

# Bei Protocol

*Decentralized, fair distribution, high liquidity, scalable stablecoin platform on BSC*

## Preface

Why choose Binance Smart Chain?

Binance's vision is to promote the free flow of value. The expansion of freedom will greatly improve the lives of people around the world. Binance has built a whole set of ecology to empower practitioners and users. The Binance Smart Chain, developed by the Binance Ball team and jointly driven by its community, aims to increase the freedom of assets through DeFi. In Binance's vision, the "Internet of Value" will consist of the Internet of Blockchains. The interoperable DeFi currency Lego is not limited to specific blockchains. Assets and users flow freely according to their needs, while the Ethereum mainnet will assume The role of the global settlement layer. In this "Internet of Value", the Binance Smart Chain provides different advantages for the DeFi protocol and its users:

- EVM compatibility
- Rich and growing asset and ecosystem
- Low transaction fees
- High performance
- Cross-chain DeFi mechanism-Let DeFi have no boundaries

We believe that in the Binance Smart Chain, the ecological development potential is greater.

## Abstract

We introduce Bei Protocol and the Bei stablecoin. The goal of the Bei Protocol is to maintain a liquid market in which BNB/Bei trades closely to the BNB/USD price. Bei achieves this via a new stability mechanism known as *direct incentives*. Direct incentive stablecoins use dynamic mint rewards and burn penalties on DEX trade volume to maintain the peg. Bei uses Pancakeswap as its incentivized DEX at launch. Governance can add and update DEX integrations and other incentives as needed.

New supply of Bei enters circulation via a buy-only bonding curve denominated in BNB. We refer to the BNB accrued from purchases on the bonding curve as *Protocol Controlled Value (PCV)*. We define PCV as any value which is completely owned and controlled by the protocol, without an IOU. It is a subset of Total Value Locked with a stronger use case. The Bei Protocol deploys its PCV exclusively as Pancakeswap BNB/Bei liquidity at the



genesis of the protocol. This is a "liquidity-collateralized" model which removes the need for an overcollateralized debt position. As the supply grows, the bonding curve price approaches a fixed peg to the oracle price. The fixed peg bonding curve creates a guaranteed arbitrage opportunity when the Pancakeswap price trades above the peg. The protocol will use its liquidity PCV to backstop the Pancakeswap price when it trades below the peg for a certain period.

The BIBE governance token is used to upgrade the protocol over time. Bei Protocol releases BIBE to bonded Bei/BIBE Pancakeswap LP tokens. The Bei Protocol design has key advantages that are not present in other widely used stablecoin designs. Bei is decentralized and scalable. New supply is fairly distributed to new demand. PCV provides flexibility to governance to add future integrations and incentives. Bei holders benefit from the mechanisms designed to create a high fidelity peg and liquid exchange.

## Direct Incentive Stablecoin

Bei's *direct incentive* approach presents a promising improvement over existing stablecoin models, which fall into three broad categories: fiat-collateralized, crypto-collateralized, and non-collateralized.

Fiat-collateralized stablecoins, such as USDC and USDT, are issued by centralized entities. These custodians escrow USD and issue the stablecoin on chain. Stablecoins in this category have two key advantages. One is capital efficiency, since they can scale rapidly with demand at a 1:1 exchange rate. The other is collateralization, as they can always be redeemed for underlying assets. However, there are always risks that the centralized authority issuing.

Fiat-collateralized stablecoins is not fully collateralizing them. The reserves are a black box in between solvency audits, if any at all. Fiat-collateralized stablecoins are also subject to regulatory risk. This can take the form of blacklisting accounts, mandatory KYC, or even erasing funds. This poses an existential risk to platforms which integrate with them. The advantages of fiat-collateralized coins have led them to dominate the current market. Decentralization solves the issues with fiat-collateralized stablecoins due to their permissionless nature. The popular decentralized stability mechanisms have their own unique drawbacks. We will explore these below.

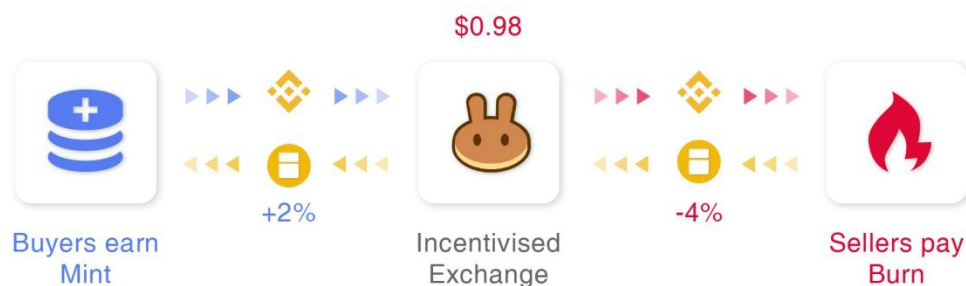
Crypto-collateralized stablecoins, such as DAI and sUSD, are issued on chain via some kind of overcollateralization mechanism. The overcollateralization allows for trustless issuance. The drawback is the capital inefficiency that results from the need to have a sufficient buffer to protect against price volatility in the collateral. All supply requires an excess of collateral which must be monitored for solvency. This limits the growth of decentralized stablecoins. The primary example, DAI, even has a debt ceiling which cannot be exceeded.



