Klima 2.0

The Dark Sole Enterprise Ltd ds@darksole.vip
with contributions from the Klima and Carbonmark teams

23 Jan 2026 (Version 1.48)

Notice to Readers

This document describes a proposed technical and economic model developed by 01X as part of exploratory research conducted in connection with the Klima ecosystem. It reflects conceptual design work informed by prior learnings from KlimaDAO and related on-chain carbon market initiatives.
The model presented herein is illustrative only and is intended to explore one possible approach to scaling carbon market infrastructure using blockchain-based systems. It does not represent a commitment to implement any specific architecture, mechanism, parameter, or economic outcome.
The Klima Protocol is expected to deploy a production system for on-chain carbon market infrastructure in or around February 2026. At that time, a separate implementation whitepaper will be released describing the deployed system, and the corresponding smart contract code will be made publicly available as open-source software.
This document should not be relied upon as a description of the final protocol, its operation, or its economics. It does not constitute an offer, solicitation, investment advice, or a representation regarding the legal, regulatory, or economic characteristics of any future deployment.

1 Prologue

Klima 2.0 is an autonomous, rules-based coordination protocol designed to support the retirement of carbon credits through transparent pricing, continuous execution, and onchain settlement.

It is not a financial product, investment vehicle, or asset management system, but a piece of market infrastructure that enables carbon supply and retirement demand to interact under predefined conditions.

The protocol operates through a dual-token architecture that facilitates coordination without discretionary control: **kVCM** functions as the internal unit of account and pricing reference for protocol-facilitated carbon retirement, while **K2** provides signalling inputs related to system capacity. Together, these tokens inform protocol parameters through deterministic smart-contract logic. This architecture enables the protocol to:

- price and intake eligible, tokenised carbon credits according to transparent, onchain rules;
- make acquired credits available exclusively for irreversible retirement;
- coordinate liquidity provision and participation incentives required for continuous operation.

Participant actions such as locking tokens, signalling preferences, or providing liquidity serve as non-custodial inputs into a coordination mechanism that adjusts protocol parameters within predefined bounds. These inputs do not confer ownership rights, redemption rights, or claims on protocol-held carbon, nor do they constitute discretionary management of assets.

The protocol consists of three interdependent functional layers:

- a carbon inventory layer that holds credits solely for the purpose of facilitating retirement;
- a governance layer that aggregates participant signals to inform pricing and intake parameters; and
- a liquidity layer that supports entry and exit from the system through external markets.

These layers are designed to operate together as a self-contained system, adjusting to observable supply and retirement demand without reliance on external oracles, manual intervention, or fee-extractive intermediaries.

Klima 2.0 abstracts complex carbon market interactions into a transparent and auditable execution framework, enabling participants to interact with carbon retirement infrastructure directly, programmatically, and on equal terms.

Any economic effects arising from protocol activity result from predefined rules and market interaction, rather than from asset ownership, portfolio management, or profit extraction.

2 Klima 2.0

KlimaDAO launched in 2021 on the Polygon blockchain as an early experiment in applying tokenisation and onchain liquidity to voluntary carbon markets. The initial design centred on the KLIMA token and a treasury-based mechanism intended to bootstrap liquidity and participation in a nascent onchain carbon ecosystem.

That first iteration played a meaningful role in demonstrating that carbon credits could be represented, transferred, and retired using blockchain infrastructure. It also catalysed the development of a broader ecosystem of tools and services, including integrations with multiple carbon registries, marketplaces and point-of-sale interfaces, APIs for third-party applications, and direct onchain issuance by project developers.

Over time, it became clear that the original architecture was not well suited to serving large-scale, enterprise carbon buyers or to supporting continuous, rules-based market operation without manual intervention. In particular, treasury-centric designs introduced complexity, opacity, and governance challenges that limited scalability and operational clarity.

Klima 2.0 is a ground-up redesign informed by these lessons. Rather than relying on treasury management or discretionary allocation, the new protocol is structured as neutral, non-extractive market infrastructure focused exclusively on facilitating carbon retirement through transparent pricing, programmatic settlement, and open participation.

The Klima 2.0 protocol replaces treasury-backed mechanisms with a rules-based coordination model that uses protocol-native tokens to parameterise pricing bounds, intake capacity, and participation incentives. Carbon credits handled by the protocol are acquired solely to fulfil retirement demand and are not held, traded, or managed for financial gain.

This shift reflects a deliberate move away from capital-centric designs toward infrastructure that prioritises auditability, predictability, and long-term operational resilience. Klima 2.0 is intended to function as a shared execution layer for carbon markets, enabling suppliers, buyers, and integrators to interact under predefined conditions without reliance on discretionary intermediaries.

2.1 Protocol Tokens

Klima 2.0 operates using two protocol-native tokens, **kVCM** and **K2**, which together enable rules-based coordination of pricing, capacity, and participation within the system. These tokens do not confer ownership rights, redemption rights, or claims on protocol-handled carbon, and do not represent investment interests.

kVCM functions as the internal unit of account and pricing reference for protocol-facilitated carbon retirement, while **K2** provides signalling inputs related to system capacity. Both tokens are used exclusively to parameterise protocol behaviour through deterministic smart-contract logic.

kVCM tokens set core allocation choices, whereas **K2** acts as the calibration mechanism for inventory development.

2.2 High-Level Architecture

Klima 2.0 is composed of three interdependent functional layers that together support continuous, non-discretionary operation:

1. **Carbon Inventory Layer**:
   - Accumulates carbon credits by minting **kVCM**.
   - Sells carbon certificates by burning **kVCM**.
   - Prices carbon based on the system's code.

   Carbon credits handled by the protocol cannot be withdrawn, transferred, or resold.

2. **Governance Layer**:
   - **kVCM** holders may **time-lock** their **kVCM** for a fixed time period and become eligible to select carbon assets for the inventory.
   - This action creates a **kVCM** Base Accrual curve, which is distributed to the time-locked holders. This is utilised to derive discount rates and governance weightings.

3. **Liquidity Layer**:
   - **kVCM** and **K2** holders are able to pair their tokens together, or in the case of **kVCM** with USDC, in order to generate liquidity fees.

- Staking the resulting liquidity provider tokens may generate a share of protocol incentives.
- Liquidity locked in the **kVCM/K2** liquidity pool participates in general governance alongside time-locked **kVCM** holders.

These layers operate together as a self-contained system that responds only to its own observable state, without reliance on external oracles or centralised intervention.

2.3 Incentives and Participation

The protocol issues incentives to participants who provide defined services necessary for system operation.

2.3.1 kVCM Incentives

kVCM incentives are continuously emitted to:

1. Time-locked **kVCM** ('**kVCM** Base Accrual').
2. User-locked **K2**.
3. Both **kVCM** and **K2** liquidity providers.

2.3.2 K2 Incentives

The supply of K2 is allocated to stakeholders at various rates, depending on overall system balances:

1. Time-locked **kVCM**.
2. User-locked **K2**.
3. Both **kVCM** and **K2** liquidity providers.

2.4 Carbon Inventory

The protocol's carbon inventory layer accumulates and distributes carbon. It is driven by parameters determined by its rules-based smart contracts, and token holder actions.

Carbon credits are acquired from suppliers, and consumed by offset buyers. Carbon credits are grouped by pre-defined classifications called **carbon classes**. The protocol does not sell carbon credits.

Aggregate token holder allocations collectively set the parameters for the pricing of **each class** by defining:

- Inventory weighting.
- Capacity.

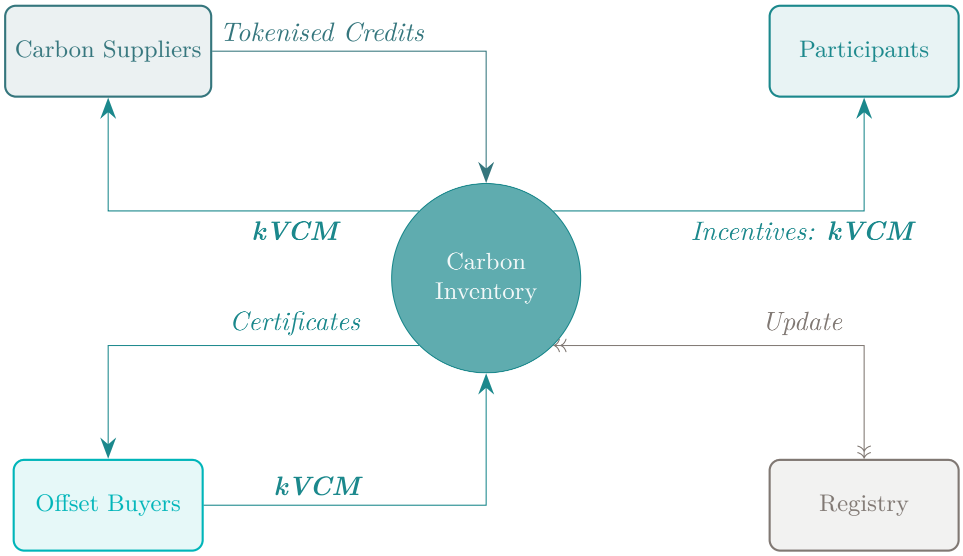


Figure 1: Klima 2.0 Carbon Inventory.

Additional **global** parameters are also determined by the aggregate allocations, including the **kVCM** incentive curve.

There are no oracles or external inputs required for Klima 2.0 as it is fully autonomous and responds to its own native state of token balances.

The protocol does not facilitate the trading of unretired carbon credits and does not engage in discretionary allocation, resale, or optimisation of carbon inventory.

2.5 Tokens

Locking or staking the protocol's tokens allows participants to signal pricing preferences and capacity parameters within the protocol. However, holding or locking the tokens does not represent risk ownership, profit participation, or exposure to carbon price movements. Participants may receive protocol incentives for performing defined coordination functions, distributed according to transparent, rules-based mechanisms.

Together, **kVCM** and **K2** enable the protocol to operate as neutral, non-extractive infrastructure, coordinating participation and execution without discretionary management.

2.5.1 kVCM

kVCM is the protocol's primary utility token. Its supply is not capped: it grows when new carbon is supplied to the protocol, and contracts when it is retired.

- When **time-locked**:
  - It *may* vote for carbon classes for inventory weighting.
  - It receives **kVCM** base accrual and **K2** incentives.
  - In aggregate, it determines the rate of incentive issuance.

- **Transactional** usage:
  - **Mint**: when suppliers deliver carbon to the protocol.
  - **Burn**: when credits are retired from the protocol.
- When **staked** in liquidity pools it is also eligible for incentives, based on the position's relative share.

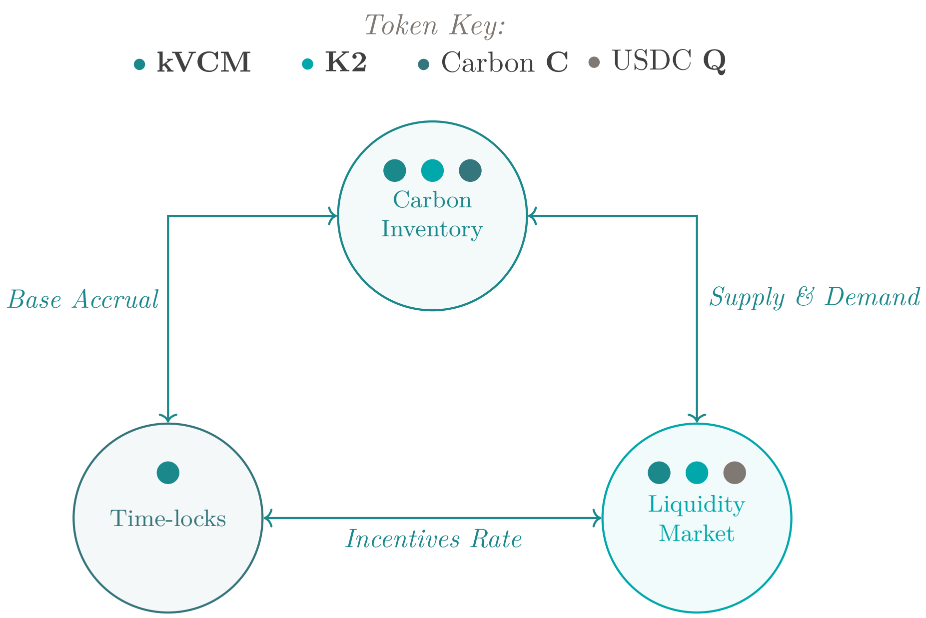


Figure 2: Token utility.

2.5.2 K2

K2 is a fixed-supply token distributed programmatically over time.

- When **user-locked**:
  - It *may* vote for carbon classes to reduce the difference between execution terms on carbon intake and retirements.
  - It receives **kVCM** and **K2** incentives.
  - In aggregate, it influences the rates of incentive issuance.
- When **staked** in the kVCM/K2 liquidity pool it is also eligible for incentives, based on the position's relative share.

2.5.3 Utility Functions

The **kVCM** token has two utility functions which are not independent:

1. **Time lock**: The **kVCM** token is locked for a specific period of time which determines a kVCM 'base accrual' rate. This cannot be amended.

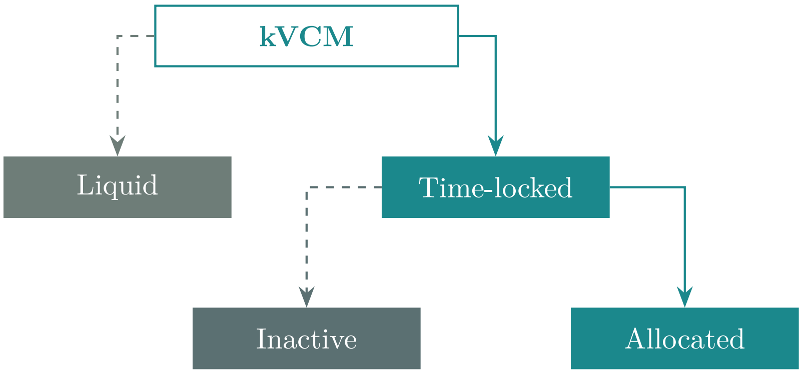


Figure 3: **kVCM** utility functions.

2. **Price allocation**: Collective selection of carbon classes by **kVCM** allocations determines the **real-time** execution ratio for carbon intake and retirements, in kVCM terms. This selection can be amended and withdrawn at any time to allow modulation of protocol parameters.

The **K2** token also has two utility functions:

1. **User lock**: The **K2** token remains locked for at least 24 hours.
2. **Capacity allocation**: Collective selection of carbon classes by **K2** allocations determines the rate of issuance or retirement of **kVCM** for the specified carbon class. More capacity allocations on a given carbon class reduce the impact that new transactions have on the execution ratio created by price allocations.

Both tokens facilitate the carbon market to function efficiently, with the **kVCM** token responsible for setting execution ratios, and the **K2** token modulating capacity.

2.6 Token Initialisation

There is an initial issuance of tokens at the genesis of Klima 2.0. All future emissions are distributed autonomously via incentives.

Token	Supply	Notes
kVCM	20 million	• Supply expands and contracts programmatically in response to carbon intake and retirement activity. • A portion of the initial supply is allocated to existing KLIMA holders.
K2	100 million	• Fixed supply. • Distributed programatically over time, with a portion allocated to existing KLIMA holders.

Table 1: Token Summary

kVCM is issued when carbon credits are supplied to the protocol for the purpose of facilitating future retirement, and permanently removed from circulation when carbon is retired. This mint-and-burn process serves as an internal accounting mechanism and does not represent asset ownership or claims on protocol-held carbon.

2.7 Participants

1. **Carbon Suppliers & Retirees**

   Participants may supply or retire eligible, tokenised carbon credits to the protocol at quoted execution rates. Supplied credits are handled solely for retirement and cannot be withdrawn, transferred, resold or otherwise arbitraged.

   Carbon inventory: Real-time execution terms for suppliers are continuously updated based on protocol token balances.

2. **Liquidity Providers**

   Participants may provide liquidity in supported token pairs to facilitate entry and exit from the system. Liquidity provision supports continuous execution and is incentivised according to predefined protocol rules.

   Staked liquidity: Provides continuous incentives for those contributing liquidity to the system.

3. **Governance Users**

   Participants who wish to affect carbon price and capacity may do so by allocating **kVCM** and **K2** tokens.

