Empati Carbon Abatement Standard

The Empati Carbon Abatement Standard sets forth a certification framework for quantifying the carbon abatement achieved through the displacement of electricity generation from fossil fuels.

Version 1.2

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1 Introduction

The Empati CO2 Abatement (CO2a) standard provides the foundations for a new carbon economy. The CausalTrace platform created by Empati records data associated with the creation of carbon abatement.

This document lists the requirements for creating fungible units of carbon abatement, ensuring that they are accurately measured and tracked.

CO2a must be verifiable using historic sensor data that provide scientifically provable carbon baselines and counterfactuals. Each CO2a token is underpinned by a probabilistically certain carbon quantification that necessitates that for a token to be minted, the causal carbon model must be 90% certain that carbon abatement has taken place.

Empati coordinates the data curation, quantification, and verification necessary to mint (create) CO2a tokens. This coordination happens on the CausalTrace platform. All data, calculations, and model fundamentals associated with the creation of CO2a are provided to key financial and validation actors for transparency and trustworthiness.

This CO2a standard is designed to create a transparent framework with clear technological, data and financial requirements necessary for a project to be eligible to issue CO2a tokens It also outlines stakeholders' duties and obligations, ensuring a predictable and streamlined experience for all parties engaging with the CausalTrace platform and CO2a standard.

CO2a Token Definition

"The reduction in carbon flows into the atmosphere, expressed in metric tonnes of carbon abated, as a result of replacing fossil-fuel generated electricity with zero or lower carbon alternatives."

CO2a Calculation Equation

$$CO2a = Baseline\ Emissions - Project\ Emissions$$
$$CO2a = Energy\ Consumed * (Carbon\ Counterfactual - Emission\ Factor)$$

1.1 Purpose

The Empati CO2a Standard exists to:

1. Provide guidance, data-driven methodologies, and scientifically validated baselining and counterfactual techniques to measure abatement due to the replacement of carbon flows into the atmosphere.

2. Issue verified CO2a tokens that can be used as financial assets and to reduce carbon emissions.

1.2 Principles

The Empati CO2a standard adheres to the following key principles:

1.2.1 Fungibility

- Empati is working with standards setting organisations to define a unit of CO2a as a fungible unit, meaning one token of abatement calculated at one location/time is equivalent to another token of CO2a created at another location and time.
- CO2a tokens are divisible into individual grams produced.
- CO2a tokens are created over time as part of the curtailed emissions flows. Uncertainty arises due to changes in weather or energy consumption, and such uncertainty can be objectively calculated for forecast CO2a tokens.
- To establish a fungible unit of CO2a, data-driven methodologies are applied over historical datasets to calculate and forecast counterfactual.

1.2.2 Impartiality

- Empati does not sell nor broker the sale of CO2a tokens.
- Empati charges creators, buyers, and sellers of CO2a tokens for the use of the CausalTrace platform for the purpose of:
    1. Creating tokens of CO2a.
        - Recording the data underlying the CO2a tokens.
        - Providing and updating the causal model to generate the carbon counterfactuals.
    2. Tracking exchanges of tokens
- Empati collaborates with key financial institutions and government bodies to assure the acceptance of abated CO2a tokens across jurisdictions and financial markets.
- Empati collects fees for the provisioning of knowledge bases across different sectors, helping buyers, sellers, and creators of CO2a tokens make better decisions in the short and long term. This includes forecasting the performance of CO2a projects and providing continual updates on such projects.

1.2.3 Data-driven Approach

- Empati does not employ heuristics to establish baselines or calculate counterfactuals.
- Empati provides measurements that enable the calculation of CO2t abated, which in turn enables the minting of CO2a tokens. Measurements are sensor-based, historical or real-time (at high frequency).
- Counterfactuals of renewable energy production are calculated using data collected at high frequency before the deployment of the abatement intervention.
- CO2a token forecasts are calculated using high-precision datasets collected locally at project sites, climate data, and other independent weather forecasting solutions.

1.2.4 Probabilistic Certainty

- CO2a tokens are generated when, and only when, the carbon abatement from a project is 90% certain as defined by the Empati CausalTrace platform.
- P90 carbon abatement certainty is a statistical measure indicating that the claimed amount of carbon abatement is expected to occur at least 90 times out of 100, based on rigorous analysis or modeling. It signifies the lower bound of the expected range of outcomes, with a 90% probability that the actual abatement will meet or exceed this level.
- The causal model combines the uncertainty in carbon counterfactual combined with the uncertainty due to larger matching averaging periods.
- The causal model inspects the uncertainty in the carbon counterfactual and the uncertainty in the consumer's energy origination to create a value of CO2t abated that is 90% certain (P90 level of certainty).
- CO2a tokens are only created based on the P90 level of carbon abatement, ensuring trustworthiness and certainty in CO2t abated.

1.2.5 Traceability

- Empati CausalTrace provides a data management framework to trace and verify every token of CO2a exchanged between creators, buyers, and sellers on the platform.
- Every unit of CO2a is recorded on a blockchain to avoid tampering.

- CausalTrace records each use of its causal model and records its output on a ledger to ensure the verifiability and accuracy of the model.
- Empati provides a W3C PROV compliant tracking solution to ensure every transaction can be traced back to its source. This includes tracing back to the individual data points and forecasts underlying every CO2a token.

1.3 Scope

The scope defines the types and locations of eligible projects.

1.3.1 Project Type

Empati works with generators of CO2a tokens, project developers looking to create CO2t abated opportunities, banks looking to finance such projects, technical advisory groups that need to assess the technical and financial viability of abatement projects, and market makers looking to improve the efficiency of carbon trading.

1.3.2 Geography

Empati works with carbon market participants across the globe. The language used to describe its products and services is country-dependent.

Our calculations and reporting procedures are translatable across jurisdictions by virtue of our Carbon PROV-based ontology specifications and tailoring to various protocols.