Non-collateralized stablecoins are a compelling alternative. They enable unconstrained growth in supply and are decentralized in issuance. The current primary mechanisms for achieving this are seigniorage and rebasing. Seigniorage models like ESD have supply adjustment dynamics to maintain the peg. When demand is high, the protocol issues new supply to a group of stakeholders known as the seigniorage holders. When demand is low, there are deflationary mechanisms for contracting supply. These seigniorage models have two drawbacks. First, there is no collateral or liquidity backing the peg. This can create liquidity crises and amplify volatility when these coins fall below their peg. Additionally, the economic mechanics heavily favor the seigniorage stakeholders. The broader community often disregards seigniorage stablecoins due to the unfairly centralized rewards. Fractional reserve models like FRAX attempt to address the no collateral issue, but they still retain the flawed economics of a seigniorage model. Rebasing tokens like AMPL adjust user balances to shift the demand weighted price to the peg. They have usability issues when integrating with other platforms, since user balances are not static. Non-collateralized stablecoins have also proven to be extremely volatile.

This paper proposes a new stability mechanism called *direct incentives*. A direct incentive stablecoin is one in which both the trading activity and usage of the stablecoin are incentivized, where rewards and penalties drive the price towards the peg. In general this would include at least one incentivized exchange acting as a hub. All other exchanges and secondary markets can arbitrage with the incentivized exchanges. This helps maintain the peg throughout the ecosystem. The direct incentive model by itself suffers from similar issues to other non-collateralized stablecoins. There is no guarantee of liquidity and no collateral backing the system. To solve this, Bei Protocol combines the direct incentive model with Protocol Controlled Value deployed as liquidity. These mechanisms together create a stablecoin that is decentralized, scalable, fair, and liquid.

## Direct Incentives



## Protocol Controlled Value

In most DeFi applications, users deposit funds with an IOU attached. For example, users could be issued tokens representing the pro rata percentage of the supplied assets. These assets are a part of the Total Value Locked (TVL). The protocol would define a utility around how these funds are deployed. The contract may offer incentives to keepers to close unhealthy positions. There may even be some fee which accrues to stakeholders or a reserve. This value does not belong to the protocol in any meaningful sense, but rather to the users and owners of the protocol.

This lack of ownership creates the “mercenary capital” problem, evident in all user owned TVL-based mechanisms. For example, Pancakeswap LP tokens and Aave aTokens are redeemable for the underlying assets. During periods of high APYs or incentives, the TVL would increase. As soon as those rewards dry up, the capital will move on to the next best opportunity, perhaps Autofarm or Venus.

The key innovation behind the Bei Protocol's mechanism is the idea of ***Protocol Controlled Value (PCV)***, a subset of TVL in which the protocol outright owns the assets with no IOU. PCV opens up a new design space for DeFi protocols beyond what user-owned TVL models can do. The protocol can influence market conditions in fundamental ways that are not necessarily profit-motivated. Since there are no users to redeem to, these benefits are guaranteed on the contract level. The clearest use case of PCV is to have the protocol be a liquidity provider (LP) on an Automated Market Maker (AMM) like Pancakeswap. At sufficient volume, the protocol would essentially control the exchange rate of the trading pair. It can use its PCV to rebalance the price by executing trades against the market and locking or burning excess tokens. For example, let's say there is a Pancakeswap market denominated in Bei/BUSD. The current liquidity depth is 1100 Bei and 1000 BUSD. In this example, Bei Protocol owns 90% of the liquidity. Bei Protocol can atomically execute the following trade:

1. Withdraw all liquidity (990 Bei and 900 BUSD)
2. Swap ~5 BUSD for ~5 Bei (remaining liquidity is ~105/105 Bei/BUSD)
3. Resupply 895 Bei and 895 BUSD at the 1:1 exchange rate

The net effect of the above trade is the protocol spent ~5 of its BUSD PCV to restore the peg.

This design aligns perfectly with the Bei stablecoin use case. This is a marked improvement over models in which all the TVL is user-controlled and frozen as collateral. PCV could also be used to deposit and borrow on lending markets like Venus and Cream.