   Time locks & user locks: Provide continuous incentives for those contributing activities that coordinate the protocol.

2.8 Protocol Design Principles

1. **Infrastructure, Not Extraction**:

   Klima 2.0 is designed as shared market infrastructure rather than an extractive financial product. The protocol does not charge fees, take spreads, or operate profit-taking mechanisms for any sponsor, foundation, or investor. All protocol behaviour is rules-based and applies uniformly to all participants, with no privileged economic positions or revenue capture layers.

   Design intent: Reduce opaque intermediation and hidden margins common in carbon markets, not replace them with a new rent-seeking intermediary.

2. **Consumption-only Carbon Access**:

   Carbon credits handled by the protocol are not exposed for resale, speculation, or secondary trading. Once accepted by the protocol, credits may only be accessed for irreversible retirement through protocol-defined processes.

   Design intent: Align the system with carbon's end use (retirement), rather than treating credits as financial instruments.

3. **Coordination Through Signalling**:

   Protocol tokens do not represent ownership of carbon, claims on protocol-held assets, or entitlement to surplus value. Instead, tokens function as signalling and coordination inputs that influence protocol parameters (such as execution conditions and capacity) within predefined bounds.

   Design intent: Enable decentralised coordination in a complex and competitive environment.

4. **Autonomous, Rules-based Operation**

   All protocol behaviour — including pricing logic, intake conditions, retirement execution, and incentive distribution — is governed by deterministic smart contracts. Once deployed, the system operates autonomously and does not rely on discretionary decisions by any individual, committee, or organisation.

   Design intent: Build a trustless, auditable system, that is not based on subjective, opaque intervention.

5. **Equal Access and Uniform Treatment**

   All participants interact with the protocol on identical terms. There are no side agreements, preferential execution paths, differentiated rights, or bespoke economic arrangements. Protocol rules apply uniformly to all users, including the protocol's creators and affiliated entities.

   Design intent: Ensure credibility, neutrality, and resistance to capture.

6. **Market-driven Outcomes, Not Managed returns**

   Any economic effects associated with protocol participation arise solely from predefined rules and participant interaction with the system. The protocol does not manage assets on behalf of users, target returns, or seek to optimise outcomes for any class of participant.

   Design intent: Enable transparent market coordination without positioning the protocol as an asset manager or investment vehicle

3 Core Protocol Layers

From this section we refer to **kVCM** tokens as **A**, **K2** tokens as **G**, USDC tokens as **Q**, carbon credits as **C**, and carbon offset certificates as **C***.

Three layers enable the Klima Protocol to find equilibrium through continuous dynamic feedback loops and overall system balances (supply, demand, token holder positions). There is no centralised management entity with discretionary powers, or fees that can be turned on.

1. **Time-locking mechanism**: **A** token holders can time-lock their tokens until a set date to define system parameters and to have the ability to select carbon classes for system weighting.

   - The collective locks influence the **A** rewards, as well as the real-time execution price for carbon credit acquisitions or retirements.

2. **Carbon inventory layer**: the protocol swaps **A** for carbon credits **C** (in) or carbon offset certificates **C*** (out).

   - Both allocations of time-locked **A** tokens and user-locked **G** tokens are used in the protocol: allocations of **A** determine the pricing of carbon, and allocations of **G** determine capacity.

3. **Liquidity layer**: External liquidity pools enable conversion between **kVCM** and supported settlement assets. Liquidity provision supports system availability and users may receive incentivises through the transparent, rule-based approach.

   - $\overline{\mathbf{AG}}$ liquidity pool: Native token swap **A** and **G**.

   - $\overline{\mathbf{AQ}}$ liquidity pool: The asset token **A** with USDC **Q**.

The Klima system enables each participant to contribute to various aspects of the model, in the interests of their own utility. This, in conjunction with the autonomous model, enables the protocol to fulfill its mandate of facilitating retirement demand into the carbon markets.

3.1 Time-locking Mechanics

Time-locking **A** tokens represents a non-custodial commitment to protocol participation for a fixed duration. Lock durations are standardised at 90 days increments and expire on a rolling schedule. There are always 40 durations, extending out to approximately 10 years.

- **Discount curve**: Aggregate time-locking determines the shape of the discount curve of the **A** token with regards to execution prices.
- **Incentives**: Time-locked **A** tokens may receive incentives, with a rate determined by the base accrual. The base accrual is calculated daily based on user positions, via the 'time-weighted incentive curve'.
- **Locks**: Time-locked tokens and any associated **A** incentives are released only upon time-lock expiration. Early exit is not possible.

G tokens are <u>not</u> involved in the time-locking mechanics. The discount curve is agnostic to carbon class although only time-locked **A** token holders can allocate their token to carbon classes for portfolio pricing.

3.1.1 Time-weighted Incentive Curve

Defining:

- S: Total time-locked **A** tokens expressed as a proportion of the outstanding supply of **A**.
- S_t: Total **A** tokens time-locked in bucket t, expressed as a proportion of the outstanding supply of **A**, where $\sum S_t = S$, and t is the index of standard durations $t \in \{1, 2, 3, \ldots, 40\}$.
- E_t: Duration expressed in years.

Calculating curve parameters D and C:

$$D = \frac{1}{S} \sum_{t=1}^{40} S_t \, E_t \tag{1}$$

$$C = \frac{1}{S} \sum_{t=1}^{40} S_t \, E_t^2 \tag{2}$$

The shape of the time-weighted incentive curve is produced:

$$\gamma_t = \max\left(\frac{E_t}{D} - \frac{E_t^2}{2\,C}, 0\right) \tag{3}$$

Normalising γ_t to $\hat{\gamma}_t$:

$$\hat{\gamma}_t = \frac{\gamma_t}{\sum_{t=1}^{40} \gamma_t} \tag{4}$$

With the cumulative sum of the normalised values expressed as Γ_t:

$$\Gamma_t = \sum_{i=1}^{t} \hat{\gamma}_i \quad \text{for } t = 1, \ldots, 40 \tag{5}$$

The time-weighted incentive curve Z_t is solved:

$$Z_t = (1 - S)\,\frac{\Gamma_t}{E_t} \tag{6}$$

Whereupon, the discount rate B_t that forms the discount curve is derived:

$$B_t = \exp(-Z_t\, E_t) \tag{7}$$

The incentives due on time-locked **A** tokens are calculated daily and added to the locked principal, hence the daily accrual for each duration is calculated:

$$Y_t = \exp\left(\frac{Z_t}{365}\right) - 1 \tag{8}$$

Hence, any time-locked **A** stake S_t will increase by a base accrual ΔS_t:

$$\Delta S_t = S_t\, Y_t \tag{9}$$

With the total **A** tokens created on a daily basis for time-locked inflation as

$$R = \sum_{t=1}^{40} \Delta S_t \tag{10}$$

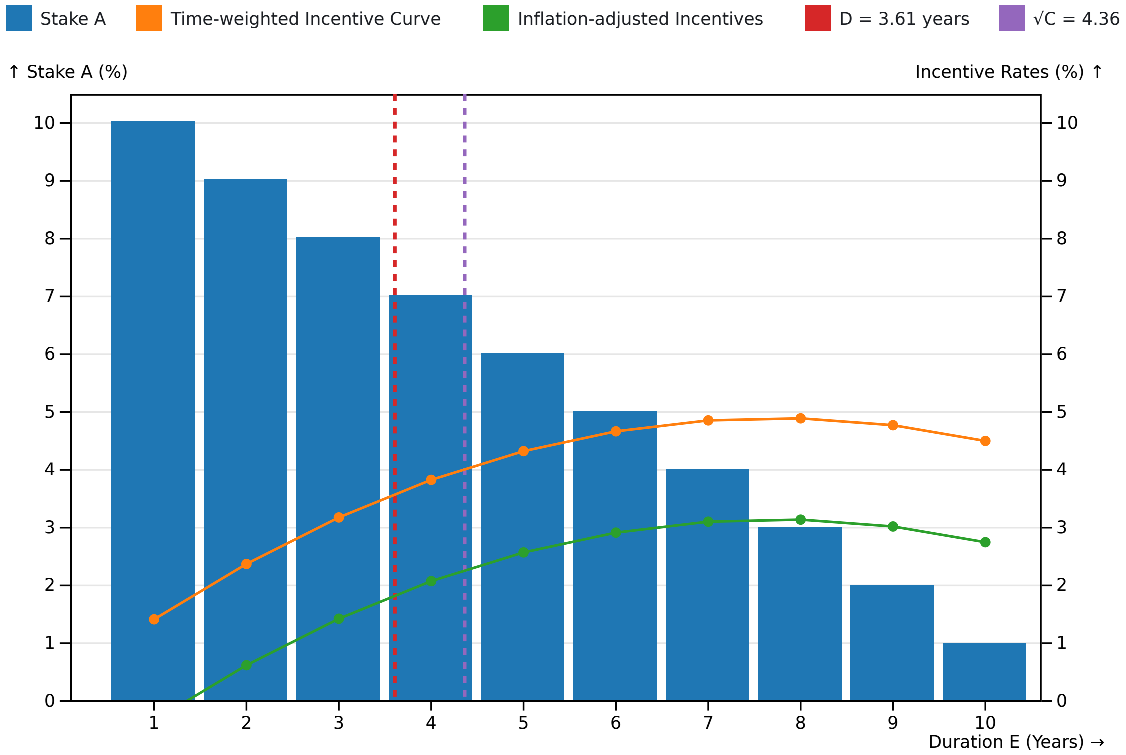
For visualising the sensitivity of overall **A** inflation rates with respect to staking and duration, Figure 5 assumes a single duration over the staking range to provide an approximation of inflation $\Delta S \approx Z\, S$.

3.1.2 Protocol Governance Signals

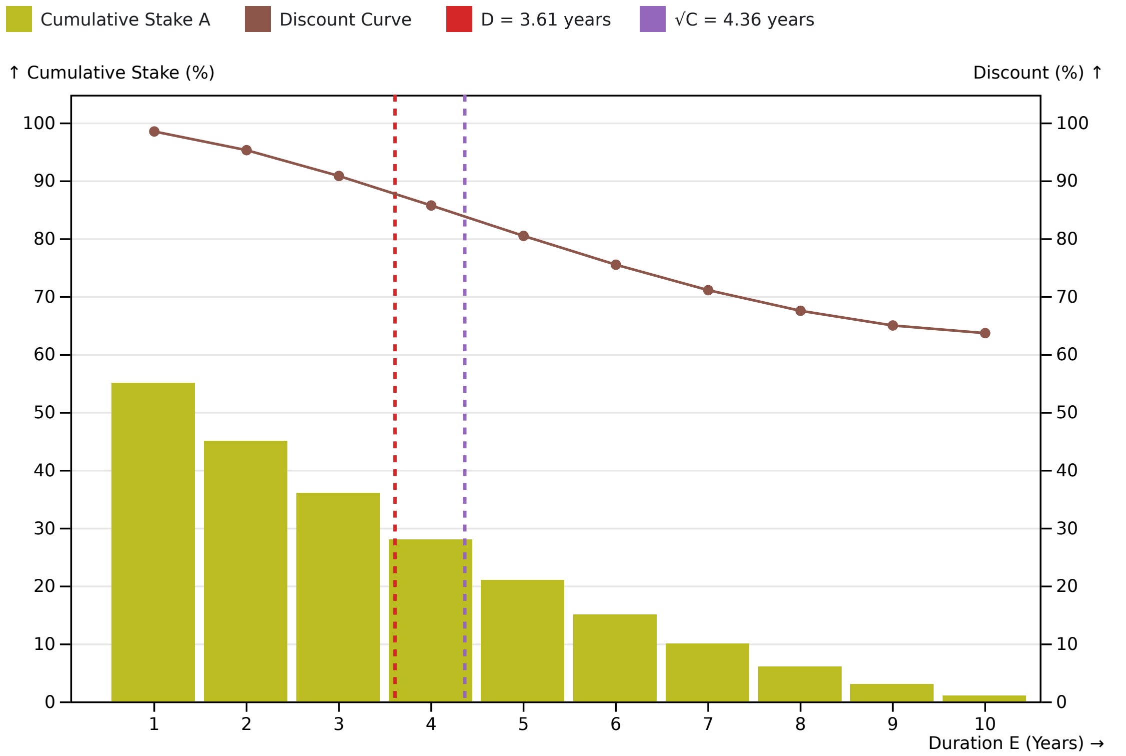
Protocol governance signals can be derived from two participation cohorts:

1. Time-locked **A** tokens: S_t
2. Staked liquidity in the **A**-**G** pair $\overline{\mathbf{AG}}$ (see Section 3.3), defined here as A_{Gt}, representing the quantity of **A** tokens held in the liquidity pool expressed as a proportion of circulating supply.

Voting power is allocated by time and applied to the respective balance of **A**:



(a) Time-weighted incentives (Total Stake = 55.00%, Inflation = 1.75%).



(b) Discount rates.

Figure 4: Example of time-locked incentives.

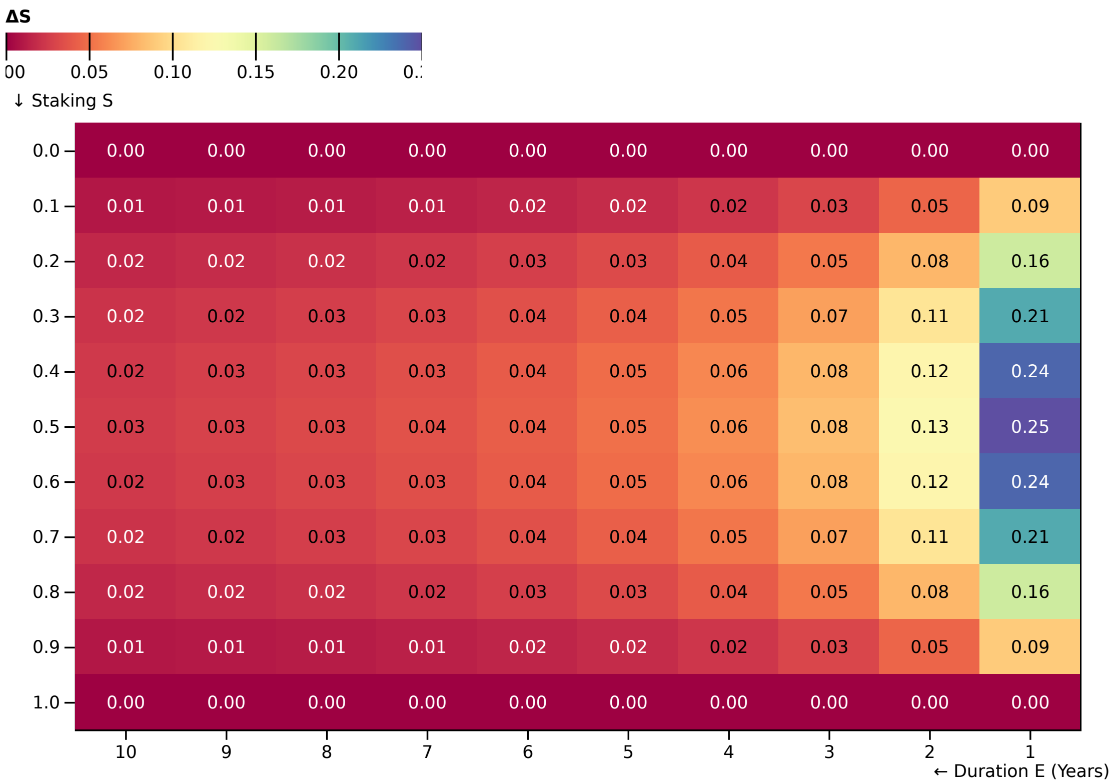


Figure 5: **A** inflation rate from base accrual ΔS.

1. Initial voting weights for time-locked **A** tokens v_t:

$$v_t = Z_t\, S_t \tag{11}$$

2. Initial voting weights for staked liquidity w_t:

$$w_t = Z_t\, A_{Gt} \tag{12}$$

3. Final voting weights for time-locked **A** tokens V_t:

$$V_t = \frac{v_t}{\sum_{j=1}^{40}(v_j + 2w_j)} \tag{13}$$

4. Final voting weights for staked liquidity W_t:

$$W_t = \frac{w_t}{\sum_{j=1}^{40}\left(\frac{1}{2}v_j + w_j\right)} \tag{14}$$

3.2 Carbon Inventory

The Portfolio Manager's role of swapping **A** for carbon is managed through a set of smart contracts driven by allocation choices from the token system, the balances of assets held, and the discount rates generated by the Time-Locked Market.