1.3.3 Greenhouse Gas (GHG) Eligibility

Empati issues verified CO2a tokens for the abatement of flows of CO2 only (not removal from the atmosphere). In evaluating a project's comprehensive greenhouse gas (GHG) emissions, all GHGs are considered. Empati uses the United States Environmental Protection Agency's definition of GHGs, which includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

If GHG emissions other than CO2 are prevented from flowing into the atmosphere, they shall be converted into CO2e via the following table. GHG emissions not included in the table are deemed to be too volatile in their CO2e conversions and too small in their quantities.

GHG	CO2e
Carbon Dioxide	1
Methane	29.8
Nitrous Oxide	273

1.3.4 Notable Exclusions

Projects partaking solely in any of the following will not meet the Empati Protocol Requirements:

- Carbon abatement projects with a lifetime of less than 25 years have not been otherwise approved by Empati on a case-by-case basis.
- Ecosystem restoration, maintenance, and management
- Nature-based solutions
- Carbon capture and storage (CCS)
- Reducing Emissions from Deforestation and Degradation (REDD+)

Projects partaking in activities leading to Enhanced Hydrocarbon Recovery (EHR) will also not meet Empati Protocol Requirements.

1.4 Versioning

This is Version 1.2 of the Empati Carbon Standard, first published on 08/05/2024. The document will undergo ongoing updates to reflect changes in operational procedures, governance, and rules applicable to Projects or activities outlined in the Registry.

Proposed significant changes to the Standard will undergo review by the Standards Review body, comprising key financial institutions, standards-setting bodies, and governmental entities. After any resulting amendments from this process, draft changes will be subjected to public commentary. Subsequently, after incorporating further feedback, the final changes will be published in an updated version of the Standard, accompanied by a transparent account of stakeholder input and its influence on the final modifications.

Version numbers adhere to the standard Semantic Versioning practice, where three positive integers (A.B.C) denote the version of the Protocol:

- Major (Integer A): Updated for significant changes affecting Project eligibility, Verification practices, or Credit issuance.
- Minor (Integer B): Updated for non-critical information additions or removals, such as optional guidance.

- Patch (Integer C): Updated for minor adjustments, such as phrasing or reference alterations.

A comprehensive changelog, along with all previously issued versions and their publication dates, will be publicly accessible on the Empati website.

1.5 Citation

The appropriate citation for the document is the "Empati CO2t Abatement Standard (2024) Version 1.2"

2 Project Requirements

This section outlines the requirements for all Empati certified protocols that can be used to generate and mint CO2a tokens.

All projects seeking to issue CO2a tokens must adhere to a certified Empati protocol. These protocols can vary depending on the nature of the intervention.

An Empati Carbon Standard Certified Protocol is defined as either:

- A Protocol crafted by Empati, subjected to a Public Consultation.
- A Protocol authored by external entities, reviewed by Empati, subjected to a Public Consultation, and ultimately endorsed by Empati for integration into the Empati Carbon Standard.

Each Protocol undergoes rigorous evaluation by Empati, with external input necessary for externally developed protocols that significantly deviate from Empati's standards. Upon completion of the protocol development process and approval by Empati, the Protocol earns certification, making it applicable for project utilisation.

Empati abstains from certifying multiple Protocols concerning identical or substantially similar carbon abatement activities.

2.1 Ownership

Projects must demonstrate legal ownership over the rights to all carbon abatement claimed from the Project, making a representation to Empati to this effect.

In cases involving multiple parties in the abatement process, to prevent Double Counting, a single Project Proponent must be designated as the sole owner of the abatement.

Ownership should be outlined in contracts between the Project Proponent and other involved parties, such as suppliers of infrastructure, transportation, and logistics firms, and/or storage site owners and operators.

These contracts must:

- Transfer ownership of all abatement tokens to the Project Proponent. The project proponent can then allocate the tokens as agreed between the parties.
- Clearly state that other participating entities cannot claim carbon abatement resulting from their involvement in the Project without the necessary tokens to back up that claim.
- Specify that unless these third parties are the ultimate owners of the generated CO2a tokens, they cannot advertise products or practices as "low emission" based on the Project's abatement efforts.

2.2 Token Issuance

All tokens generated from projects are facilitated by the CausalTrace Platform. Once a project is validated, it becomes eligible to submit validated data streams to Empati for CO2a token creation. Projects retain eligibility as token creators throughout the duration of the crediting period outlined in the project's Project Design Document (PDD).

Should a Project Proponent seek to extend the Crediting Period of a Project, an updated PDD must be submitted, and the Project must undergo re-validation. It is expected that there will be at least 5 re-validation periods for each project due to their lifetime being over 25 years. There is no limit on the number of times a project can be renewed, provided it remains compliant with the relevant Certified Protocol. Generally, the maximum Crediting Period is five years unless otherwise specified in the relevant Certified Protocol. This framework ensures transparency and accountability in carbon abatement efforts facilitated through the Empati Carbon Standard.

2.3 Documentation

For a Project to undergo evaluation for the Empati Carbon Standard, the Project Proponent must compile Project details in a Project Design Document (PDD). This document serves as the foundation for Project Validation and assessment according to the relevant Certified Protocol. The PDD should align with ISO 14064-2:2019 and should encompass the following:

- Project title, purpose(s), and objective(s).

- Project type, elucidating how the Project will achieve carbon abatement based on the emission calculation requirements specified in the relevant Protocol.
- Project location, encompassing organizational, geographic, and physical location details, facilitating the unique identification and demarcation of the Project's specific extent.
- Pre-project conditions to facilitate the identification of Counterfactual emissions and a carbon emissions baseline.
- Project technologies, products, and services.
- Expected aggregated net carbon abatement in tonnes of CO2e projected from the Project.
- Identification of risks that could significantly impact the Project's abatement efforts, along with any measures intended to mitigate those risks.
- Roles and responsibilities, including contact information for the Project Proponent and other Project participants.
- Summary environmental impact assessment.
- Description of consultations with stakeholders, communities, or other interested parties, including mechanisms for ongoing communication and the outcomes of such discussions.
- Chronological plan or actual dates and rationale for:
    - Project Start Date.
    - GHG Baseline period.
    - Project Issuance Period.
    - Monitoring and reporting frequency and the Project period, outlining relevant Project activities at each stage of the Project cycle, as applicable.