Funding PCV is a necessary design consideration. The protocol needs to be able to offer a token or service which earns the PCV. A natural mechanism for funding PCV would be protocol fees for functionality. A stronger funding mechanism might be a bonding curve. The bonding curve could mint a token controlled by the protocol for an influx of BNB or other BEP20 tokens. To accrue PCV, the bonding curve must include a spread earned by



the protocol. Bonding curves have an elegant mathematical fairness to them. New demand for the token can buy directly from the bonding curve to expand the supply. This is in stark contrast to seigniorage models which centralizes rewards. Arbitrageurs profit off of any market dislocation between the bonding curve and spot exchanges. Users receive the newly minted supply in one of two ways:

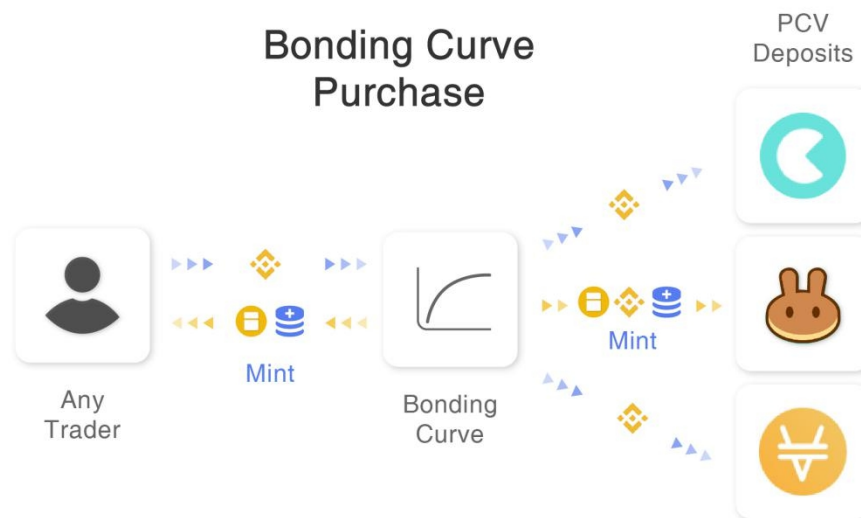
1. Directly from the bonding curve
2. Indirectly from arbitrageurs

Critically, arbitrage is not necessary as users can go straight to the curve. This results in a fair distribution of supply expansions. The protocol benefits in the form of PCV funding.

Bei Protocol uses PCV in the following way. It is funded by a one-way BNB bonding curve which does not allow selling. The PCV is deployed as Pancakeswap liquidity denominated in Bei and BNB. This can be considered indirect collateralization or "liquidity collateralization".

Liquidity collateralization inverts the traditional understanding of collateral for stablecoins. In an overcollateralized model, a user would supply a fixed amount of collateral like BNB. This collateral could be volatile. As long as the position stays solvent, the debt holder could close the position and redeem their collateral. This collateral now has a new market value. On the other hand, in the Bei model, the only way to redeem for the underlying asset is to sell Bei on a secondary market. For this reason, Bei cannot be used to lever or maintain exposure to collateral assets. Instead, Bei is collateralized by irrevocable protocol-owned liquidity.

This approach has fractional reserve properties. One can consider the collateralization ratio as the amount of PCV divided by the user-circulating Bei. If all outstanding Bei were to be sold or redeemed for PCV pro-rata, this ratio determines the amount received. In this model, there is no requirement for having equivalent levels of PCV liquidity and circulating Bei. The reasoning is the same as in traditional fractional reserve banking: it is inefficient to hold an excess of collateral for every single position if only a subset will ever want to liquidate.