The combined allocations of **A** and **G** tokens creates a dynamic pricing matrix by carbon class and by time, enabling spot and forward trading of carbon.

3.2.1 Purchase Carbon

*User swaps carbon credits for **A** tokens.*

3.2.1.1 Existing Carbon in the Portfolio

Carbon classes $i \in \{1, 2, 3, \ldots, n\}$ are whitelisted through governance by time-locked **A** token and staked $\overline{\mathbf{AG}}$ liquidity providers (see Section 3.1.2).

For carbon pricing, both **A** tokens and **G** tokens may be allocated to specific carbon classes i and these are independent allocations between the two-token systems.

For a carbon class quantity to be sold to the Automated Asset Manager, it must have a strictly positive quantity of **A** tokens allocated to that carbon class, otherwise there is no price, and the carbon cannot be sold.

Defining:

- C_i: Total tonnes of carbon class i currently held in the portfolio.
- A_i: **A** tokens allocated to carbon class i expressed as a proportion of the outstanding supply of **A** tokens, where $\sum A_i = A$.
- G_i: **G** tokens allocated to carbon class i expressed as a proportion of the outstanding supply of **G** Tokens.
- C_{it}: The quantity of carbon class i held in the Automated Asset Manager deliverable per maturity t where C_{i0} reflects the liquid quantity.

In order to determine the present-value quantity of carbon, $\bar{C}_i$, we apply the discount curve from Equation 7 to the liquidity schedule and sum the discounted holdings:

$$\bar{C}_i = C_{i0} + \sum_{t=1}^{40} B_t \, C_{it} \tag{15}$$

Similarly, taking ΔC_{it} as the quantity of carbon i to be sold with a specific maturity index t:

$$\Delta\bar{C}_i = \Delta C_{i0} + \sum_{t=1}^{40} B_t \, \Delta C_{it} \tag{16}$$

Once standardised by the discount curve, trades can be aggregated in the same class for the defined trade or auction period.

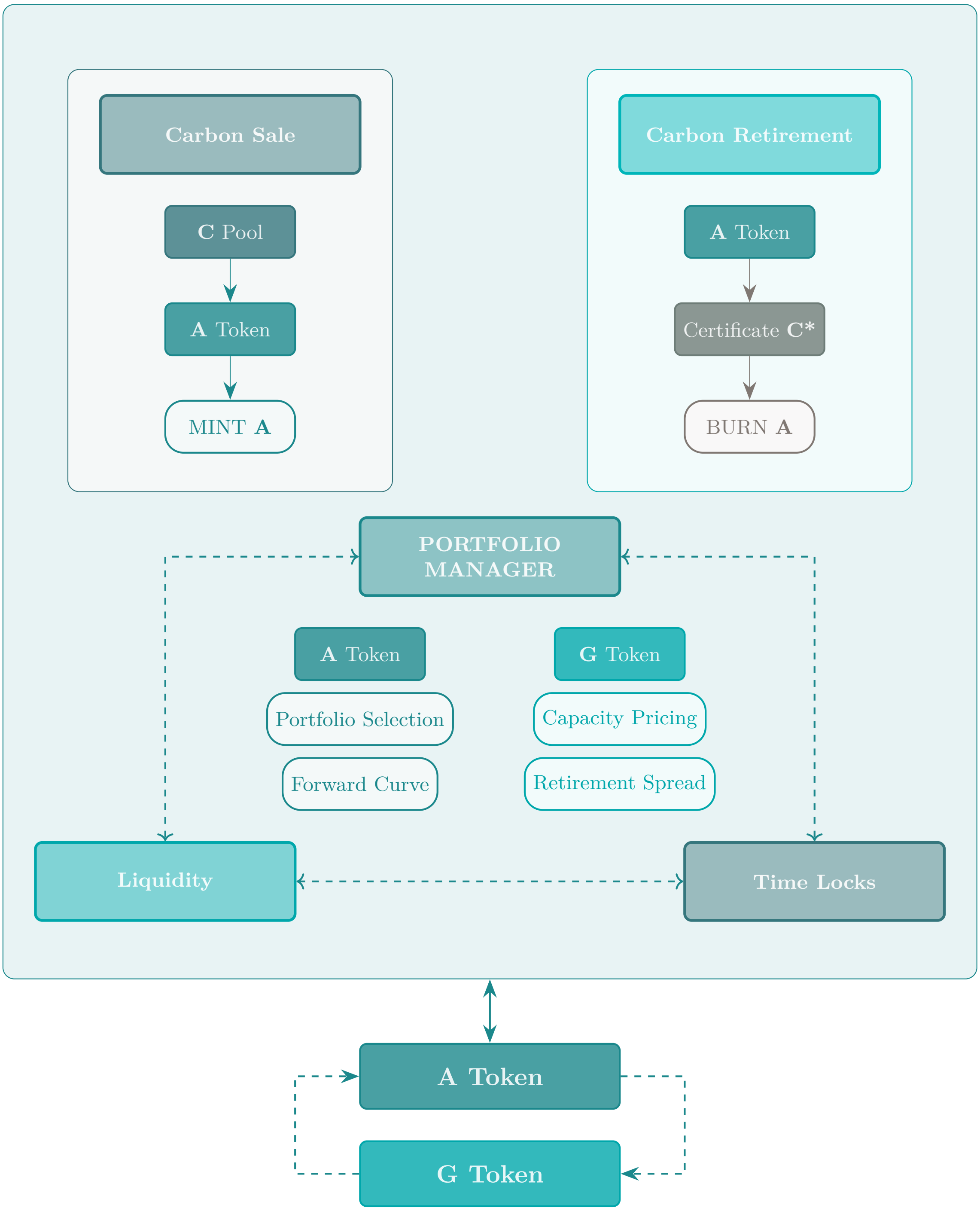


Figure 6: Klima 2.0 Portfolio Manager.

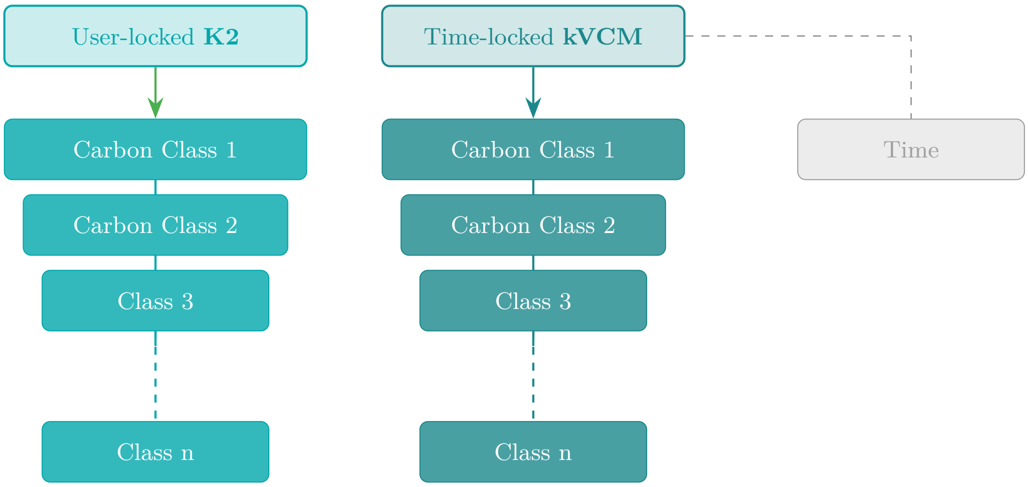


Figure 7: Token staking class structure.

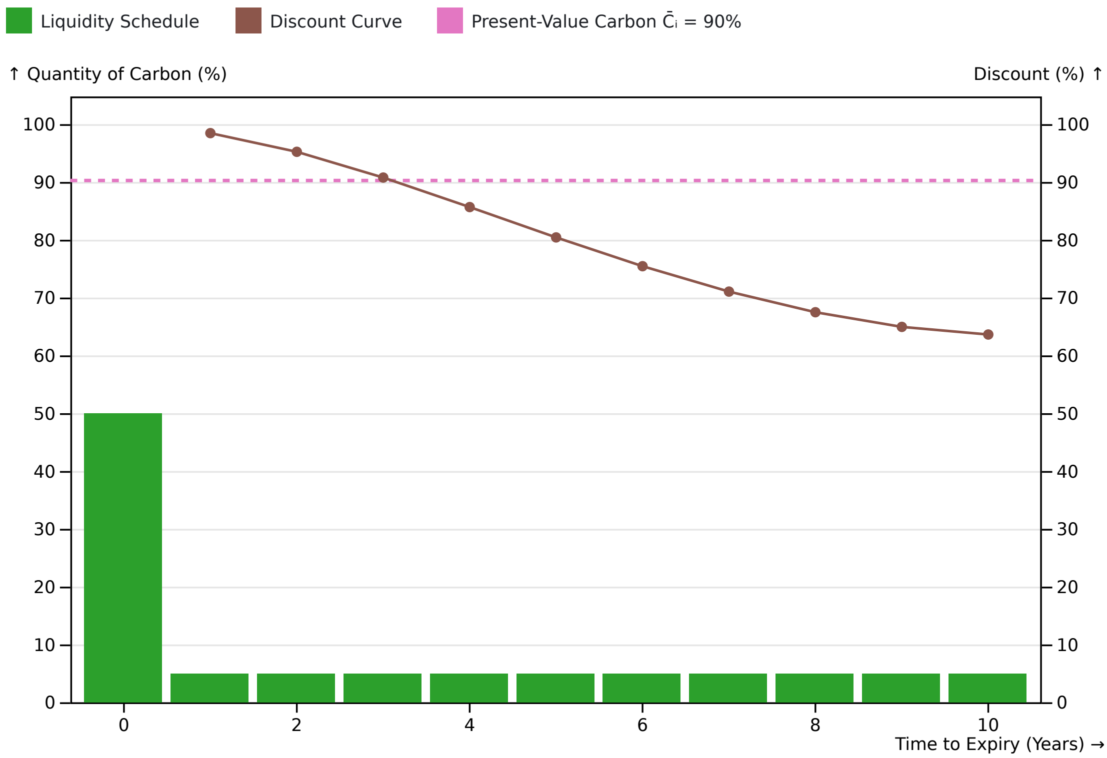


Figure 8: Carbon held in the portfolio.

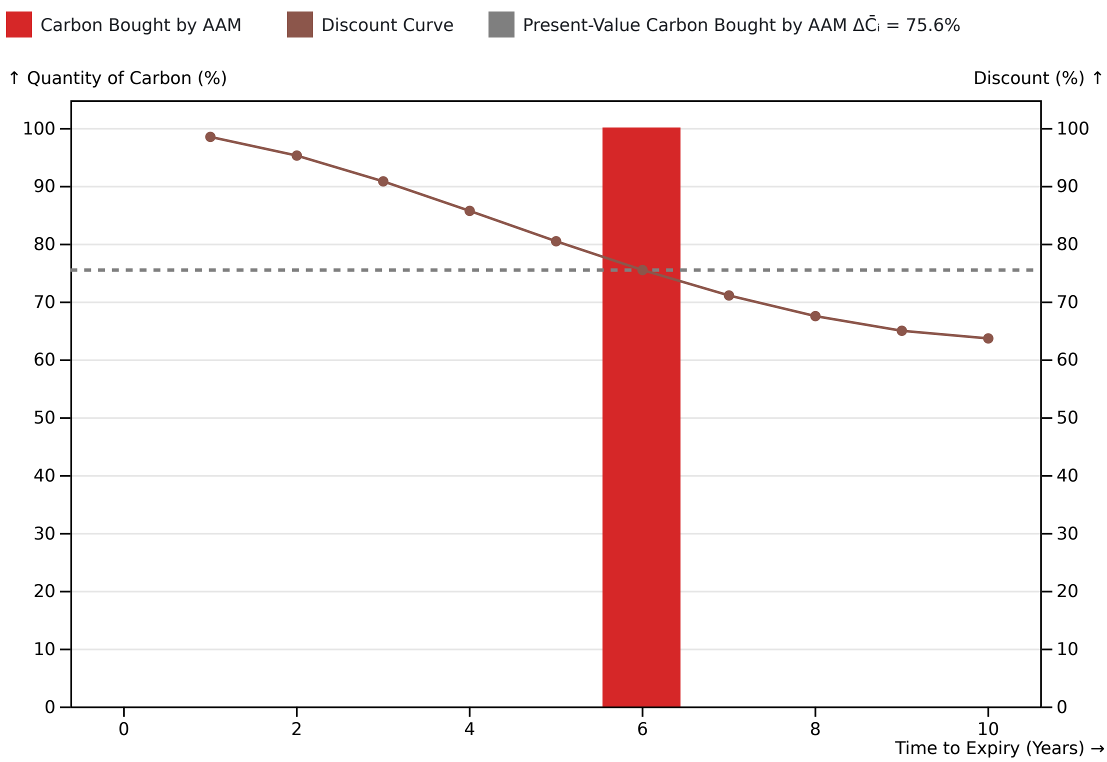


Figure 9: Carbon bought by the Portfolio Manager.

Where $\Delta\bar{C}_i$ is expressed as the relative increment to its respective pool balance, the amount of **A** tokens issued to pay for carbon, ΔA, expressed as a proportion of current supply, is determined as:

$$\ln(1 + \Delta A) = \left(A_i - \frac{A_i^2\,(1 - G_i)^2}{2}\right)\ln(1 + \Delta\bar{C}_i) \tag{17}$$

Denoting the expression on the right hand side of Equation 17 as RHS:

$$\Delta A = \exp(\mathsf{RHS}) - 1 \tag{18}$$

Finally, ΔA is applied to the outstanding supply of **A** to solve for token quantities.

Figure 10 illustrates the **G** token's capacity to maintain the initial portfolio pricing of the **A** token. The data has been normalised in Figure 11 to $\Delta\bar{C}_i\,A_i$.

Noting that the sensitivity to G_i increases as A_i increases and the effects become more pronounced as $\Delta\bar{C}_i$ increases.

3.2.1.2 Zero Carbon Scenario

There are circumstances when there is zero carbon held in the portfolio for a particular class, i.e. $C_i = 0$, which invalidates the calculation of $\Delta\bar{C}_i$ and a different approach is required.

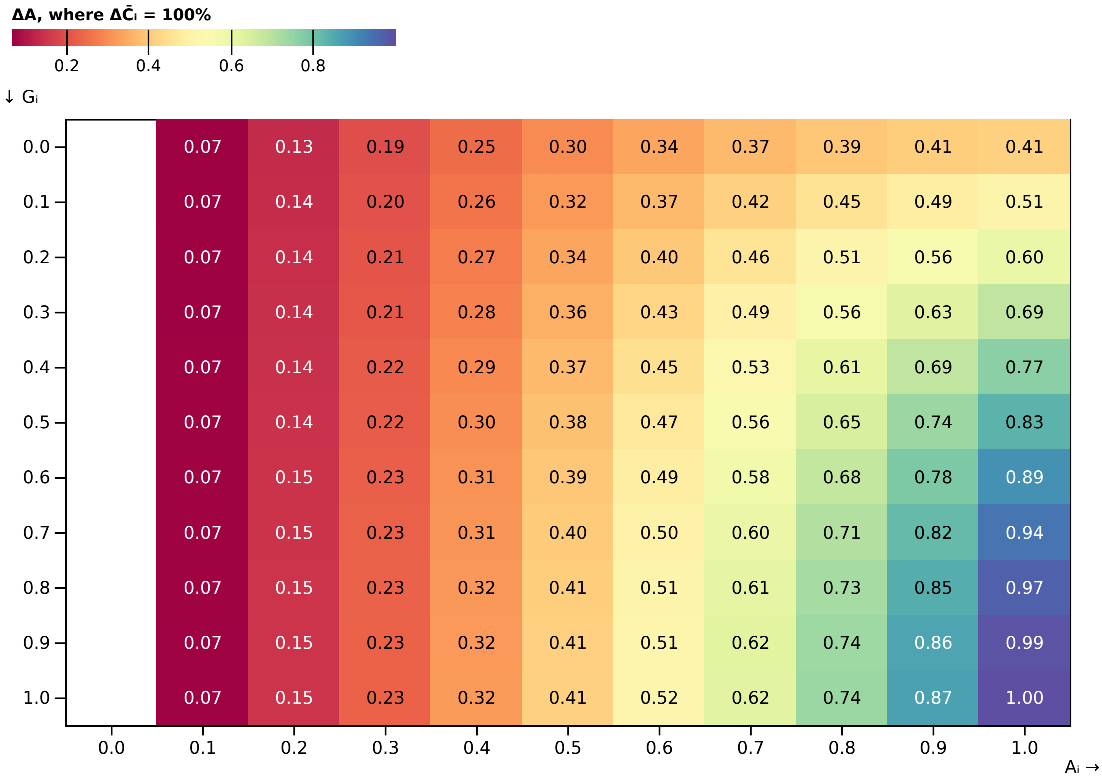


Figure 10: **A** price curves (ΔA).