Empati Carbon Standard will uphold the confidentiality of sensitive business information contained within the PDD or provided by the Project Proponent. Information designated as sensitive by the Project Proponent will not be publicly disclosed by Empati Carbon Standard. Empati Carbon Standard will communicate with the Project Proponent regarding the necessity of sharing any sensitive information to accurately reflect carbon abatement calculations. Sensitive business information may include, but is not limited to, locations, names, proprietary processes, and non-public acquisitions/partnership plans.

2.4 Data Sharing

Data transparency is a fundamental aspect of the Empati Carbon Standard. All evidence and data pertinent to quantifying CO2a tokens will be accessible to the public through the CausalTrace Platform for any Verified carbon abatement. This includes details such as the Project Design Document, measurements and metadata recorded, causal models employed, and scientific literature utilised in the assessment process.

While ensuring transparency, we also recognise the importance of confidentiality for certain sensitive information. Therefore, the Project Proponent may request that confidential data be restricted, limiting access to authorised Buyers, Empati, and designated Validation and Verification Bodies (VVBs). However, it's essential to note that numerical data utilised or generated during the quantification of CO_2e removed may not be subject to such restrictions, ensuring accountability and integrity within our carbon abatement initiatives.

2.5 CO2a Protocols

In adherence to the Empati Carbon Standard, each project endeavouring to produce and issue CO2a tokens must adhere to specific protocols designed to accurately calculate the quantity of CO2a tokens generated.

These protocols incorporate a dynamic causal model, continuously updated to evaluate the project's and its broader ecosystem's baseline carbon emissions. The model determines the carbon counterfactual used at various project stages. Each protocol delineates a predetermined set of causal factors deemed pivotal in determining the quantity of CO2a tokens minted.

Moreover, the protocols specify monitoring requirements for electricity consumption and generation to ascertain carbon abatement values, ensuring precision and reliability in all tokens issued. When projects cannot meet granularity requirements, the causal model adjusts accordingly, reducing the number of tokens generated to accommodate additional uncertainty.

Furthermore, the protocols prescribe data requirements for the project, specifying data storage locations and transfer protocols to the CausalTrace platform for analysis. In some cases, the causal model may be deployed directly onto a device at the project site, with the CausalTrace platform node conducting on-site carbon abatement calculations. Regular verification with the master platform is conducted to ensure data integrity and accuracy.

2.6 Eligibility

Empati Carbon Standard sets stringent eligibility criteria for projects seeking to generate CO2a tokens, ensuring transparency and adherence to established standards.

1. **Registry Exclusivity**: Projects can only claim CO2a tokens for activities registered exclusively with the Empati Carbon Standard Registry. Tokens can only be obtained through an Empati Certified Protocol.
2. **Protocol Compliance**: Projects must utilise the latest version of a Certified Protocol at the time of application and validation unless a specified grace period allows for using previous protocol versions. Projects already validated may continue using the protocol version under which they were validated until the next crediting period renewal unless otherwise stipulated.
3. **Legal Compliance**: Projects must comply with all relevant laws and regulations in their operating jurisdiction.
4. **Notification of Changes**: The Project Proponent is responsible for promptly notifying Empati of any operational changes that could impact the eligibility of their process.

By adhering to these eligibility criteria, projects can ensure alignment with Empati Carbon Standard principles and contribute effectively to global carbon abatement efforts.

2.7 Environmental & Social Impacts

Empati Carbon Standard mandates strict adherence to national, local, and international laws, regulations, conventions, and standards governing environmental and social aspects.

1. **Legal Compliance**: Projects are obligated to comply with national and local laws and regulations, as well as relevant international conventions and standards.
2. **Environmental and Social Impact Considerations**: Projects must thoroughly assess their activities' potential environmental and social impacts, both within and beyond their boundaries. It is imperative that projects, at minimum, do not cause net environmental or social harm. Any unintended harm must be promptly remediated by the Project Proponent. Failure to remediate adequately may result in Credit cessation and cancellation. This assessment should be continuous throughout the project's lifecycle, with provisions for closure and post-closure considerations.
3. **Risk Assessment and Mitigation**: Projects must demonstrate how environmental and social risks have been assessed and present mitigation plans to address them. If risks are deemed not applicable, justification must be provided to Empati Carbon Standard and relevant environmental regulators.

4. **Environmental and Social Impact Assessment (ESIA)**: While recommended for all projects, a full ESIA conducted by a third party is mandatory only if the anticipated impacts are significant or it is required by the host jurisdiction. It is the responsibility of the project to ensure that any ESIA conducted complies with all applicable regulations and laws at the local, regional, national, and international levels.

Empati Carbon Standard underscores the importance of proactive environmental and social stewardship, ensuring that projects are conducted in a manner that minimises adverse impacts and maximises societal and ecological benefits.

3 Protocol Requirements

3.1 Project Boundary

Under the Empati Carbon Standard, all Projects must delineate a defined temporal and geographical boundary as stipulated by the relevant Protocol. This boundary must encompass, at a minimum, all greenhouse gas (GHG) sources and sinks originating from:

- The construction or manufacturing of each physical site and associated equipment.
- The closure and disposal of each site and associated equipment.
- The operation of each process.

Protocols necessitate a Cradle-to-Grave GHG Assessment encompassing all emissions linked to a Project's Abatement process. The GHG emissions arising from the Project's activities within the specified boundary, along with any Leakages, should collectively encompass the entire GHG emission impact of a Project.

3.2 Causal Model

At the core of each protocol is the causal model. The causal model defines the baseline carbon emissions of the project, the carbon counterfactual due to the intervention of the project and the main causal factors that affect the number of CO2a tokens generated by the project.

3.2.1 Project Baselining

The baseline is the reference behaviour of the system with respect to its CO2 emissions before the intervention is introduced. The baseline records the system's CO2 emission profile over the baselining period and its causes, or the conditions

leading to the recorded emissions. These are used to help construct the causal model to explain the emission behaviour of the system over the baselining period.