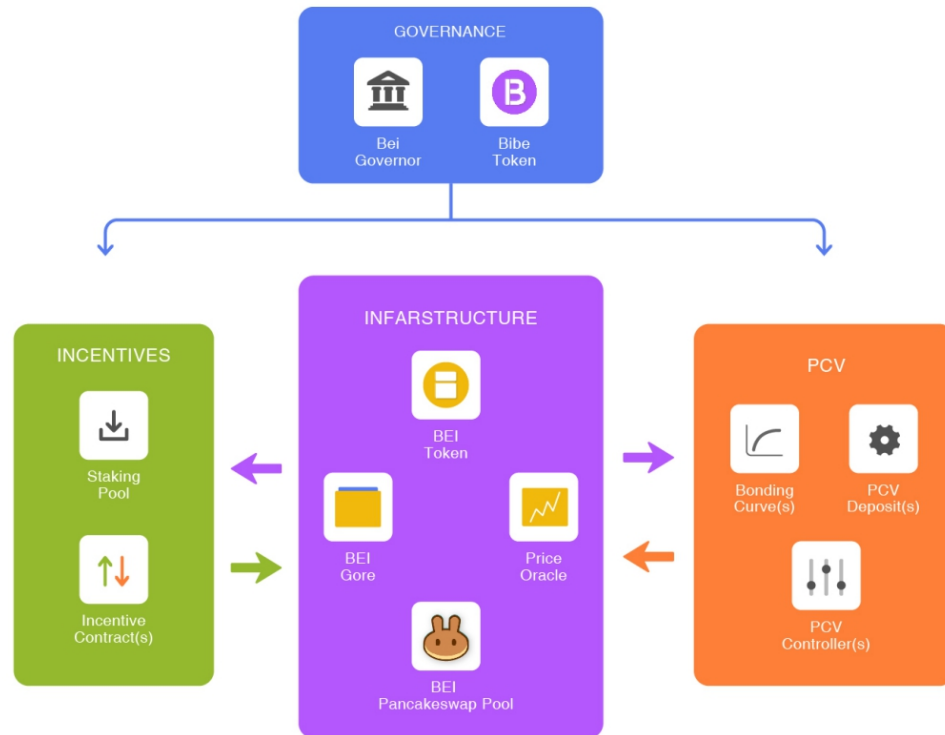


Behind the scenes, Bei Protocol allows for generalized PCV funding and deployment. The funding can come via additional bonding curves denominated in other tokens. Each bonding curve can deploy its PCV to a portfolio which is configurable by governance. A sufficient amount will be allocated to liquidity. The remainder can go to funding interest rate pools on lending markets. It can even be invested in platforms like Autofarm to grow the PCV. Another approach could be a Graph Protocol integration in which PCV is deployed to curate a Bei Protocol manifest.

PCV represents a natural progression over Total Value Locked (TVL) in valuing a DeFi protocol. TVL is simply a metric of usage, whereas PCV represents irrevocable value controlled by the protocol.

## Bei Protocol Design

As seen below, the system has several core components: Bei Core, the Bei stablecoin, bonding curve(s), PCV Deposits, PCV Controllers, Bei Incentives, and the BIBE governance token and DAO.



### Bei Core

Bei Core is the access control hub for the Bei Protocol. It defines several roles and what each can do. It also maintains a mapping of which contracts have which roles. The roles are as follows:

- **Minter** - can mint Bei to any address
- **Burner** - can burn Bei from any address
- **Controller** - can move PCV in and out from their initial deposit
- **Governor** - can grant/revoke any role, and upgrade the protocol components. This is discussed further in the BIBE and DAO section.

The role-based approach in Bei Core allows for complete modularization of the protocol. New features can be voted in by deploying a contract and granting it a role. This flexibility allows Bei Protocol to adapt to ecosystem changes and grow with DeFi.

## Bei Token

Bei is the pegged stablecoin produced by Bei Protocol, following the BEP-20 standard. Its supply is uncapped. Minter and Burner contracts control its issuance, via bonding curves and trading incentives. The Bei token exhibits certain non-standard BEP-20 functionality, but only on a subset of transactions. There are dynamic incentives overlaid on transfers involving incentivized addresses. An incentivized address is a contract that Bei Protocol wants to incentivize certain Bei behavior. Incentivized addresses have an associated incentive contract. Incentive contracts control the direction and magnitude of incentives for each transfer. The incentive contract is appointed as a Minter and/or Burner. If a user sends Bei to an incentivized address, their remaining balance will be affected by a mint or burn incentive. The primary incentivized address in Bei Protocol is the Bei/BNB Pancakeswap pool. Traders experience minting and burning controlled by the associated incentive contract. We explore these mechanics further below.

The sender's balance can change by a different amount than the transfer amount. A mint incentive results in a balance increment on the sender, whereas a burn incentive decrements the remainder of the sender's balance after the transfer. An insufficient balance will revert the transaction. This is similar to the functionality of rebasing tokens in that it directly operates on user balances. The important usability benefit of this model is the locality of incentives. They are only applied to the users who engage in the incentivized transfer. Users can plan for non-standard behavior. The incentivized addresses and incentive contracts are publicly known. Users are free to avoid incentivized addresses and other activity is completely standard. The DAO will be able to add and revoke incentive contracts tied to incentivized addresses.