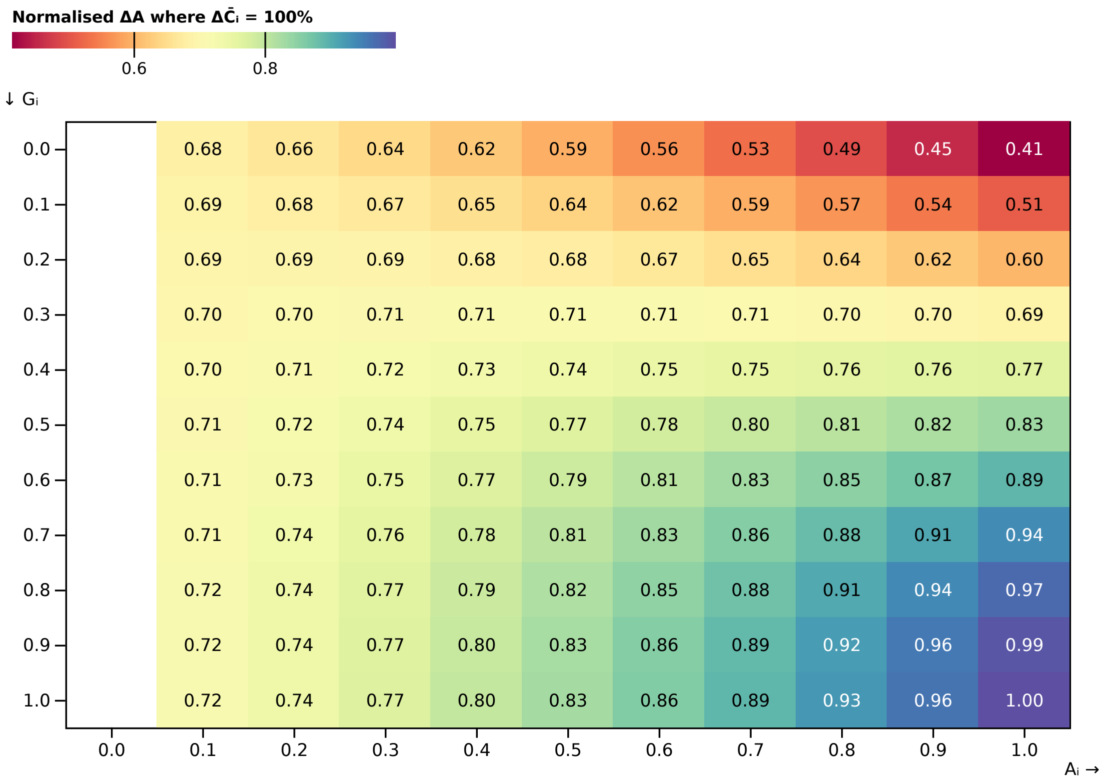


Figure 11: Normalised **A** price curves.

Taking $\Delta\bar{C}_\emptyset$ as the tonnes of carbon tokens (implying an existing balance of 1 tonne), adjusted for forward discounting, to be sold for any carbon class that has a strictly positive $\mathbf{A}$ allocation $A_\emptyset$, together with $\mathbf{G}$ allocation $G_\emptyset$:

$$\Delta A = \frac{\Delta\bar{C}_\emptyset}{1+\Delta\bar{C}_\emptyset}\left(A_\emptyset - \frac{A_\emptyset^2(1-G_\emptyset)^2}{2}\right)^2 \tag{19}$$

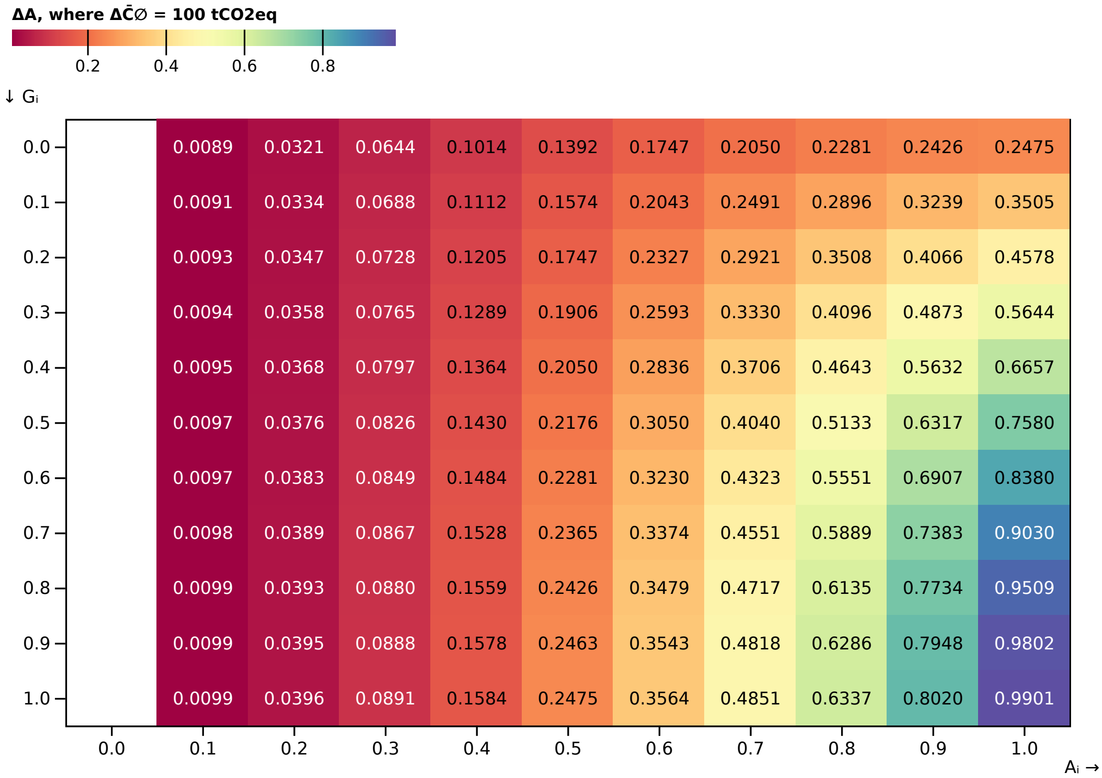


Figure 12: $\mathbf{A}$ price curves (ΔA) in the zero carbon scenario.

3.2.2 Sell Offset Certificates

User swaps $\boldsymbol{A}$ tokens for carbon offset certificates.

3.2.2.1 Weighted Carbon Class

For retiring carbon that is *weighted*, that is for which there is a strictly positive $\mathbf{A}$ token allocation, an $\mathbf{A}$ token holder can extract the carbon class offset certificate of their choice C_i but the available pool is only the liquid carbon balance, namely the element C_{i0}:

$$\ln(1+\Delta C_i) = \frac{-\ln(1+\Delta A)}{A_i + \frac{1}{2}A_i^2\,(1-G_i)^2} \tag{20}$$

As before, denoting the expression on the right hand side of Equation 20 as RHS:

Figure 13: Normalised **A** price curves in the zero carbon scenario.

$$\Delta C_i = \exp(\mathsf{RHS}) - 1 \tag{21}$$

Figure 14 shows the cost of carbon increasing with A_i and decreasing on G_i.

3.2.2.2 Unweighted Carbon Class

An offset certificate for a carbon class with a zero **A** allocation cannot be extracted from the portfolio by swapping in **A** tokens.

3.2.2.3 Liquidation: $\Delta A = 1$

In the event that 100% of **A** tokens are placed into the burn mechanism for carbon offset certificates, the balances of all carbon held in the portfolio post-trade are distributed to all **G** token holders.

Figure 15 below shows the spread captured on a 'round trip' by the system where ε is the proportion retained:

Figure 16 shows the component 'spread' contributions on a carbon sale and purchase round trip of a carbon offset certificate.

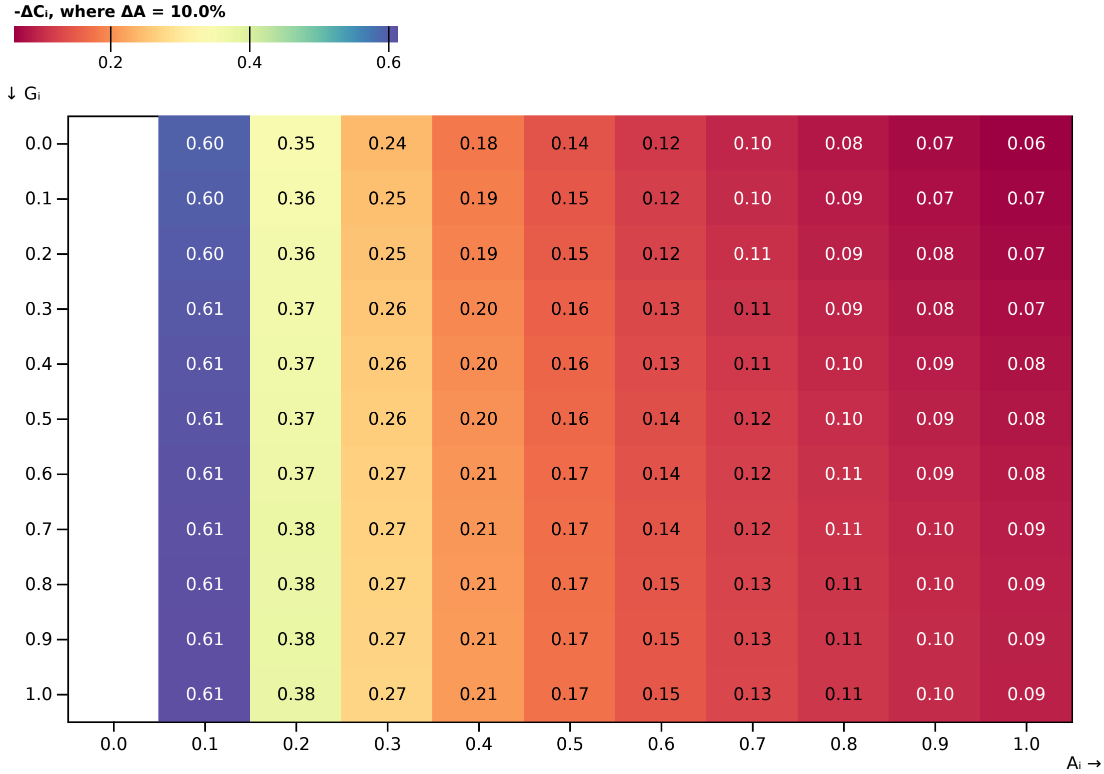


Figure 14: Proportion of carbon retired.

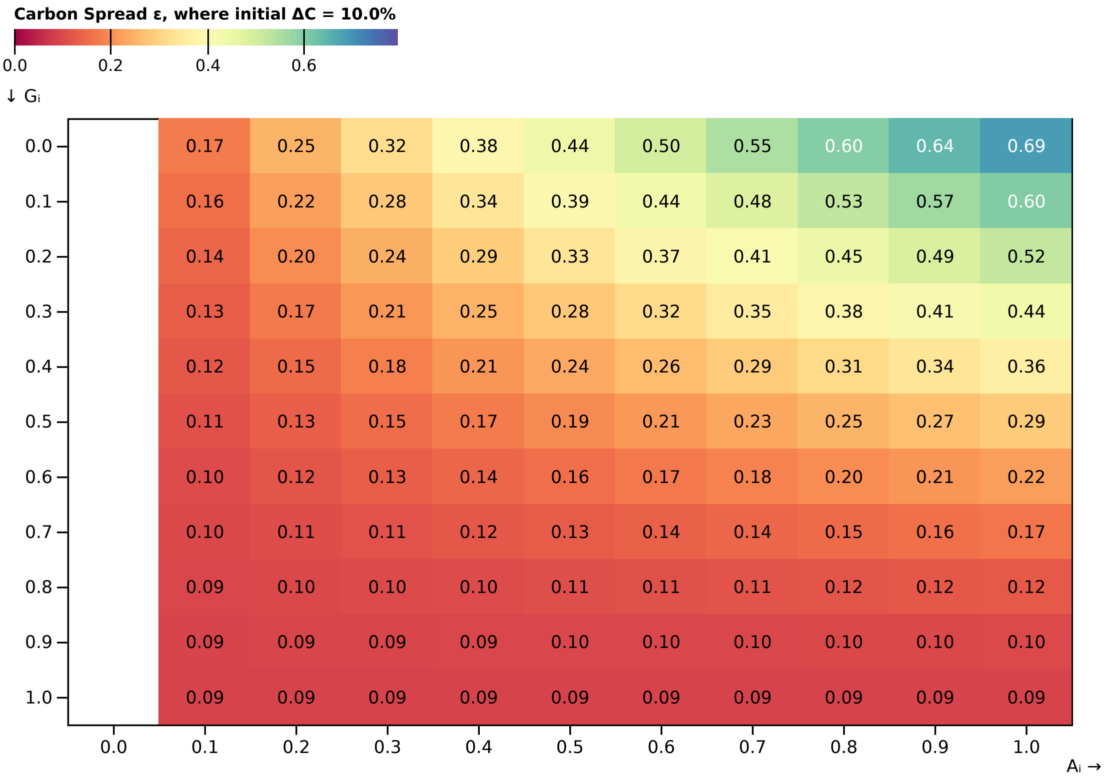
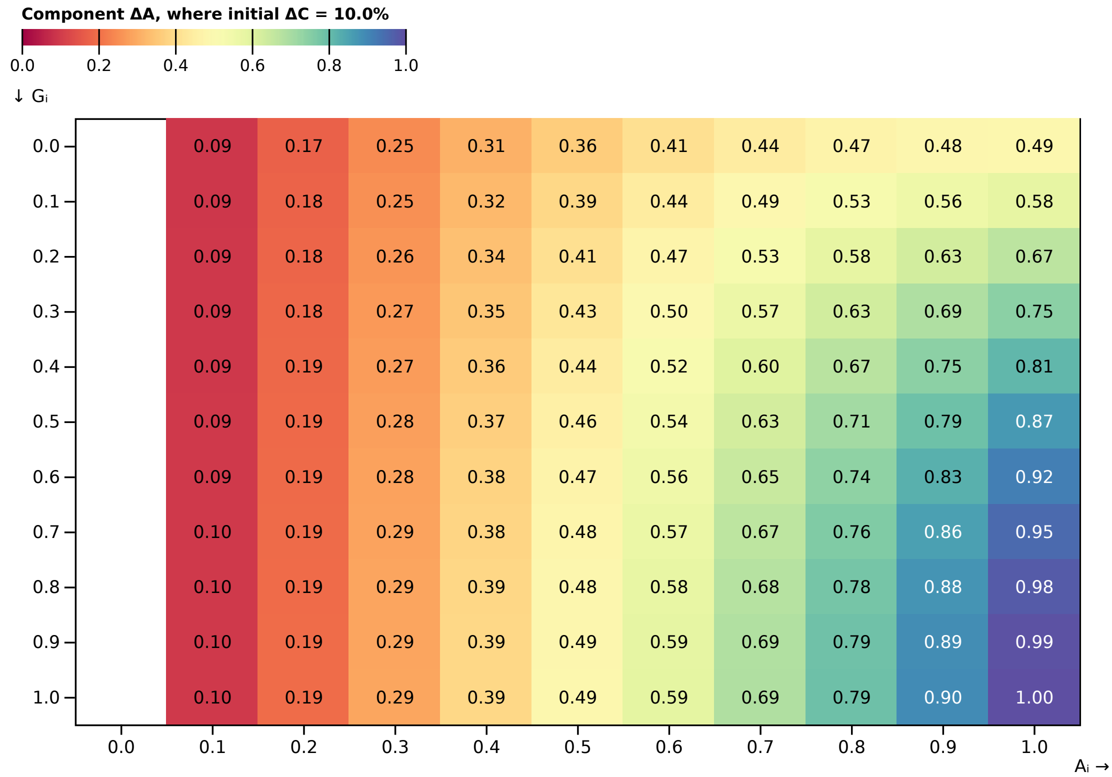
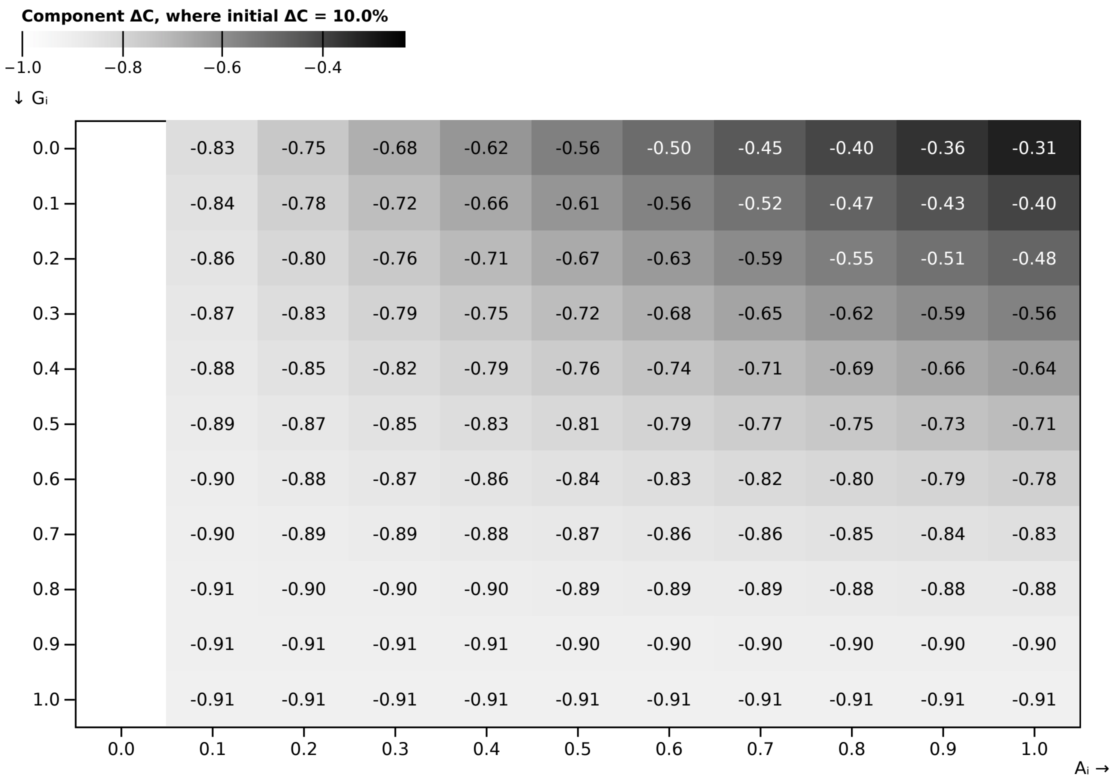