The baseline is used for (1) identifying the emission causal factors requiring monitoring and (2) based on the observed real-world conditions, used estimating the counterfactual emissions along with the counterfactual model as if the intervention had not been in place (usually referred to as "business as usual").

The baseline of a project is calculated through the thorough data analysis of the project before the intervention, or if the project is entirely new, it is calculated from the data analysis of the grid and surrounding ecosystem in which the project is to be located.

3.2.2 Carbon Counterfactual

With the causal model of the system and surrounding ecosystems CO_2 emissions constructed from the baselining phase, the conditions observed during the monitoring phase are used to predict the system's counterfactual behaviour during the accounting period. This, in turn, will determine the amount of CO_2 emissions that the system would have emitted without the intervention.

Since the causal model is probabilistic in nature, the estimated CO_2 emission comes with a level of uncertainty, represented by the confidence intervals of the estimated value, which will be considered in the calculation of CO_2 abated in the next step.

The carbon counterfactual also takes into account the grid into which energy is being injected by the project. The CausalTrace platform includes a digital twin of the project along with the grid into which energy is injected to help calculate the causal carbon counterfactual. This digital twin model examines the grid system's perturbations to find the marginal emission factor for each unit of electricity at each point in time.

3.2.3 Causal Factors

The causal factors that underpin the causal model are those deemed to have a statistically significant impact on carbon emissions and the resulting CO2a tokens generated.

These factors can range from the time and size of energy injection to the predictability of energy generation from the resource.

The causal factors are determined from the project’s baselining and the digital twins of both the project and the surrounding ecosystem.

3.2.4 Updating the Causal Model

A system's behaviour may change to react to (new) market, regulatory, or other stimuli. In such cases, the causal model will need updating to ensure confidence in the counterfactual case. Therefore, the causal model must be revalidated over each accounting period by checking its accuracy using observations from the previous accounting period.

The Empati standards review body and validated verification bodies will continually review each protocol to determine if a thorough review is needed.

A thorough review is performed every 5 years regardless of whether the standards body deems it necessary.

3.3 Monitoring

Each protocol will have monitoring requirements that determine what data needs to be captured, what third-party metadata needs to be captured, and what the matching requirements are for consumption and generation.

3.3.1 Matching Requirement

The matching requirement determines at what granularity the generation and consumption data must be recorded in the ideal case and in the minimum case. In some cases, only generation may need to be monitored; however, in other scenarios, both generation and consumption of that power will need to be monitored and matched to make sure that the carbon abatement claims are valid to 90% certainty.

Where matching or monitoring cannot be done in the ideal case but is done greater than or at the minimum level, a probabilistic transformation mapping will be performed on a P90 basis through the CausalTrace platform.

This tool operates at the P90 level of certainty, ensuring that all mappings are performed with the stipulation that the true value must possess at least 90% certainty in its carbon abatement assertions. Moreover, the mapping tool utilises Monte Carlo simulations of varied consumption and generation profiles to enhance the determination of the value deemed adequate to meet the certainty threshold.

3.3.2 NPL Time

Accurate time measurement is vital for issuing CO2a tokens, which are the results of the temporal match between energy generation and consumption.

NPL time, or National Physical Laboratory time, refers to the highly precise time standard maintained by the National Physical Laboratory (NPL) in the United Kingdom. It is based on atomic clocks and is used as a reference for various

timekeeping applications, including scientific research, telecommunications, and navigation.

NPL time is derived from the coordinated universal time (UTC), which is the internationally recognized standard for timekeeping. However, NPL time has additional levels of accuracy and stability compared to UTC, making it particularly useful for applications that require extremely precise timing.

NPL time will be used for all measures of time to ensure temporal accuracy and certainty in all CO2a tokens.

3.3.3 CausalTrace

The Empati CausalTrace platform is responsible for ingesting all data streams from the project. It contains all the causal and counterfactual models used to determine certainty in carbon abatement.

The data requirements section will outline when data needs to be transferred to the system.

In some cases, a local CausalTrace node will be created at the project site that contains all the vital models for that project and the protocol implemented. This will allow for the carbon abatement to be calculated on-site, reducing the project's data transferring requirements.

In this case, only the carbon abatement data streams, along with relevant metadata, will be transferred to the CausalTrace platform.

In all cases, CO2a tokens are only generated by the CausalTrace platform to ensure unification and certainty.

3.3.3.1 Metadata Validation

Metadata validation is a crucial part of the CausalTrace platform. The required metadata for the project to mint CO2a tokens needs to be outlined in the protocol.

3.3.4 Carbon PROV

Carbon PROV is intrinsically linked to the matching requirements of a project. Carbon PROV takes in the data streams from generation, consumption and the grid’s carbon content and links that data according to the Carbon PROV ontology.

Carbon PROV matches renewable energy generation to its consumption. The CausalTrace platform is then responsible for linking this energy match with the causal model and carbon counterfactual to generate the CO2a tokens.

This ontology ensures that all matching and verification is tracked using a standardised methodology that preserves data provenance.

3.4 Data Requirements

This section details the necessary data requirements for the Empati Carbon Standard protocol, ensuring robust data collection, storage, analysis, and transfer procedures.

3.4.1 Data Capture

During each defined accounting period, the monitoring phase meticulously records the CO_2 emissions, or their absence, of the system while the intervention is in place. Concurrently, the conditions that contributed to emissions during the baselining phase are monitored and documented to construct the counterfactual scenario of the system's CO_2 emissions for the same period in the absence of the intervention.

The protocol specifies essential information required for constructing the causal model and carbon counterfactual, as well as the metadata necessary for data validation.

3.4.2 Data Storage

Empati Carbon Standard emphasises secure and reliable data storage practices. All collected data must be stored in designated repositories that adhere to stringent security and privacy standards. These repositories ensure the integrity and accessibility of the data throughout its lifecycle.