Within the protocol, there are three distinct types of Bei from an accounting perspective, with some overlap. These are all fungible and treated identically from a token perspective. The protocol calculates the supply of each to be used in calculations. The types are the following:

- $Bei_p$  : Protocol-controlled Bei, deployed in LP pools or other allocations per PCV
- $Bei_b$  : Bonding curve distributed Bei given to users. These will be accounted on a per bonding curve level
- $Bei_u$  : User-controlled Bei, the `totalSupply()` of Bei less  $Bei_p$

In general, there is overlap between  $Bei_b$  and  $Bei_u$  . When users sell to protocol LP via an AMM,  $Bei_u$  can become  $Bei_p$  . Vice versa — when users buy Bei, it goes from  $Bei_p$  to  $Bei_u$  .

## Bonding Curves

Bonding curves are Minters appointed by the Bei Protocol. They issue  $BEI_b$  and generate PCV used to maintain the peg. The initial curve will be one-sided and denominated in BNB. Its pricing function approaches an oracle peg price. This bootstrapping mechanism offers early BEI at a discount to users for supplying PCV. The point at which the pricing function reaches the peg is known as Scale. Scale is the target  $BEI_b$  supply at which a Bei bonding curve pricing function switches to 1. The Scale number can be different for different bonding curves. This allows incentivized PCV funding for various underlying



tokens. The initial Bei bonding curve will use BNB as the underlying asset. The peg will be the Time-Weighted Average Price (TWAP) of the BNB/BUSD Uniswap pool over a 10 minute window.

**New Bei bonding curves should only use decentralized tokens to maintain decentralization of the protocol.**

The bonding curve issues Bei at a discount with a sublinear growth rate based on the supply. Sublinear curves reward initial investors while still bootstrapping sufficient underlying value to the protocol. A linear or superlinear model would be explosive and lack retained PCV.

Let  $O_A(B)$  be the oracle price of A paid in B e.g.  $O_{BNB}(Bei) = 500 \text{ Bei/BNB}$ . The oracle price represents the "target" at which that trading price would imply  $1 \text{ Bei} = \$1$ . Let  $S$  be the Scale target of a given bonding curve, in terms of  $Bei_b$ . The instantaneous BNB price for a unit of Bei at current total supply  $X$  pre-Scale uses the following formula:

$$(1) \quad P(X) = \sqrt{\frac{X}{S}} * O_{Bei}(BNB)$$

One can integrate the curve to determine the quantity  $Q$  of BNB required to get from a given level of supply  $r$  to another level  $s$ :

$$(2) \quad \int_r^s P(X) = dx = Q$$

Using the above formula one can calculate the amount of BNB required to achieve Scale for  $S = 250 \text{ million Bei}$  and  $O_{Bei}(BNB) = 1/500 \text{ BNB/Bei}$ :

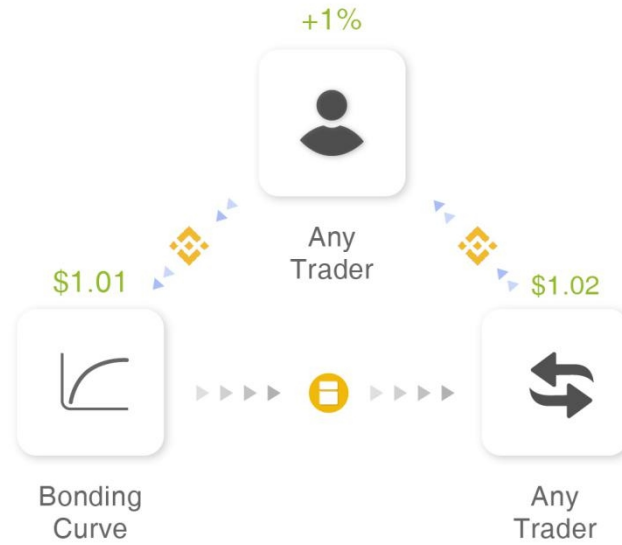
$$\int_0^S P(X) dx = 333,333 \text{ BNB}$$

Regarding equation (2), we can define  $y$  as the end supply. One can rearrange the integral to solve for the amount  $y - C$  of Bei received for a given BNB investment  $Q$  at a current user supply  $C$ :

$$\begin{aligned} \int_C^y P(X) dx &= Q \\ \left( \frac{2y^{3/2}}{3\sqrt{s}} - \frac{2C^{2/3}}{3\sqrt{S}} \right) * O &= Q \\ (3) \quad y - C &= \left( \frac{3\sqrt{S} * Q}{2 * O} + C^{3/2} \right)^{2/3} - C \end{aligned}$$

Once a bonding curve achieves Scale, it will fix the exchange rate at  $\$1 + b$ .  $b$  is a buffer to keep the mean price around  $\$1$ . When any secondary market price exceeds  $\$1 + b$  there is a riskless profit opportunity. Arbitrageurs can purchase against the bonding curve and sell on the secondary market.