Figure 15: Carbon ‘spread’.



(a) Carbon ‘spread’ component ΔA.



(b) Carbon ‘spread’ component ΔC.

Figure 16: Carbon ‘spread’ components.

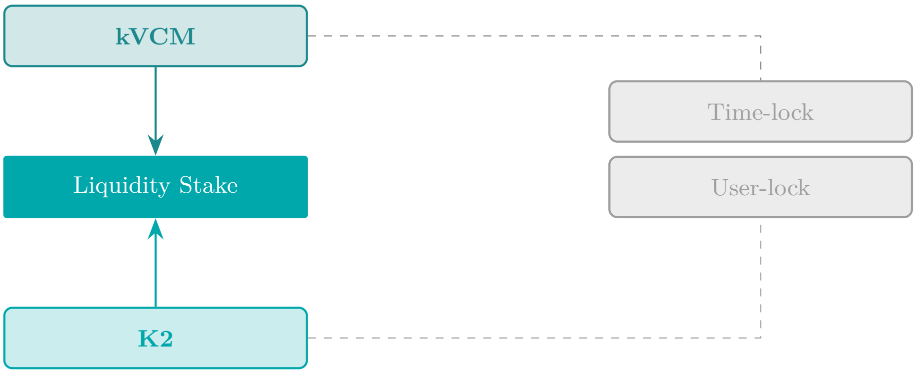


Figure 17: Token liquidity and pricing structure.

3.3 Liquidity Markets

Both **A** and **G** tokens can be used for providing liquidity.

There are two core liquidity pools:

1. An AAM 50:50 pairing of **A** and **G** tokens: pool $\overline{\mathbf{AG}}$.
2. A hard currency USDC denoted as **Q** paired with **A**: pool $\overline{\mathbf{AQ}}$.

3.3.1 Liquidity Fees

The $\overline{\mathbf{AQ}}$ pool will have its own set of fees in the normal way.[1]

The $\overline{\mathbf{AG}}$ pool has different economics as the assets are highly correlated since they represent the same economy. For this reason, the fees are extremely low.

By staking liquidity (liquidity provider tokens) to the **standard maturities**, both pools may receive a distribution of **A** tokens determined from the Risk Premium calculation below. This is an additional primary issuance to the Base Accrual already discussed.

3.3.2 Risk Premium: Beta Determination

We can consider the Time-Locked Market yield as the system's *risk-free* rate. In addition to this mechanism, a *risky* spread is determined that is ultimately paid to the staked liquidity providers of the **A** and **G** tokens as compensation for the risk levels assumed.

As we have seen, the **G** token has an impact on risk-pricing of **A**. As **G** staking increases, the relationship between the carbon class selected under G_i and the portfolio token **A** strengthens. We can consider G_i staking as an estimate of residual or idiosyncratic risk in the carbon class and this allows us to calculate a portfolio beta β from the implied betas of each carbon class i.

$$\beta = \sqrt{\sum_{i=1}^{n} A_i - A_i\,(1 - G_i)^2} \tag{22}$$

[1]Note the development of liquidity pool pricing functionality may be applicable.

The portfolio β determines a yield factor for the liquidity pools of $\mathbf{A}$ to compensate for the implied risk levels.

For intuition, the map in Figure 18 shows the various outputs of the function per carbon class.

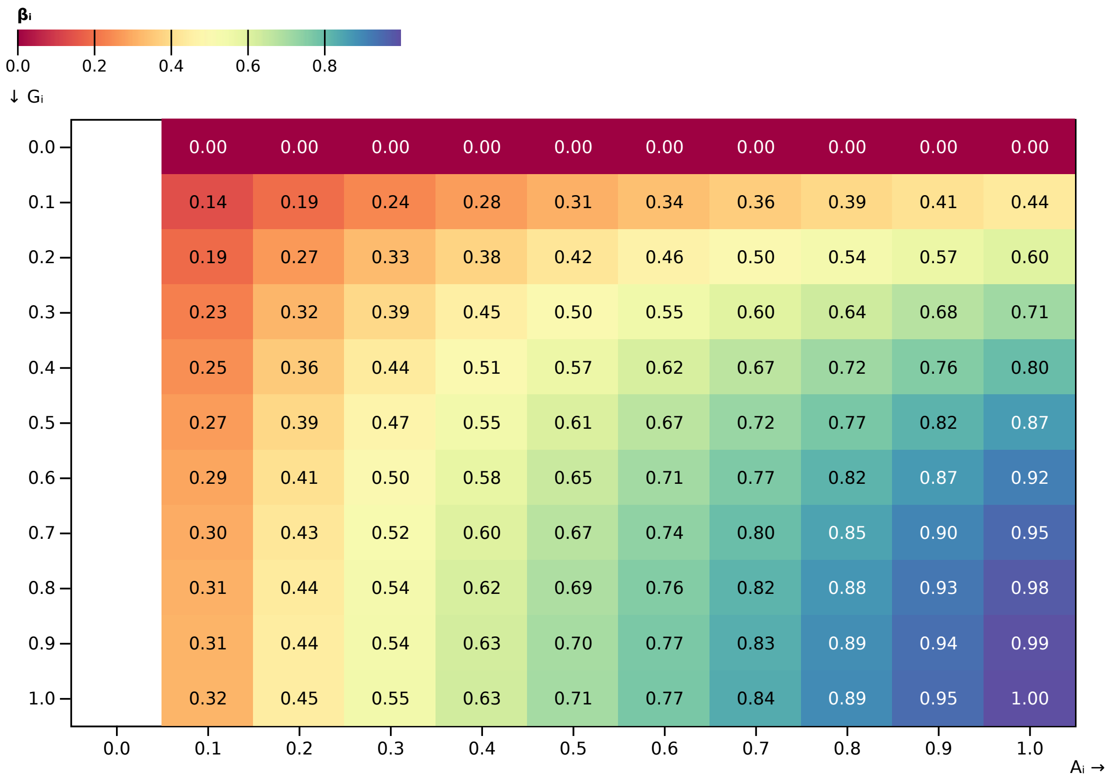


Figure 18: Range of β_i.

The table and figure below show an example of the effects on β of allocating large G_i values to small A_i values where the shift in G_i results in a lower β (0.27 from 0.55) with no change to total $\mathbf{G}$ and $\mathbf{A}$ allocations.

Class	1	2	3	4	β
A_i	0.50	0.20	0.10	0.05	
Initial G_i	0.30	0.10	0.05	0.01	
Initial β_i^2	0.2550	0.0380	0.0098	0.0010	0.5511
New G_i	0.01	0.05	0.10	0.30	
New β_i^2	0.0100	0.0195	0.0190	0.0255	0.2719
ΔG_i	(0.29)	(0.05)	0.05	0.29	
$\Delta \beta_i^2$	(0.2451)	(0.0185)	0.0092	0.0245	

Table 2: Effect on β from outsized $\mathbf{G}$ allocation.

Figure 19 shows β's sensitivity to $\mathbf{G}$ allocation as a function of $\mathbf{A}$ allocation; that is to say that a large G_i stake on a small A_i stake has limited effects (notwithstanding other consequential factors).

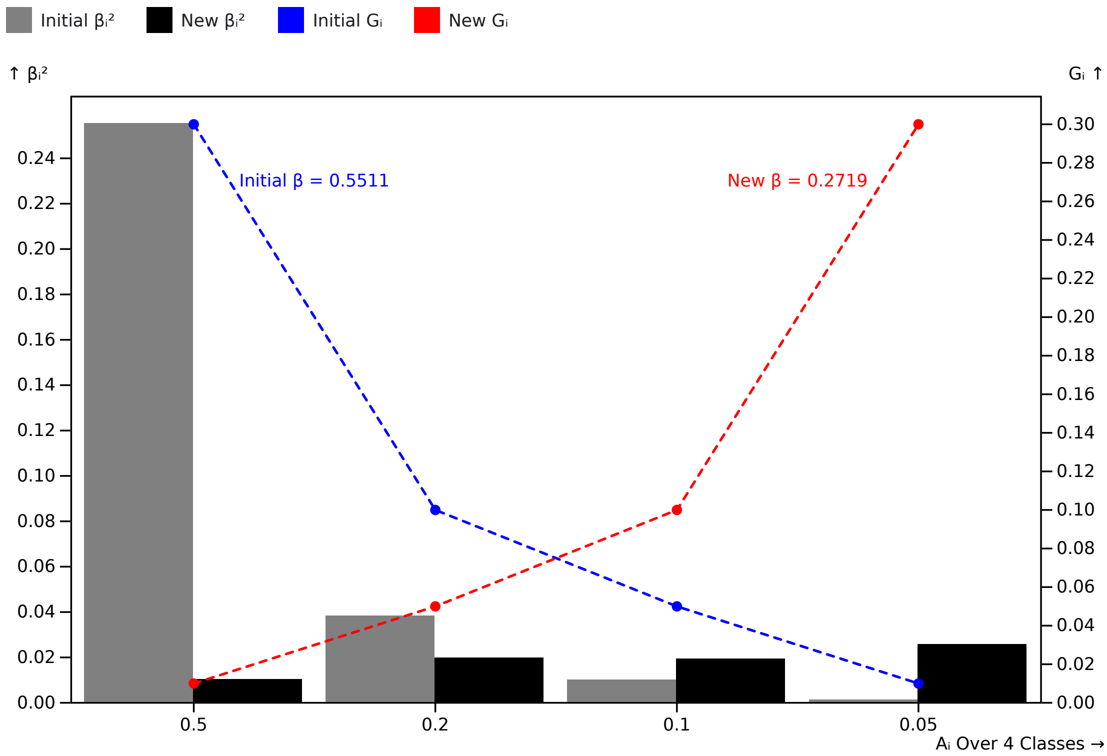


Figure 19: Example of **G** allocation on β.

3.3.3 Allocation of Risk Premium

The full issuance of **A** tokens is depicted below including now the Risk Premium for the liquidity pools accordingly.

3.3.4 Share of Risk Premium

The Risk Premium allocation is shared between user-locked **G** tokens, $\overline{\mathbf{AG}}$. and $\overline{\mathbf{AQ}}$ pools, with shares λ_{GG}, λ_G, and λ_Q respectively.

Defining:

- G_G: Total **G** tokens in the $\overline{\mathbf{AG}}$ pool, expressed as a proportion of the outstanding supply of **G**.
- A_G: Total **A** tokens in the $\overline{\mathbf{AG}}$ pool, expressed as a proportion of the outstanding supply of **A**.
- A_Q: Total **A** tokens in the $\overline{\mathbf{AQ}}$ pool, expressed as a proportion of the outstanding supply of **A**.

The allocation to user-locked **G** tokens, λ_{GG}:

$$\lambda_{GG} = \frac{1 - A_Q}{1 + \left(\frac{\sum_{i=1}^{n} G_i}{G_G}\right)^2} \tag{23}$$

Noting the relationship between G and β, and particularly if $G = 0$, $\beta = 0$.

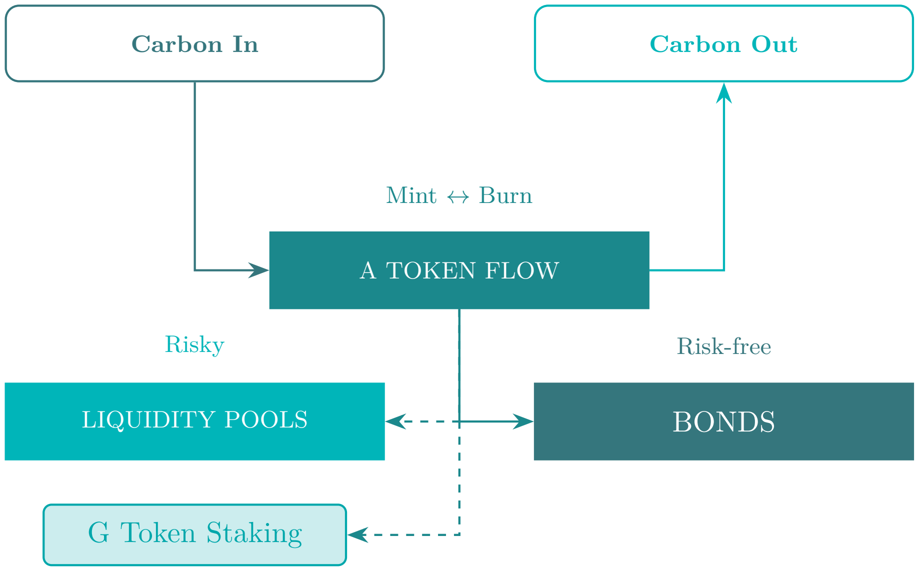


Figure 20: **A** token flow structure.

