental and social safeguards, as defined in Section 6.4 of the [Puro General Rules 4.0](#). The responses from the supplier are expected to be commensurate with the identified impacts and risks. This document consists of five sections with the fifth section not being applicable for all suppliers:

1. General overview and compliance
2. Labor practices and rights
3. Environmental impact and management
4. Social impact and community relations
5. Biomass sustainability

This document forms part of the Production Facility Audit package. It is corroborated by other documents and evidence provided by the supplier to Puro.earth and the VVB, demonstrating environmental and social safeguards. This document is validated in a Production Facility Audit.

CO₂ Removal Suppliers should consult the applicable methodology and the corresponding audit document index to find a comprehensive list of evidence required for Production Facility and Output Audits.

1. General overview and compliance

Provide a description of your operations and the context where you are operating in.

The project is carried out in a manner that complies with all applicable HSE laws and regulations. On top of that, additional HSE processes are in place. Climeworks has developed a ten-point guide, called Zero Harm Behaviors, to ensure that all employees are held accountable to the highest possible HSE standard. The Zero Harm Behaviors were developed to highlight the high-risk activities that are part of daily work and the importance of following the risk control measures we have in place to manage them. All Climeworks and Carbfix contractors must ensure that all staff are aware of Climeworks' Zero Harm Behaviors rules and that these rules are always adhered to. If non-conformities are identified at any time during the project, the contractors must have remedial measures in place to promptly address any identified deficiencies. All Climeworks and Carbfix contractors have standards, processes, procedures and/or systems in place that meet or exceed the minimum requirements set out and the relevant Climeworks policies, procedures, standards, and specifications.

Behaviours guide:

- People first, always
- Always identify and control hazards
- Always be fit for work
- Always wear the correct PPE
- Do not start work without the correct preparation and authorization
- Do not start work without checking and verifying the isolations
- Do not ride a vehicle without wearing a seat belt and do not use mobile devices while driving
- Do not conduct lifting work without a lifting plan and never walk under suspended loads
- Do not work at height without the correct approval and the correct fall protection equipment.
- Do not pollute our environment, dispose of wastes correctly and protect our company

Provide an overview of the material environmental and social impacts and risks in your operations, and how they were determined.

Project Mammoth has undergone an impact assessment in line with relevant (inter)national regulations.

Further to the regulatory compliance, a chemical and water management plan are implemented within the project, safeguarding safe and stable project operations. Please consult the following documents for further information:

- Safety – Chemicals Management.pdf
- 04131-SOP-00001 Mammoth Emergency Response Plan_Revo2.pdf
- Safety – CO₂ Risk Assessment of exposure and failure.pdf
- [Environmental Impact Assessment on the CO₂ injection/storage activities \(Icelandic\)](#)

Requirement: Abide by national and local laws, objectives, programs, and regulations and, where relevant, international conventions and agreements.

Rule
6.4.1.1.i

Do you comply with the requirement?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
If not, how and why do you not comply? If yes, how do you know that you comply with the requirement? Please provide details considering the laws and regulations that are most relevant to your operations. Also, include any regulations that are specifically related to your carbon removal activities.	
Via consultation and collaboration with national authorities and dedicated procedures and management processes.	
Identify any documents or other records that you rely upon to verify compliance.	
See PDD section 4.3	

Requirement: Respect for human rights and avoiding discrimination; abiding by the International Bill of Human Rights and universal instruments ratified by the host country.		Rule 6.4.1.1.ii
Do you comply with the requirement? Motivate below.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Climeworks: - See Supplier Conduct Code - See Anti-Harrassment and Anti-Discrimination Policy. - See Diversity equality & inclusion commitment statement. Carbfix & ON: - See Reykjavik Energy Group (parent company of Carbfix and ON) Equality Policy and Carbfix Code of Conduct and Code of Ethics - Reykjavik Energy Group is supporting the United Nations Global Compact, which is derived from the Universal Declaration of Human Rights, the International Labor Organization's Declaration on Fundamental Principles and Rights at Work, the Rio Declaration on Environment and Development, and the United Nations Convention Against Corruption - See ISO 45001 certification		

Requirement: Recognize, respect, and promote the protection of the rights of IPs & LCs (indigenous peoples and local communities) in line with applicable international human rights law, and the United Nations Declaration on the Rights of Indigenous Peoples and International Labor Organization (ILO) Convention 169 on Indigenous and Tribal Peoples.		Rule 6.4.1.1.iii
Do you comply with the requirement? Motivate below.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
In line with the above. Furthermore, to the best of our knowledge, Project Mammoth has limited impacts on indigenous peoples and local communities other than the ones addressed in close collaboration and in line with national authorities and further described in the dedicated EIA.		