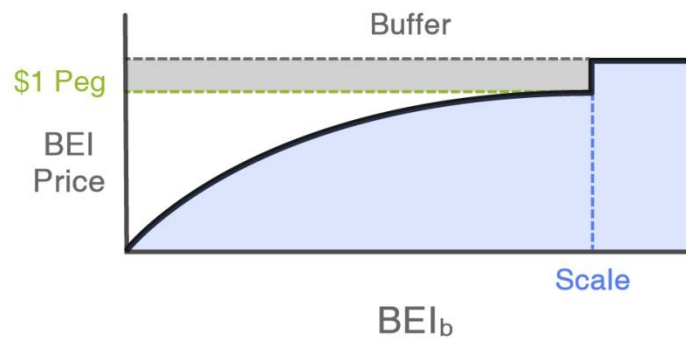
# Arbitrage



At  $b=0$  the majority of the price variance is below \$1. By adding in the buffer  $b$ , initially set to 1%, there is room for some variance above \$1 as well. Including this price fix behavior, the pricing function extends to

$$P(X) = \max \left( \sqrt{\frac{X}{S}}, 1+b \right) * O$$

# Bonding Curve



This pure arbitrage opportunity means the protocol requires no additional incentive to maintain the peg when prices exceed  $\$1 + b$ . Governance can gradually vote to converge  $b$  to 0 as the liquidity increases and volatility decreases.

It is important to note that the curve is one-way and Bei cannot be sold on the curve. As previously mentioned, incoming tokens on the curve are retained as PCV. Deploying the PCV on Pancakeswap allows for "liquidity collateralization" as opposed to a traditional collateralized model.

Each bonding curve has an adjustable allocation rule which defines a set of PCV Deposits. PCV Deposits are contracts that receive incoming PCV and deploy them in predefined ways. The DAO can adjust ratios and add new contracts (appointed as Minters and/or Burners) as needed.

## PCV Deposits

PCV Deposits are the recipients of PCV, funded by bonding curves. Because Bei cannot sell on these curves, it is crucial to create a liquid market that allows for the sale of Bei. The sale price should track the peg. The Bei Protocol will allocate all initial PCV to a Pancakeswap liquidity pool denominated in Bei and BNB. The concept extends to other token types assuming access to an oracle price to peg to. In this case, the PCV Deposit uses the BNB/BUSD TWAP as the oracle. We will now explore the Pancakeswap PCV Deposit in depth.

The Pancakeswap PCV Deposit receives incoming BNB from the bonding curve and deposits it into an BNB/Bei Pancakeswap pool. The Bei for this deposit comes from minting, and therefore this PCV Deposit must be appointed as a Minter by Bei Core. The amount of Bei minted is equivalent to the amount of BNB times the spot price of Bei/BNB in the pool. This mint is distinct from the mint associated with the bonding curve and sent to the user. The former is FEIp and the latter is both FEIb and FEIu. The bonding curve mint is associated with the bonding curve price and the PCV Deposit mint is associated with the Pancakeswap spot price. These numbers should be similar but do not have to be identical. It seems then that there is double the expected inflation associated with a bonding curve purchase, with half going to the user and half to the protocol-controlled LP. A critical caveat is this Beip does not circulate and will only be used as a burning mechanism for the protocol to reweight. It would not impact the price negatively as it would never be sold.

While this is the only PCV Deposit at launch, other implementations are possible to be added via governance. These include liquidity in other AMMs like Curve or Pancakeswap. They could also generate yield via a Compound, Aave, or Yearn deposit. They could even serve as collateral to open derivative positions such as Bei yTokens on Yield. The flexible design will allow for new creative deployments of PCV and integrating with future DeFi protocols as they arise.

## Bei Incentives

We discuss the mechanics of the Bei incentive contracts in the Bei token section. This section focuses on the way that incentive contracts help maintain the peg. There will be a single initial incentivized Pancakeswap pool, BNB/Bei. If the price is below the peg, the incentive contract will offer a Bei mint to traders. The next trader to buy Bei on the pool will receive the mint as an incentive for helping return towards the peg. This incentive will take into account the time-weighted magnitude of the distance from the peg.