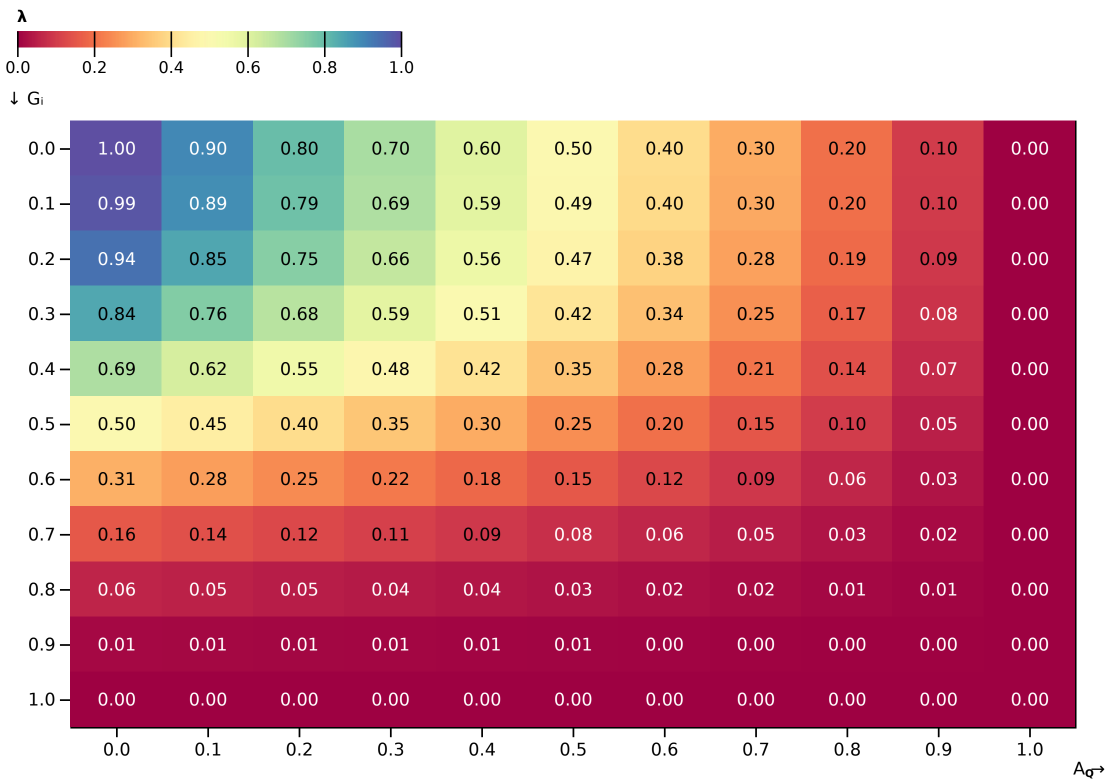


Figure 21: **G** stake allocation (assuming $G_G = 1 - G_i$).

The residual share, $1 - \lambda_{GG}$, is split between the liquidity pools:

$$\lambda_G = (1 - \lambda_{GG}) \frac{2A_G}{2A_G + A_Q\sqrt{2}} \tag{24}$$

For completeness:

$$\lambda_Q = 1 - \lambda_{GG} - \lambda_G \tag{25}$$

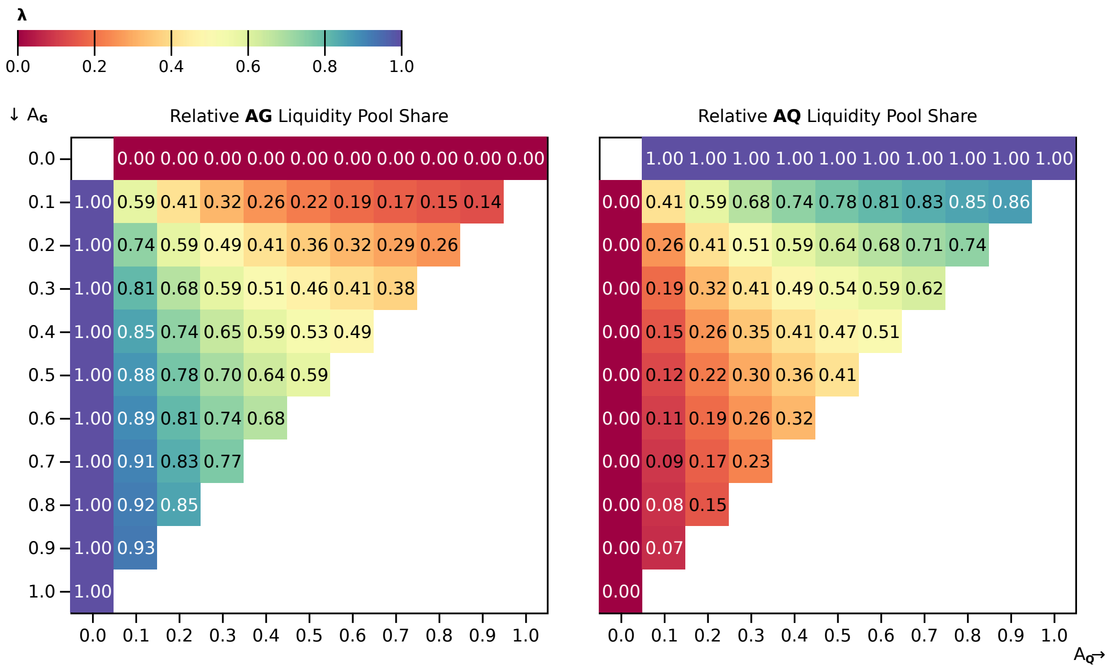


Figure 22: Liquidity pool split λ_G, λ_Q.

3.3.5 Risk Premium Distribution

For λ_{GG}, λ_G, λ_Q we apply β:

$$\Lambda_X = \lambda_X \, \beta, \quad \text{for } X \in \{GG, G, Q\} \tag{26}$$

Taking b as a discount parameter:

$$b = \frac{\sum_1^{40} Z_t \, S_t \, B_t}{\sum_1^{40} Z_t \, S_t} \tag{27}$$

The total Risk Premium tokens R_λ:

$$R_\lambda = b \, R \, (\Lambda_{GG} + \Lambda_G + \Lambda_Q) \tag{28}$$

The allocations of R_λ are pro-rata to Λ_{GG}, Λ_G, Λ_Q, and thereafter:

1. Locked $\mathbf{G}$: Λ_{GG} in proportion to $\mathbf{G}$.
2. Locked $\overline{\mathbf{AG}}$, $\overline{\mathbf{AQ}}$ tokens are allocated a weighting G_t, Q_t depending on their time bucket t:

$$G_t = \frac{Z_t\, L_{Gt}\, B_t}{\sum Z_t\, L_{Gt}\, B_t} \tag{29}$$

$$Q_t = \frac{Z_t\, L_{Qt}\, B_t}{\sum Z_t\, L_{Qt}\, B_t} \tag{30}$$

   Where L_{Gt}, L_{Qt} are the proportion of all liquidity locked in each time bucket for $\overline{\mathbf{AG}}$ and $\overline{\mathbf{AQ}}$ respectively.

Thereafter each time bucket allocation is proportionate to staked liquidity provider token holdings.

4 Klima 2.0 Token Distribution

4.1 Planned Allocations

Cohort	Proportion	Quantity (m)
Klima Holders	87.5%	17.5
DAO/Treasury	10.0%	2.0
01X	2.5%	0.5
Total	**100.0%**	**20.0**

Table 3: **kVCM** token.

Cohort	Proportion	Quantity (m)	Liquidity
Klima Holders	40.0%	40.0	Logistic Vesting 48 months
Ecosystem Grant	5.0%	5.0	Logistic Vesting 48 months
Programmatic Incentives	40.0%	40.0	Incentive Curve
pKlima Holders	3.0%	3.0	Logistic Vesting 48 months
DAO/Treasury	4.5%	4.5	24 month locked LP of $\overline{\mathbf{AG}}$
01X	2.5%	2.5	24 month locked LP of $\overline{\mathbf{AG}}$
Product Design and Development	5.0%	5.0	Logistic Vesting 48 months
Total	**100.0%**	**100.0**	

Table 4: **K2** token.

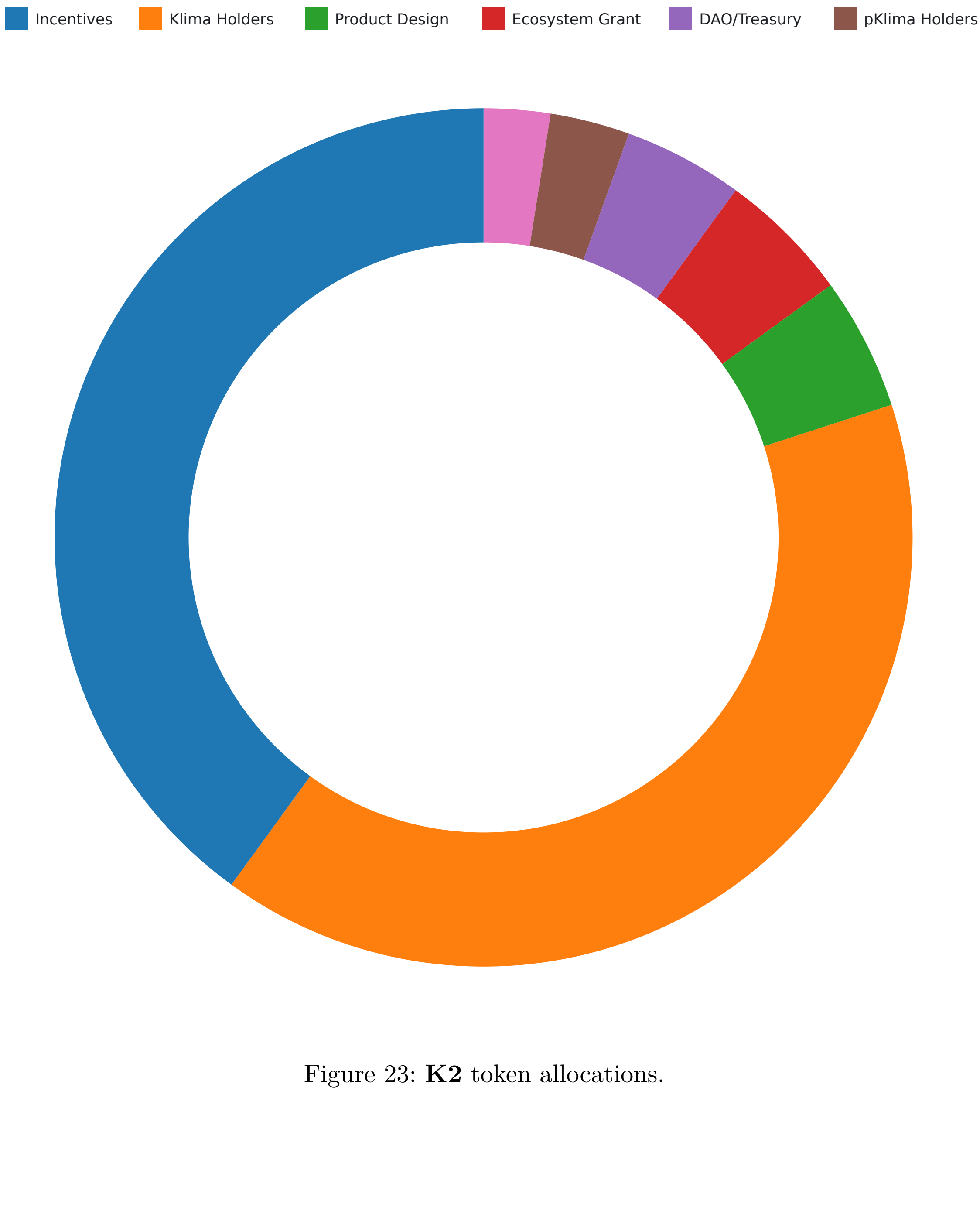


Figure 23: **K2** token allocations.

4.2 Programmatic Incentive Curve

The incentive issuance is built on a logistic function, P, to generate total proportion of supply in issue. It is calibrated from the initial issuance at TGE P_0 and the inflection point time T where 50% of **G** token incentives have been released.

Setting x_0 from the initial supply parameter:

$$x_0 = \ln\left(\frac{P_0}{1-P_0}\right) \tag{31}$$

With x_t at time point $t \in (0, \infty)$:

$$x_t = x_0\left(1 - \frac{t}{T}\right) \tag{32}$$

Giving supply function $\mathrm{P}(t)$ as:

$$\mathrm{P}(t) = \frac{\exp(x_t)}{\exp(x_t)+1} \tag{33}$$

P_0 set at 7% and T at 24 months:

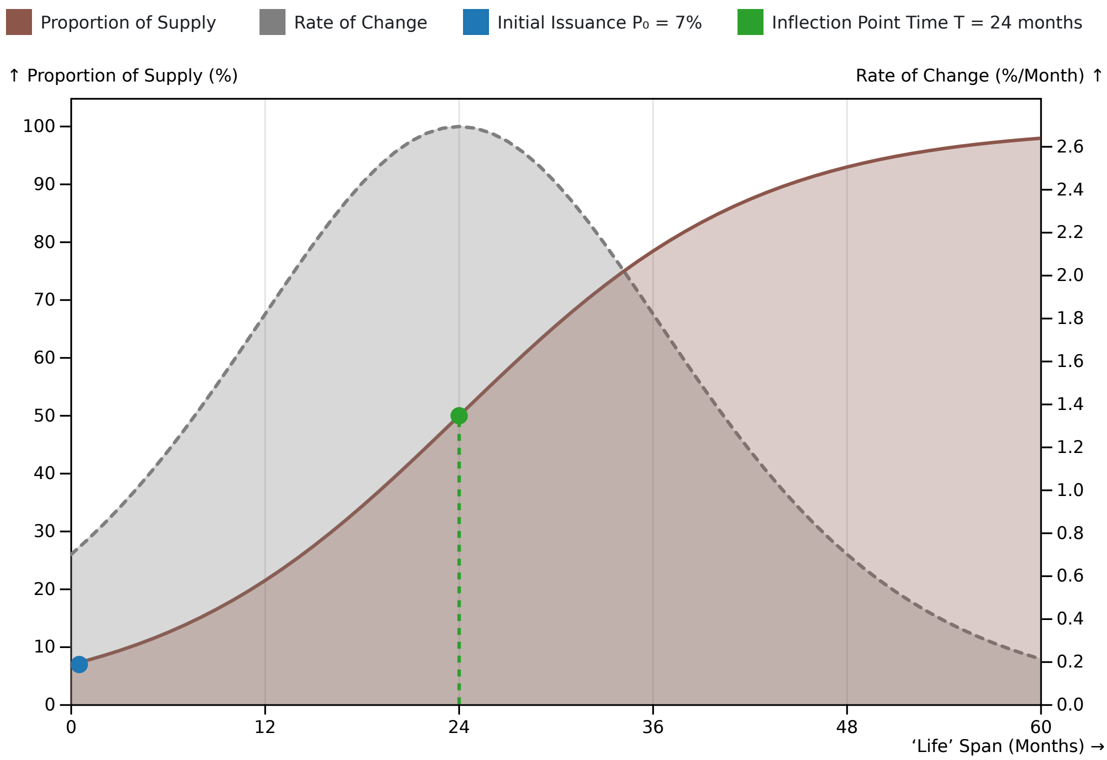


Figure 24: Incentive Issuance

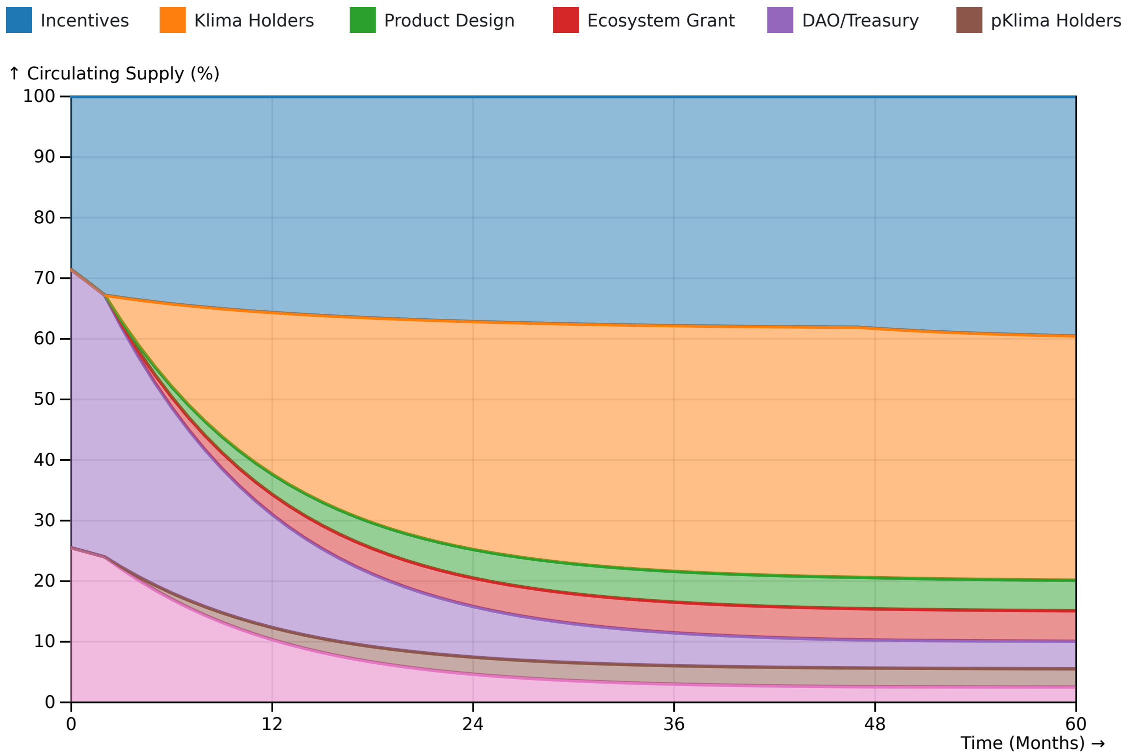


Figure 25: **K2** token circulating supply over time.