Note that there is an additional question on free, prior, informed consent below, and there is a requirement to publish a separate stakeholder engagement report based on a Puro template.

2. Labor practices and rights

Requirement: Labor rights and working conditions, including prohibiting forced labor, child labor or trafficked persons whether in own operations or employed by third parties, fair treatment of employees.		Rule 6.4.1.1.iv
Do you comply with the requirement?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
If not, how and why do you not comply? If yes, how do you know that you comply with the requirement?		
According to Climeworks' and Carbfix' alignment with national laws and regulations.		
Identify any documents or other records that you rely upon to verify compliance.		
See Climeworks' Quality, Health, Safety and Environment Policy See Carbfix Code of Conduct		

Requirement: Ensuring a safe working environment and mitigating occupational health and safety hazards.	Rule 6.4.1.1.iv
Describe occupational health and safety hazards that you have identified.	
In line with dedicated management processes following Climeworks' Zero Harm behavior guide.	
Describe the measures undertaken to mitigate the hazards.	
Commitment to Zero Harm and a corresponding culture of safety is implemented at Climeworks. This is being strengthened via: Leadership training; Staff training; dedicated responsibilities; site managers; PPE; HSE performance dashboards and regular reporting; near-miss reporting; Safety data sheets; Core values. See also Carbfix and Reykjavik Energy Group health and safety policies.	

Requirement: Providing for equal opportunities in the context of gender; providing equal pay for equal work and protecting against and appropriately responding to violence against women and girls.	Rule 6.4.1.1.v
Do you comply with the requirement?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

If not, how and why do you not comply?

If yes, how do you know that you comply with the requirement?

Implementation of our Anti-Harassment and Discrimination policy.

Identify any documents or other records that you rely upon to verify compliance.

Climeworks' Anti-Harassment and Discrimination Policy and Carbfix and Reykjavik Energy Group equality policies

3. Environmental impact and management

Requirement: Pollution prevention, including pollutant emissions to air, water, and soil as well as noise and vibration, and generation of waste and release of hazardous materials, chemical pesticides, and fertilizers.	Rule 6.4.1.1.vi
Does the carbon removal activity result in the following impacts? For each potential impact , please provide detailed information about its extent and the current measures in place to mitigate these negative impacts.	
a. Pollutant discharges to air	
De-minimis, but regularly monitored to safeguard compliance.	
b. Pollutant discharges to water	
De-minimis, but monitored according to the water sampling plan and storage monitoring plan.	
c. Pollutant discharges to soil	
Regularly monitored to safeguard compliance	
d. Noise	
All Climeworks assets where environmental noise can have an impact on the surrounding community and areas in which we operate shall apply the Climeworks Environmental Noise Control procedure (provided as attachment) and Safety – Noise Control (provided as attachment)	
e. Vibration	
n/a	
f. Waste	
In line with the Climeworks Waste Management Procedures applicable to anyone at Climeworks who handles or generates wastes on site for disposal or reduce/reuse (attached)	
g. Release of hazardous materials	

In line with Climeworks' Chemicals Management procedures (attached)
h. Chemical pesticides and fertilizers
N/A

Requirement: Biodiversity conservation and sustainable management of natural resources, including avoiding or minimizing negative impacts on terrestrial and marine biodiversity and ecosystems; protecting the habitats of rare, threatened, and endangered species, including areas needed for habitat connectivity.	Rule 6.4.1.1.viii
Is the activity taking place in or near environmentally sensitive areas, including protected areas (e.g. nature reserve or national park), or other areas included in a conservation plan? Describe where the nearest such areas are.	
The Engidalur water well protection zone is located ca. 2.5 km North of the CO ₂ injection site, with the drinking water wells located inside this zone ca. 4 km North of the injection site.	
Describe impacts and risks that you have identified	
Potential impacts on the Engidalur water well protection zone was assessed as part of the Environmental Impact Assessment (EIA) carried out regarding the CO ₂ injection/storage activities, see https://www.skipulag.is/skipulagsstofnun/mal-i-kynningu/safn/nidurdaeling-co2-til-geymslu-a-hellisheidj (Icelandic). Note that this EIA covers the wider Hellsisheiði storage site that includes injection activities other than that from Mammoth. The EIA estimated that there will be no significant impacts on the Engidalur water resources from the planned activities. This is based on the baseline data and reservoir models that predict that the injected CO ₂ will not spread to the shallow groundwater aquifer nor the Engidalur water well protection zone, and also taking into account the measures described below.	
Describe the measures undertaken to minimize and address the impacts and the risks.	
To confirm the absence of significant impacts on the Engidalur water well protection zone, extensive monitoring of the groundwater resources is in place. This includes regular analysis of water samples from both a deep reservoir monitoring well and a number of shallow groundwater wells located in between the CO ₂ injection site and the protection zone, including the drinking water wells themselves. This data and regularly updated reservoir models will be used to identify potential impacts on the shallow groundwater system. If significant impacts are identified, measured will be taken, including increased monitoring, changes to injection parameters, or injection stops. Furthermore, any work with oil or other potential pollutants in the area needs to use the correct equipment to prevent pollution accidents and be aware of the correct response to any such accidents.	