For example, a 5% immediate deviation from the peg will have a small initial incentive. The incentive will grow over time and at a faster rate than if there was only a 1% deviation from the peg. This creates a reverse Dutch auction mechanism. The mint offered increases over time until a trader accepts the offer by purchasing on Pancakeswap. This happens atomically and directly on the Pancakeswap transfer. The traders who are willing to come in for a lower incentive will be the first to restore the peg and get the mint. The following formula is used to achieve this mechanism. Let  $w(t)$  be a time-weighted function where  $t$  is the number of blocks since the last time the peg was restored. The output is initialized at 0 and grows linearly at rate  $r$  per block (set by governance). Let  $m$  be the magnitude of the price deviation from the peg before the swap executes.  $m$  is defined as  $\frac{P(x) - O(x)}{O(x)}$ . The incentivr function is:

$$I(x, t) = w(t) * m * x$$

The time variable  $t$  will reset to 0 each time a Pancakeswap trade restores the peg. If a trade partially fills the peg,  $t$  will be partially updated by multiplying it by  $m_{end}/m_{start}$ . A 50% move towards the peg by trade volume required would result in a 50% reduction of  $t$ , which will resume its growth at rate  $r$ .

To give a concrete example, let's have  $r$  be .01 per block, the total liquidity in the pool be 200 BNB and 10000 Bei, and an oracle price of 500 USD/BNB. The instantaneous exchange rate here is 525 Bei/BNB, representing a 5% deviation from the peg. After 10 blocks the time weight will equal 0.1. At this point the purchase of Bei towards the peg will reward the trader with 0.5% of the trade value in Bei.

It is important for this mechanism to not be gamed. It is also important to disincentivize trading away from the peg. Bei Protocol achieves this via a dynamic burn mechanism on top of the Pancakeswap pool when trading below the peg. Similar to the mint, this burn will take into account the distance from the peg. The burn is not dependent on time. The  $m$  used is  $m_{end}$  as opposed to  $m_{start}$  in the case of the mint incentive. The Bei balance of the sender will be burned by the fee amount, having a net deflationary impact on the supply. This counters the price movement away from the peg. A quadratic growth rate is used to increase the penalty as the trade size increases via the following burn formula:

$$B(x) = m^2 * x * 100$$

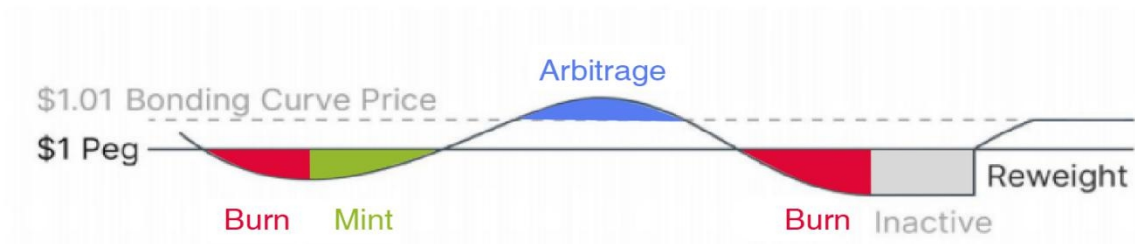
Volatility below the peg should result in net deflation. Any mint associated with buying should not exceed the burn paid to get to that price. For this reason, the incentive is capped at the output of the fee function. The incentive function is extended to:

$$I(x, t) = \min(w(t) * m * x, B(x))$$

The peg maintenance mechanics are even simpler above the peg. If the Pancakeswap price exceeds the

bonding curve price, a pure arbitrage opportunity arises. Traders can purchase via the bonding curve and sell on Pancakeswap. This is true of any other secondary market as well. The buffer plays a critical role here. If the price is always at or below the peg, then every trade would end below the peg and incur the burn penalty mentioned above. By adding in the buffer, users can trade in this window above \$1 without incurring the burn for trading below the peg. This one-sided fixed arbitrage loop is a notable advantage to the Bei Protocol mechanism.

## BEI peg dynamics



An address can be exempted from any incentive or penalty if approved by the DAO. The PCV deposit contract, for example, would be exempted from incentives and penalties. This will also be useful when attempting to integrate with other contracts throughout DeFi.

The flexibility of issuing incentives extends beyond simply maintaining the price on exchanges. Incentives can drive behavior such as depositing or borrowing Bei on lending protocols. They can also be used to supply liquidity to AMM pools used as oracles.