3.4.3 Data Analysis

Data analysis is pivotal in deriving insights and conclusions from collected data. Empati Carbon Standard employs advanced analytical techniques to analyse data, including high-frequency sensing and data-driven science. Through sophisticated analytics, the carbon counterfactual of actions is developed, providing valuable insights into the impact of interventions on carbon emissions.

In most scenarios and protocols, data analysis is performed on the CausalTrace master platform. However, there may be cases when a CausalTrace node is installed on the project site to perform certain data analysis at the node. This node will have to sync with the master CausalTrace platform regularly.

3.4.4 Data Transfer

Efficient and secure data transfer mechanisms are essential for seamless collaboration and communication within the Empati Carbon Standard framework. Data transfer protocols ensure the timely and accurate exchange of information between project stakeholders and the Empati Carbon Standard platform. These protocols prioritise data integrity, confidentiality, and traceability, maintaining the highest data governance and security standards.

Each protocol must define when data is transferred from the project to the CausalTrace platform. This may be a data streaming process where data is transferred as soon as it is generated, or it may be done in batches at a regular intervals as defined by the protocol.

3.5 Protocol Updates

The Empati Advisory Team will conduct a protocol review if Empati deems it necessary due to significant changes in areas such as scientific knowledge, technology, and/or regulatory frameworks. This review process must be completed within six months from the date an issue is identified. Should the review result in substantial changes to a Protocol necessitating a new version, these changes must undergo the full Certification process.

Moreover, each Protocol will undergo review based on the earlier occurrence of the following criteria:

- Two years have passed since the original Certification.
- The issuance of a specific number of CO2a tokens under a Protocol reaching the following milestones: 100,000 tokens Issued; 500,000 tokens Issued; 1,000,000 tokens Issued; 5,000,000 tokens Issued.

All modifications will be documented on the Empati CausalTrace Platform and disclosed along with the outcomes of a public commenting period lasting at least 30 days. All Protocol versions will be recorded, archived, and publicly accessible. Revisions and updates to Protocols will be conducted following our standard Versioning policy.

Empati retains the authority to suspend and/or withdraw a Protocol if deemed necessary due to credible, evidence-based concerns regarding the overestimation of carbon abatement activities or potential double-counting concerns. In such exceptional circumstances, Empati may immediately suspend and/or withdraw a Protocol. In case of any significant changes, the Protocol may subsequently be reintroduced following the standard period of public consultation.

4 CO2a Token Issuance

Each CO2a token symbolises one metric tonne of verified CO2 abatement and is subject to issuance, transfer, and retirement as per the rules and regulations outlined in this section.

Empati Carbon Standard serves as the exclusive authority for issuing tokens on the Empati Registry.

4.1 Token Issuance Process

Empati CO2a tokens are allocated based on verified carbon abatement actions, ensuring accountability and transparency in carbon mitigation efforts. This allocation process follows the verification of specific abatement actions undertaken by projects.

Tokens are issued to the project proponent responsible for implementing the abatement action. The project proponent retains the authority to transfer tokens to buyer token accounts on the Empati Carbon Standard registry at their discretion, allowing for flexibility and streamlined transactions.

While tokens are generated through the real-time matching of energy generation and consumption, they are issued after thorough analysis and verification done by the CausalTrace platform at the end of each month. This verification process ensures the integrity and accuracy of carbon abatement data, maintaining the credibility of Empati Carbon Standard tokens.

4.2 Token Attributes

Each CO2a token represents a singular unit of carbon abatement, maintaining uniformity across all certified tokens. We use cutting-edge high-frequency sensing and data-driven methodologies to establish baseline measurements for carbon emissions, facilitating the accurate assessment of carbon abatement efforts.

Employing advanced analytics, we construct carbon counterfactuals to evaluate the impact of initiatives such as integrating additional renewable energy sources into the grid on carbon emissions. Ensuring transparency, every unit of carbon abatement is meticulously traced throughout its lifecycle, accessible for scrutiny by all stakeholders.

Ownership of each token is exclusive and clearly documented. A comprehensive ownership history that is publicly accessible accompanies each token, detailing its issuance, transfer, retirement, and cancellation, thereby maintaining accountability and transparency within the system.

A token is designated as Active upon issuance until its redemption or cancellation. Empati Carbon Standard token metadata includes essential information such as:

- a unique serial number
- issuance date
- issuing project
- country of abatement
- ownership history
- redemption details
- current status

4.3 Probabilistic Measurement

In adherence to the Empati Carbon Standard, each CO2a token undergoes creation only when there is a 90% certainty that carbon abatement has occurred. This stringent requirement ensures the reliability and accuracy of carbon abatement measurements within the Empati framework.

The CausalTrace platform quantifies uncertainty, as outlined in each protocol. This process involves analysing raw data streams using Carbon PROV, the causal model, and the carbon counterfactual model to ascertain the level of carbon abatement with 90% certainty.

Only carbon abatement instances that reach the 90% certainty threshold are tokenised, ensuring that all CO2a tokens represent credible and verifiable carbon abatement actions. This principle of P90 certainty serves as the cornerstone of the Empati Carbon Standard, providing a robust foundation for the creation of fungible units of carbon abatement.

4.4 Issuance Period

In alignment with the Empati Carbon Standard, a project's token minting period extends for the duration that the project continues to generate carbon abatement. However, licenses are issued on a five-year basis, requiring project re-validation every five years. During these re-validation cycles, protocols are updated, and the causal model undergoes scrutiny to ensure its ongoing accuracy.

A project is anticipated to encompass a minimum of five minting periods, each lasting five years, covering the project's lifespan. Even after this initial timeframe, projects remain eligible to generate CO2a tokens. However, the minting period may be shortened to one or two years after the initial 25-year period to maintain certainty during the latter stages of the project's lifecycle. This approach ensures continued adherence to the Empati Carbon Standard while accommodating the evolving needs and circumstances of carbon abatement projects.

4.5 Issuance Timeline

In adherence to the Empati Carbon Standard, data streams originating from project sites are transmitted either in real-time or at predetermined intervals to the CausalTrace platform or node. These streams contain essential information for assessing the carbon abatement achieved at the respective locations.