Requirement: Minimizing soil degradation and soil erosion.	Rule 6.4.1.1.viii
Describe impacts and risks to soil that you have identified.	

n/a
Describe the measures undertaken to minimize and address the impacts and the risks.
n/a

Requirement: Minimizing water consumption and stress.		Rule 6.4.1.1.viii
Are you located in an area impacted with water stress?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
If yes, describe local conditions in terms of water stress and any risk analysis done on the impacts of the CO ₂ removal activity on water stress		
n/a		
Describe any agreements and/or regulations relating to water sourcing.		
n/a		
Describe the measures undertaken to minimize water consumption.		
n/a		

Requirement: The CO ₂ Removal Supplier shall not convert natural forests or high conservation value habitats .		Rule 6.4.1.1.viii
Do you comply with the requirement?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
If not, how and why do you not comply? If yes, how do you know that you comply with the requirement?		
In line with national regulations		
Identify any documents or other records that you rely upon to verify compliance.		
For further information, please consult the Environment Impact Assessment.		

4. Social impact and community relations

Requirement: Avoiding or minimizing adverse impacts to community health and safety.	Rule 6.4.1.1.vii
Describe potential sources of impact, taking into account all relevant factors in the given context. Consider both routine and non-routine circumstances.	
The project is taking place in a designated industrial area. Potential adverse impacts to community health and safety are monitored and mitigated in line with (inter)national regulation, such as the European CCS Directive for the safe and permanent geological storage of CO ₂ .	
Describe the measures undertaken to minimize and address the impacts and the risks.	
According to the provisions of the CCS Directive and respective guidance documents, in line with the Environmental Impact Assessment regarding the CO₂ injection/storage activities .	

Requirement: Preserves and protects cultural heritage and cultural and religious sites.	Rule 6.4.1.1.ix
Describe the impacts and the risks to cultural heritage and cultural and religious sites that you have identified.	
n/a	
Describe the measures undertaken to minimize and address the impacts and the risks.	
n/a	

Requirement: Avoiding forced physical and/or economic displacement. If avoidance is not feasible, CO2 Removal Suppliers shall minimize physical and/or economic displacement. This applies also to any access restrictions to lands, territories, or resources, and any customary rights of local right holders.		Rule 6.4.1.1.x
Did/does the activity result either in forced physical or economic displacement?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
If yes, describe the impact to local communities and how it was assessed?		
n/a		

Provide a comprehensive description of the process that was undertaken, compensation arrangements and measures to mitigate the negative impacts.
n/a
Also describe in detail how you minimized forced physical or economic displacement.
n/a

Requirement: When the activity directly or indirectly impacts indigenous peoples or their livelihoods, ancestral knowledge or cultural heritage, the CO ₂ Removal supplier shall develop the Production Facility with free, prior, informed consent (FPIC).		Rule 6.4.2
Is the CO ₂ removal activity taking place in an area inhabited by or claimed by indigenous people, or does it influence such an area?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
If yes: does the activity directly or indirectly impact indigenous peoples or their livelihoods, ancestral knowledge or cultural heritage? How was that determined?		
n/a		
If there is a direct or indirect impact:		
a. Provide a description of the impact and the measures that were taken to minimize the impact.		
n/a		
b. Describe how and when the indigenous communities were identified and approached for the FPIC process.		
n/a		
c. Describe the mutually agreed process for the negotiations.		
n/a		
d. Describe how the indigenous communities were informed about the potential impacts of the activity on their livelihoods, ancestral knowledge, or cultural heritage.		
n/a		

e. Describe the outcome of the negotiations.
n/a
f. Describe how the ongoing consent process is managed to ensure that the indigenous communities continue to agree with the activity as it progresses.
n/a
g. Describe grievance mechanisms that are in place for the indigenous communities.
n/a
h. Describe how the impacts on the indigenous communities are monitored and addressed during the operation of the Production Facility.
n/a

5. Biomass sustainability

Puro methodologies require that whenever biomass feedstock is used in the carbon removal activity, it must be sourced in a sustainable way	
Is your carbon removal activity based on using biomass feedstock?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Describe how you ensure that it is sourced sustainably	
n/a	