4.3 Incentive Allocations

The **relative utilisation** measurement factor υ is calculated as follows.

Defining initially:

- G: Total **G** tokens staked expressed as a proportion of the circulating supply, $G \in [0, 1]$.
- L: Total **G** tokens held in the $\overline{\mathbf{AG}}$ pool expressed as a proportion of circulating supply, $L \in (0, 1]$.

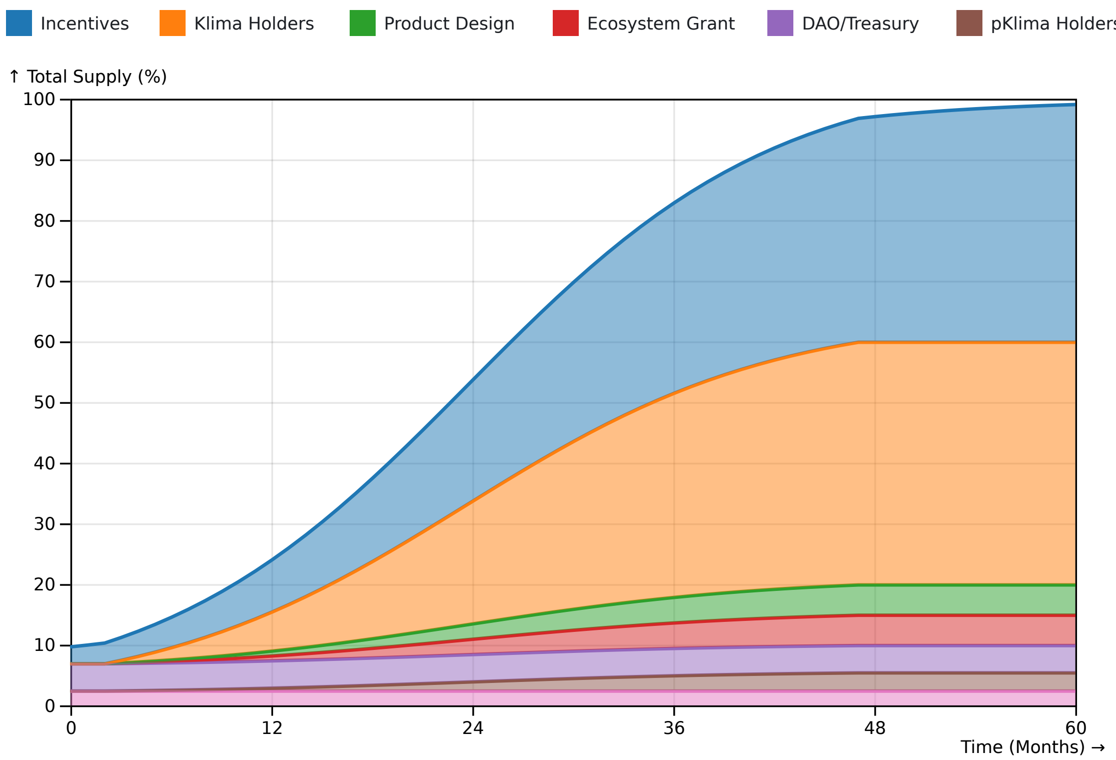
Where $\upsilon = 0$ if $G + L = 0$, otherwise:

$$\upsilon = \left(\frac{2GL}{G^2 + L^2}\right)^2 \tag{34}$$

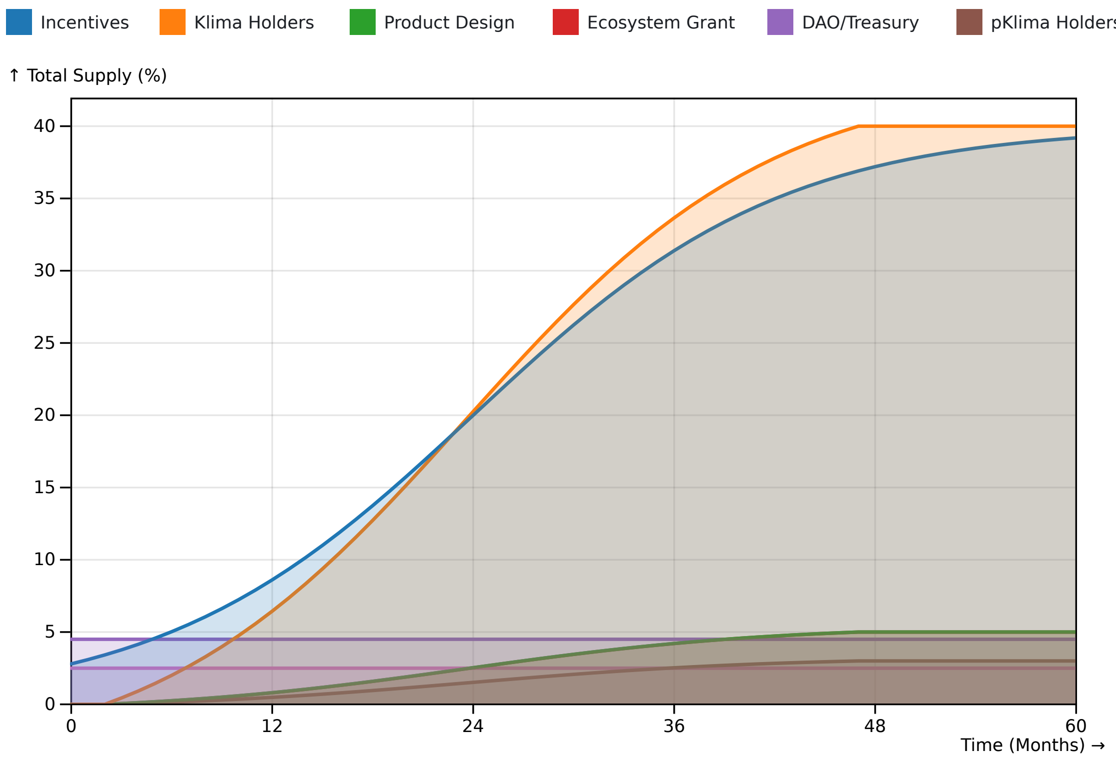
The **absolute utilisation** parameter η is defined as $\eta = 0$ if $G + L = 0$, otherwise:

$$\eta = \frac{2GL}{G(1-G) + L(1-L)} \tag{35}$$

Incentives I are allocated as follows:

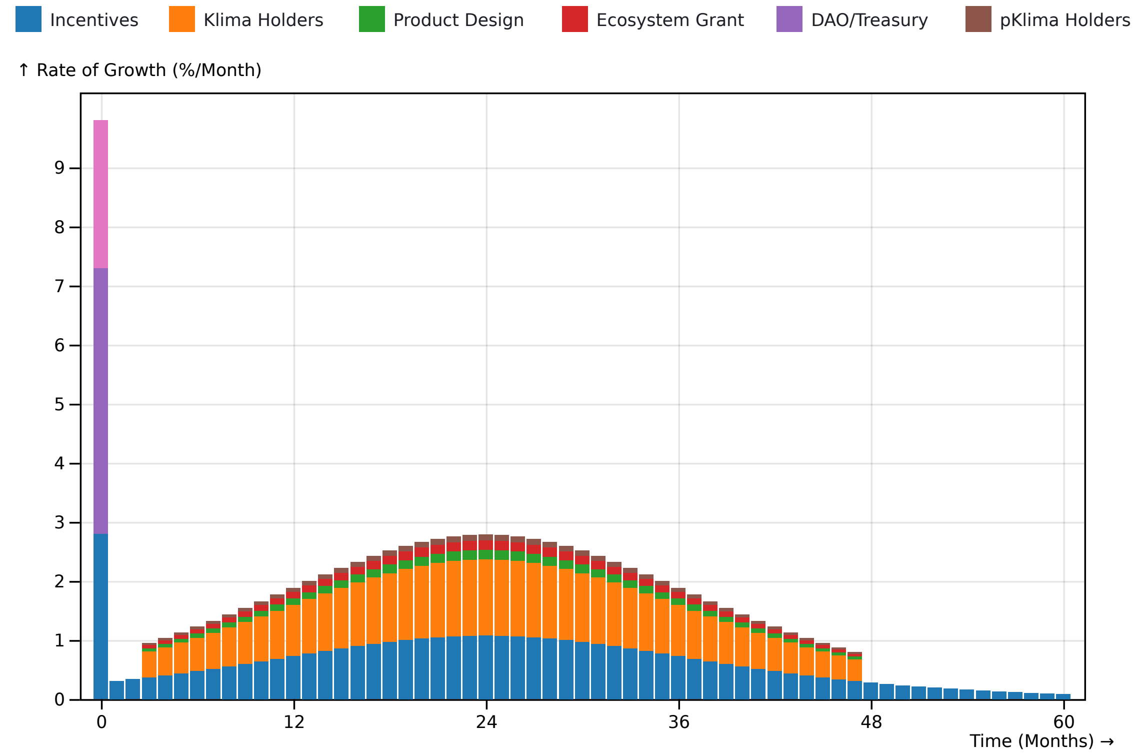


(a) Total supply (stacked).

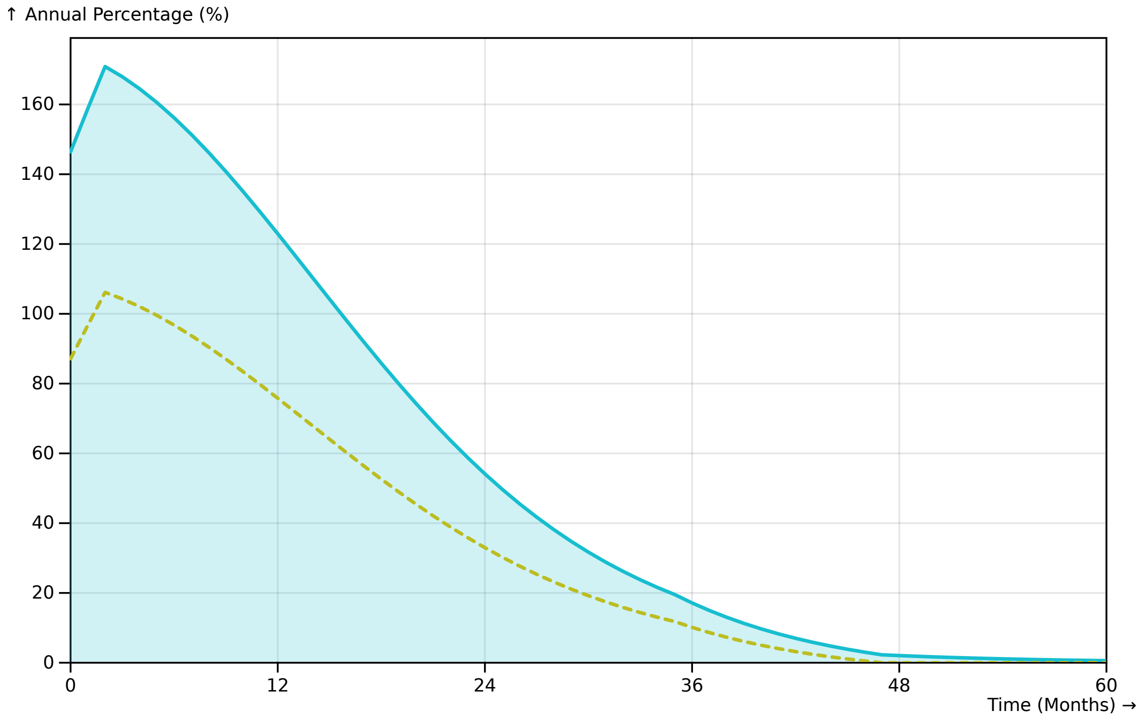


(b) Total supply (unstacked).

Figure 26: **K2** token total supply over time.



(a) Total supply differential (stacked).



(b) Utility incentive yield.

Figure 27: **K2** token supply risk metrics.

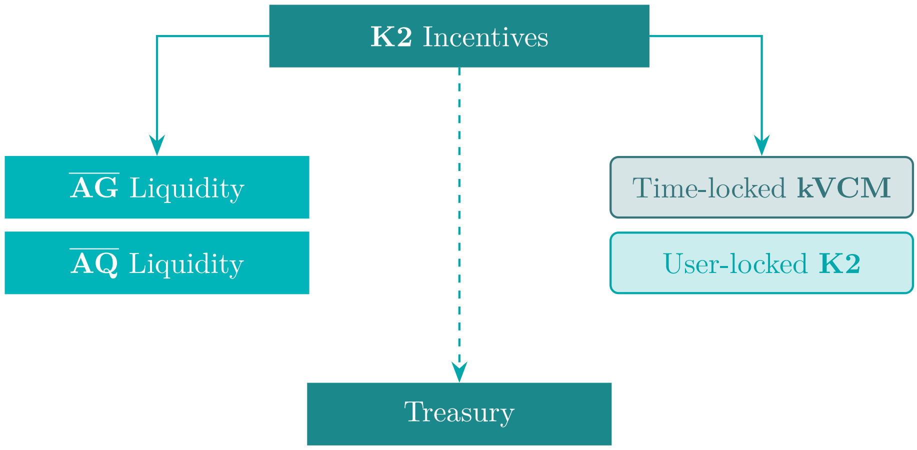


Figure 28: **K2** token incentive distribution structure.