Regardless of the volume of CO2a tokens generated or the frequency of data transmission to the CausalTrace platform, credits are allocated to the project account only at the conclusion of each month. This procedural approach ensures thorough analysis of all data streams and streamlining the token minting process, maintaining integrity and accuracy within the Empati Carbon Standard framework.

4.6 Token Redemption Rules

Within the framework of the Empati Carbon Standard, token redemption plays a pivotal role in affirming the ownership status of carbon abatement. This critical process ensures that once a token symbolising the abatement of a metric ton of CO2 is redeemed, it cannot be reissued or reused for subsequent carbon accounting endeavours.

At the core of token redemption is the identified beneficiary, representing the organisation on whose behalf the token is redeemed. This publicly acknowledged beneficiary can either be the current token holder or an organisation specified during the redemption process. Empowering stakeholders, the redemption procedure is facilitated through the token account on the Empati Carbon Standard registry, providing account holders with the autonomy to execute redemptions per established protocols.

While the ownership of an unredeemed token can be publicly marketed, it is only upon redemption that the associated environmental benefits can be claimed. Adhering to specific regulations, the Empati Carbon Standard ensures the integrity and transparency of the redemption process:

- Token redemption is restricted to tokens held within the ownership of the account holder.
- Each token can undergo redemption only once, affirming its singular status in the carbon abatement ecosystem.
- The redemption process is not limited by quantity, provided it remains within the total holdings of tokens within the account.

4.7 Carbon Reserve Account

In adherence to the Empati Carbon Standard, all certified carbon abatement projects are mandated to establish a carbon reserve account. These reserve accounts serve as a buffer pool to mitigate the risk associated with fluctuations in carbon abatement levels.

Typically, projects are financed through a combination of debt and equity, a common practice observed in renewable energy project finance. Should a project fail to meet its debt obligations due to insufficient CO2a tokens, it faces the risk of default. To mitigate this risk, equity CO2a withdrawals are restricted until project completion, and a predetermined portion of CO2a tokens are allocated to the project's carbon reserve account. These tokens are reserved to fulfil debt repayments in scenarios where carbon abatement falls below anticipated levels for an extended period.

The carbon reserve account is project-specific and remains accessible only after all project-related debts have been settled. Its capacity is set at six months' worth of principal and interest payments.

Upon the issuance of CO2a tokens post-verified carbon abatement, these tokens are allocated between debt and equity according to project status. Monthly issuance and verification processes ensure a steady flow of tokens. Debt repayments, including principal and interest, are made monthly, with the goal of requiring less than 100% of the total carbon abatement produced in that month. Any excess carbon abatement in each month contributes to the project's equity.

Until the carbon reserve account reaches its required capacity, 50% of the surplus carbon abatement is directed to this account monthly. All surplus carbon abatement is credited to equity once the carbon reserve account is fully funded. This mechanism ensures financial stability and risk mitigation throughout the project lifecycle.

In alignment with the Empati Carbon Standard, tokens within the carbon reserve account remain non-transferable and non-saleable throughout the debt repayment phase. Only upon the complete repayment of project debts can tokens be allocated wholly to equity for the remaining minting duration.

The dimension of the carbon reserve account adheres to the guidelines stipulated by the Empati Carbon Standard. It may be adjusted to exceed the default six-month period if the minting dynamics exhibit exceptional volatility, ensuring adaptability to varying project circumstances.

4.8 No Double Counting

Empati Carbon Standard incorporates stringent protocols and procedures to mitigate the risk of Double Counting, ensuring the integrity and accuracy of carbon abatement claims. Double Counting can manifest in various forms, including double issuance, double use, and double claiming.

To address double issuance, which arises when multiple unique units are issued for the same abatement activity, Empati Carbon Standard implements robust checks and balances. Any abatement activity registered within the Empati Carbon Standard must not be concurrently listed on another carbon registry or utilised to make separate carbon abatement claims elsewhere. Empati Carbon Standard enforces these requirements through contractual agreements with project proponents, initial due diligence on projects, and ongoing monitoring to prevent instances of double issuance.

Double use, where an issued token is utilised multiple times or redeemed after already being redeemed, is mitigated through transparent record-keeping. Each token and its redemption are documented in a public records, allowing for unique identification and traceability back to the specific abatement activity for which the token was issued. Once a token is retired, it cannot be further utilised, and a distinct public redemption certificate is generated.

Empati Carbon Standard strictly prohibits double claiming, where an issued token is claimed twice to meet mitigation targets. Users of the Empati Carbon Standard Registry are forbidden from making separate claims for the same abatement underlying a token issuance. Empati Carbon Standard actively monitors for instances of double claiming, and users found engaging in such practices may face suspension of their token accounts.

5 Validation

This section outlines the requirements for the Validation and Verification of Projects on the Empati Carbon Standard Registry. Accredited Verification and Validation Bodies (VVBs) conduct Validation and Verification processes in accordance with the Empati Carbon Standard and a Certified Protocol.

5.1 Validation Body Qualification Requirements

All Validation and Verification Bodies (VVBs) undergo approval by Empati Carbon Standard independently and impartially, adhering to Conflict-of-Interest policies, VVB rotation policies, quality oversight, and the following criteria:

VVBs must demonstrate accreditation from:

- An International Accreditation Forum member against ISO 14065 or other relevant ISO standards, including but not limited to ISO 14034, ISO 17020, ISO 17029; or
- A relevant governmental or intergovernmental regulatory body.

Alternatively, VVBs may seek approval on a case-by-case basis by demonstrating to Empati that they meet all required Verification needs and competencies

outlined in the relevant Protocol and adhere to the guidelines of ISO 19011 or other relevant standards.

5.2 Conflicts of Interest

Empati Carbon Standard prioritises impartiality and transparency in the validation and verification processes. To ensure this, we have stringent guidelines regarding conflicts of interest:

1. **Organisational Independence:** Any organisation involved in developing a Project Proponent or any part of a Certified Protocol cannot serve as a Validation and/or Verification Body (VVB) for that project. This ensures independence and prevents potential biases.
2. **Disclosure Requirements:** VVBs engaged by Empati for validation and verification purposes must disclose any potential conflicts of interest. This disclosure is essential to maintain the process's integrity and uphold Empati's standards of objectivity.

By enforcing these measures, Empati Carbon Standard mitigates the risk of conflicts of interest between Project Proponents and VVBs, ensuring the credibility and reliability of the validation and verification processes.

5.3 Rotation of Validation Bodies

To uphold the integrity and effectiveness of the Empati Carbon Standard, we implement guidelines regarding the duration of engagement between Projects and Verification Bodies (VVBs):

1. **Single VVB Requirement:** Projects must collaborate with a single VVB for a maximum of five consecutive years. This requirement ensures consistency and accountability in the validation and verification processes.
2. **Limit on VVB Engagements:** Similarly, a VVB can conduct Verification for a specific Project for no more than five out of seven consecutive years. This measure prevents over-reliance on a single VVB and encourages diversity in verification procedures.

By enforcing these guidelines, the Empati Carbon Standard promotes fairness, transparency, and robustness in the validation and verification of carbon abatement projects.

5.4 Standards Review Body

At Empati, we understand the importance of maintaining the highest standards of carbon abatement protocols to ensure accuracy, reliability, and integrity in our

processes. To uphold these principles, we have established the Empati Standards Review Body, a dedicated entity responsible for overseeing the continual evaluation and enhancement of our protocols.

1. **Regular Protocol Review**: The Empati Standards Review Body conducts periodic reviews of all protocols to ensure they remain aligned with the latest advancements in carbon abatement methodologies and best practices. These reviews occur at least once every five years to incorporate updated scientific knowledge and technological innovations.
2. **Responsive to Concerns**: In addition to scheduled reviews, the Standards Review Body remains responsive to public concerns or complaints regarding any approved protocol. If such concerns arise, the review process can be initiated promptly to address the issues raised and make necessary adjustments to the protocols.
3. **Timely Resolution**: Empati is committed to the swift and transparent resolution of public complaints or worries related to our carbon abatement protocols. The review process will be initiated within 30 days of receiving a complaint to thoroughly investigate and understand the underlying reasons. This ensures that any issues are addressed promptly and effectively.
4. **Expert Panel**: The Empati Standards Review Body comprises a diverse panel of experts in carbon abatement, environmental science, data analytics, and related fields. This multidisciplinary approach ensures that protocols are rigorously evaluated from various perspectives, leading to robust and scientifically validated standards.
5. **Stakeholder Engagement**: To promote transparency and inclusivity, the Standards Review Body engages with stakeholders from industry, academia, government, and civil society. This collaborative approach allows for feedback and input from diverse perspectives, enriching the review process and enhancing the credibility of Empati's carbon abatement standards.
6. **Continuous Improvement**: Empati is committed to continuously improving its standards and practices. The Standards Review Body actively seeks opportunities to enhance protocols based on emerging research, technological advancements, and stakeholder feedback, ensuring that Empati remains at the forefront of carbon abatement efforts.

Through the diligent work of the Empati Standards Review Body, we reaffirm our commitment to maintaining the highest standards of excellence in carbon abatement and contributing to a more sustainable future for all.

6 Definitions and Acronyms

Empati Carbon Standard employs a comprehensive set of definitions and acronyms to ensure clarity and consistency in our carbon abatement practices. Here are the key terms and their meanings:

Attributional Analysis: Analysis aimed at describing the environmentally relevant physical flows to and from a life cycle and its subsystems.

Baseline: A set of data describing pre-intervention or control conditions used as a reference scenario for comparison.

Beneficiary: The organisation benefiting from the abatement claim afforded by a token. This may be the current holder of the token at the time of redemption or an organisation specified by the token account holder during the redemption procedure.

Buyer: An entity purchasing carbon abatement, often with the purpose of redeeming tokens to make an abatement claim.

Carbon Flux: The amount of carbon exchanged between two or more Reservoirs over a period of time.

Certification (of a Protocol): The process involving expert review and Public Consultation to arrive at an approved version of a Protocol against which Projects will be Validated and abatement will be Verified.

Consequential Analysis: Analysis of specific Uncertainties, hazards, and scenarios inherent in complex systems to describe how systems-level environmentally relevant flows will change in response to possible decisions.

Conservative: Purposefully erring on the side of caution by choosing input parameter values that result in a lower net CO_2 abatement to increase the likelihood that a given Removal calculation underestimates rather than overestimates. This is the principle behind the P90 definition of carbon abatement utilised in the standard.

Counterfactual: A quantification of what would have happened in the absence of a particular intervention, assuming Baseline conditions.

CO2a (Carbon Abated): The measured quantity of carbon dioxide (CO2) prevented from being emitted into the atmosphere through mitigation efforts.

CO2t (Carbon Tonnes): A metric tonne of carbon dioxide (CO2) irrespective of whether it's removed, abated, or emitted.

CO2e (Carbon Dioxide Equivalent): A unit of measurement comparing the impact of different greenhouse gases to the equivalent amount of carbon dioxide (CO2) based on their global warming potential.

Cradle-to-Grave: Considering impacts at each stage of a product's life cycle, from extraction of natural resources to disposal.

Token: A publicly visible uniquely identifiable Token Certificate issued by a Registry that gives the owner the right to account for one net metric tonne of Verified CO_2 Abatement.

Token Accounts: Function of the Empati Carbon Standard Registry allowing Buyers or Project Proponents to receive Issued Tokens.

Issuance Period: The period during which a Project Design Document is valid and over which carbon abatement may be Verified, resulting in Issued CO2a tokens.

Delivery: The outcome of a Project Proponent providing tokens to fulfil Buyers' purchases.

Double Counting: Improperly allocating the same token of carbon abatement from a Project Proponent to multiple Buyers.

Embodied Emissions: Life cycle GHG emissions associated with production processes.