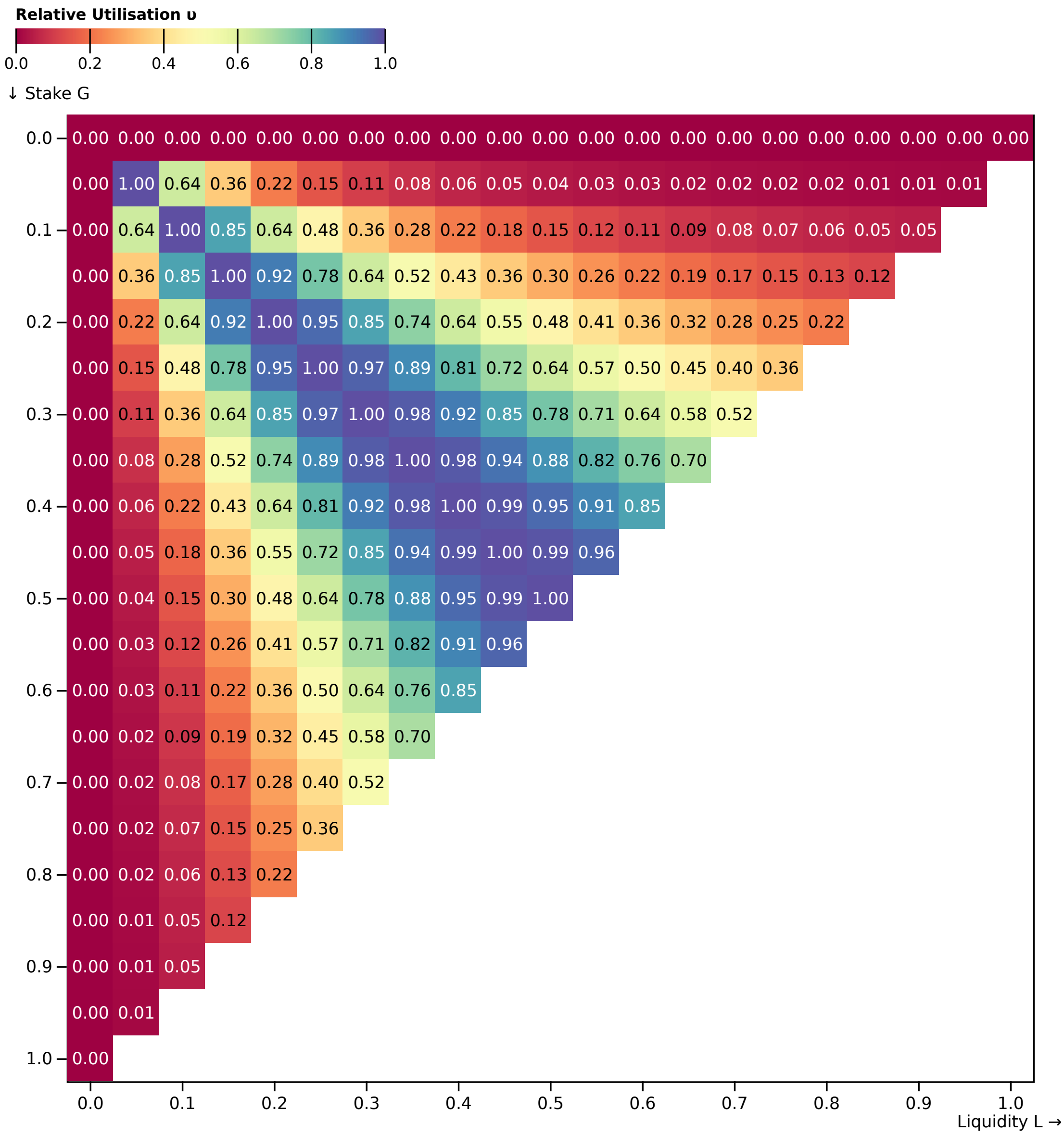


Figure 29: Upsilon υ range of values.

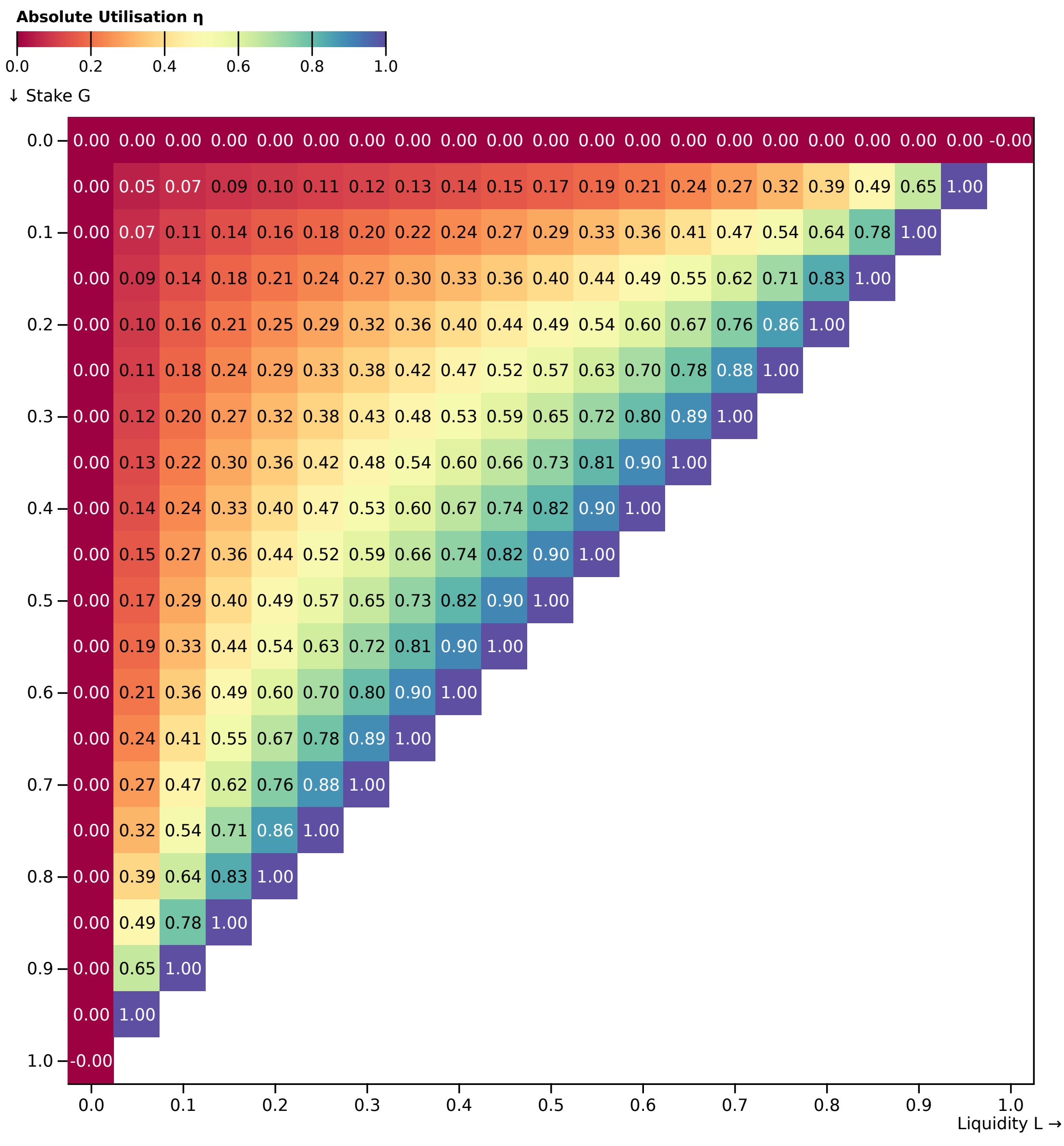


Figure 30: Eta η range of values.

4.3.1 Treasury

The allocation to the Treasury I_T is the imbalance generated from υ:

$$I_T = 1 - \upsilon\,\eta \tag{36}$$

4.3.2 Post Treasury

The residual post-treasury allocation is shared four ways within 2 buckets:

1. Time-locked **A** & user-locked **G** tokens

   Where S is the proportion of time-locked **A** tokens (as defined previously in Section 3.1.1):

   1. Time-locked **A**, I_S:

   $$I_S = S\,\frac{L^2}{G^2 + L^2} \tag{37}$$

   2. User-locked **G**, I_G:

   $$I_G = (1 - S)\,\frac{L^2}{G^2 + L^2} \tag{38}$$

2. Liquidity

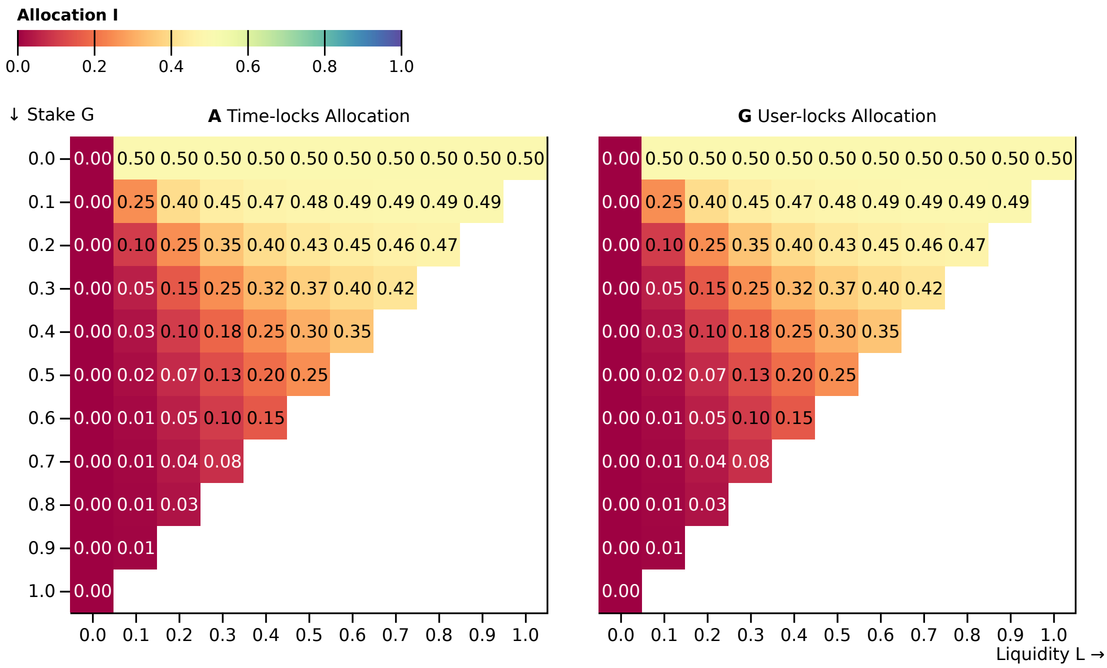
   With λ_G, λ_Q, λ_{GG} as defined in Section 3.3.4:

   3. $\overline{\mathbf{AG}}$ pool I_{AG}:

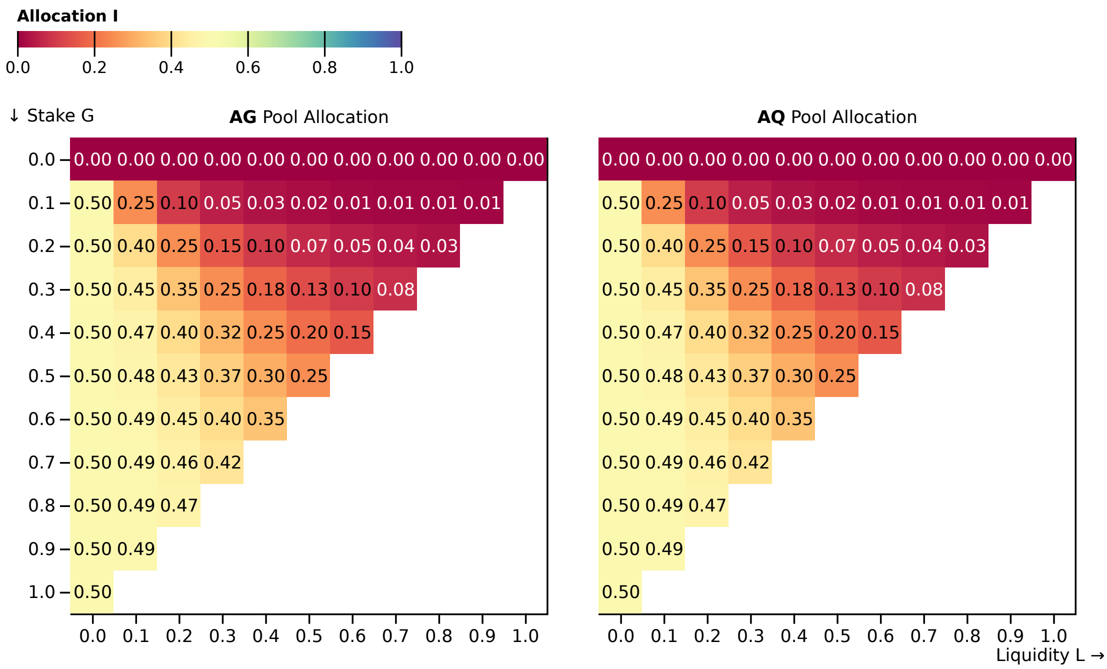
   $$I_{AG} = \frac{\lambda_G}{1 - \lambda_{GG}}\,\frac{G^2}{G^2 + L^2} \tag{39}$$

   4. $\overline{\mathbf{AQ}}$ pool I_{AQ}:

   $$I_{AQ} = \frac{\lambda_Q}{1 - \lambda_{GG}}\,\frac{G^2}{G^2 + L^2} \tag{40}$$



(a) Time-locked **A** and user-locked **G** allocations.



(b) Liquidity pools allocations

Figure 31: Share of non-treasury incentives I_S, I_G, I_{AG} and I_{AQ}.

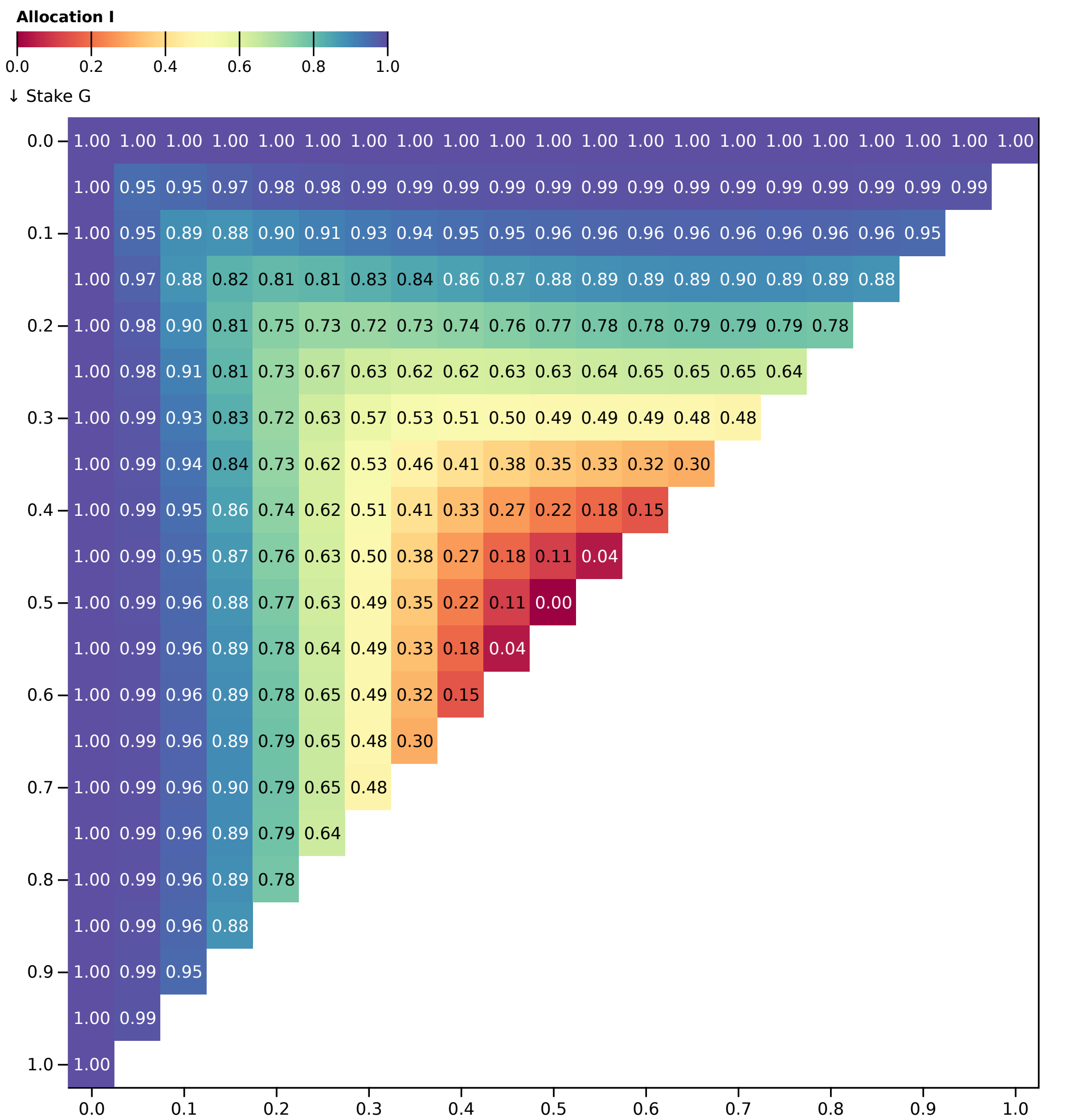


Figure 32: Treasury incentives I_T.