Emission Reductions: Lowering or avoiding future GHG releases from a specific entity.

Environmental Additionality: Evaluation of the likelihood that an intervention causes a climate benefit above what would have happened in a no-intervention scenario.

Ex-ante tokens: Issuance of tokens before carbon abatement takes place.

Ex-post tokens: Issuance of tokens after carbon abatement took place.

Heuristic: Involving or using practical, intuitive approaches or rules of thumb rather than strict, exhaustive analysis.

International Standards Organization (ISO): Worldwide federation of national standards bodies setting global standards.

Issuance (of a token): Tokens issued to the token Account of a Project Proponent after Verified carbon abatement.

Leakage: Increase or decrease in GHG emissions outside the boundary of a project due to project activities.

Materiality: An acceptable difference between reported and actual carbon abatement/emissions.

Model: Calculation or simulation using input variables to generate values for variables of interest.

Causal Factors: The factors that determine the quantum of carbon abatement from a project.

Monte Carlo Simulations: This approach estimates possible outcomes of an uncertain event through repeated random sampling.

Non-Governmental Organization (NGO): Non-profit organisation with societal, scientific, or political purpose.

Offtake: Contract in which a Buyer purchases a set abatement at a set price.

Probabilistic: Relating to or based on the likelihood of various outcomes, often quantified using statistical methods or probability distributions.

Project: Activity altering the condition of a Baseline and leading to carbon abatement.

Project Proponent: Organization developing and/or having legal ownership or control of a carbon abatement Project.

Protocol: Document describing how to quantitatively assess CO_2 abatement by a process specific to a Project Proponent's process.

Proxy: Measurement correlating with but not directly measuring the variable of interest, matching of generation and consumption not done at the sub-second level is an approximation and a proxy for true carbon abatement.

Public Consultation: Process by which a Protocol is made available for public comment.

Registry: Database holding information on Verified carbon abatement based on Protocols, issuing tokens, and tracking their ownership and redemption.

Abatement: CO2 prevented from flowing into the atmosphere due to the intervention of a renewable energy resource and associated to a renewable energy project.

Reputable Source: Trustworthy source based on the process undertaken or origin of information.

Redemption (of a token): Confirmation of final ownership of a token and its permanent withdrawal from circulation.

Sensitivity Analysis: Analysis of components contributing to overall Uncertainty.

Stakeholder: Person or entity potentially affecting or being affected by Empati or a Project activity.

Standards (scientific): Standard physical constants or values set by bodies such as NIST.

Uncertainty: The lack of knowledge of the exact amount of CO_2 abated by a particular process, quantified using probability distributions or confidence intervals.

Validation: Independent process evaluating assumptions, limitations, and methods supporting a Project to ensure conformity with Empati standards.

Validation and Verification Bodies (VVBs): Third-party auditing organisations experts in their sector, determining if a project conforms to Empati standards.

Verification: Process confirming net carbon abatement for a Project, ensuring conformity with Empati standards.

7 Appendix

7.1 Token Issuance Process Flow Diagram

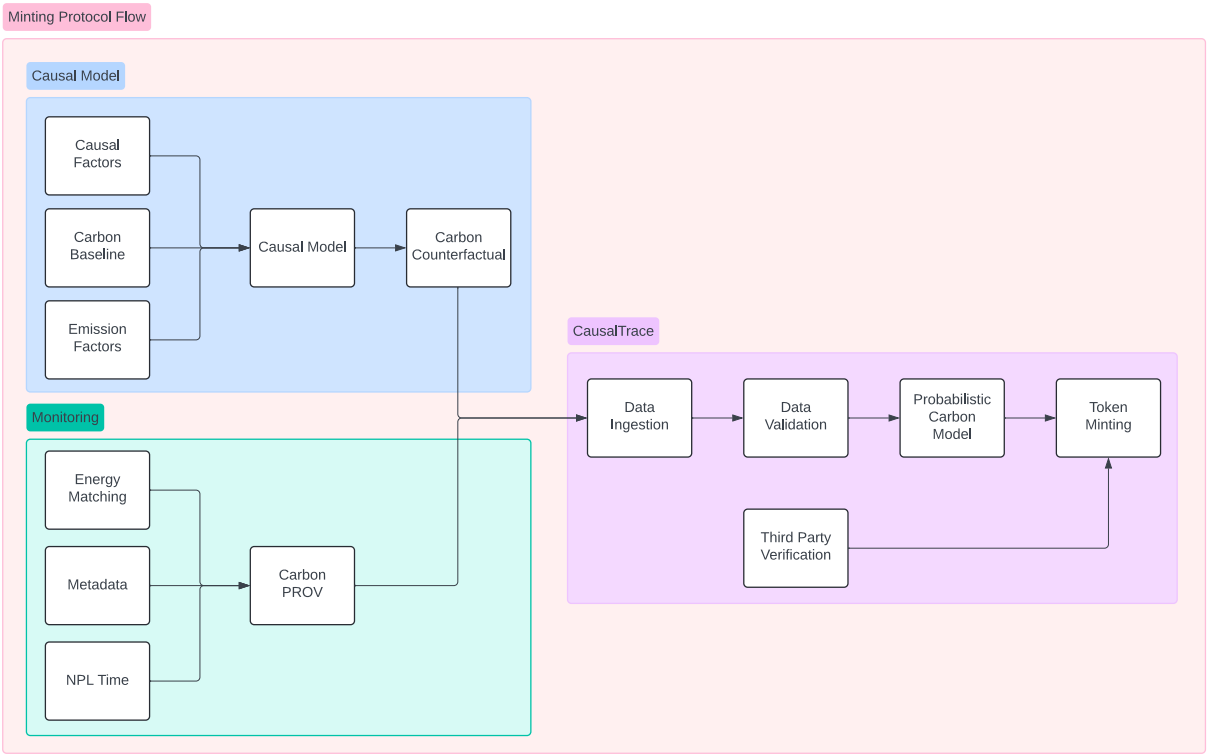

Figure 1: Process flow diagram of the CO2a token minting process.