## PCV Controller

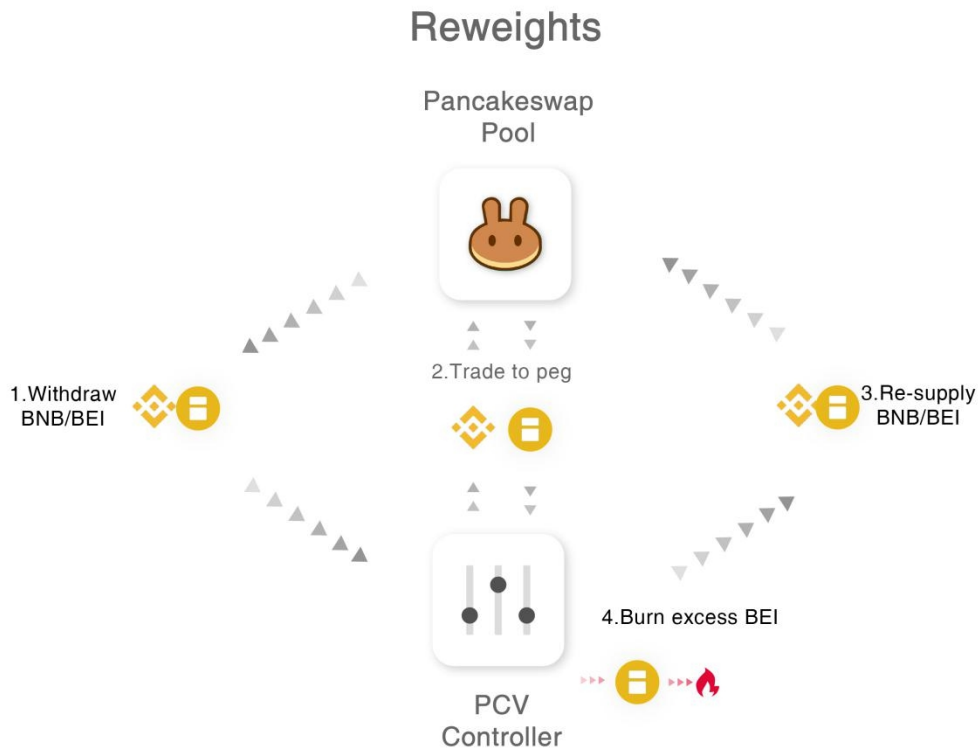
A PCV Controller is a contract approved to withdraw and reweight PCV among PCV Deposits. PCV Controllers are essential to allow the full benefits of PCV to be explored over time. At launch, there will be one primary PCV Controller contract. Governance can add more as needed.

The initial PCV Controller will focus on reweighting the Pancakeswap BNB/Bei pool. A reweight would mean that the protocol leverages its PCV to bring the spot price of BNB/Bei back up to the peg. This is important in adverse conditions when traders are not willing to support the peg. The Bei incentive may not be enough even at the maximum time weight, calculated as  $I(x,t) = B(x)$ .

When this condition is met, the protocol will open up the ability to backstop the price using this PCV Controller. Any external user, or keeper, can trigger a function which will cause the Controller to reweight the prices. The keeper will collect a mint reward denominated in Bei as an incentive. Reweights

use the following algorithm:

1. Withdraw all LP from PCV Deposit
2. If remaining LP exists in Pancakeswap pool, buy Bei with BNB PCV to restore peg
3. Re-supply the remaining BNB/Bei at the oracle price ratio
4. Burn the excess Bei



Generally, additional Controllers would be able to reweight PCV into other DeFi protocols or Bei contracts. These could include:

- Moving PCV into an oracle LP pool to increase oracle attack difficulty
- Adding to Yearn to generate yield on PCV
- Using governance token denominated PCV such as COMP to vote on proposals
- Supplying collateral for BEI derivatives such as options and futures

## BIBE and the Governance Process

BIBE governance is critical to the decentralization of the Bei Protocol. The governance mechanism will fork the Compound DAO, where holders can delegate votes. BIBE is the governance token controlling the DAO, analogous to COMP. Actions follow the proposed → queued → executed flow, if they do not fail or cancel. Governance has control over the following actions:

- Appoint Minter and Burner contracts (including new bonding curves)
- Adjust Scale target and allocation rule on bonding curves
- Adjust incentive time-weight growth rate
- Percent reward for reweight peg restoration
- Reweighting any of the peg Pancakeswap pools

The Bei Protocol DAO will be able to function like a central bank of DeFi. It can use PCV to adjust rates and market incentives on other platforms. This creates a dynamic ecosystem around Bei.

BIBE supply will be fixed at 1 billion divided into several categories.

The first category is a Bei staking pool. Bei holders can stake Bei/BIBE Pancakeswap LP tokens to earn a percentage of the BIBE distribution. The rewards will release into the pool over a linearly decreasing schedule. The release will wind down to zero after 2 years. The goal of the staking pool is threefold:

1. Access to BIBE for early Bei holders
2. A way to deploy Bei rather than statically holding it
3. More liquidity for BIBE

Another part of the BIBE supply is allocated to a special group of early adopters known as the **Genesis Group**. The Genesis Group will be open for a period of 2-3 days in which investors can pool their BNB. At the end of the period, the entire Genesis Group BNB supply will be used to purchase Bei on the bonding curve. This purchase will be the very first bonding curve transaction and have the most attractive Bei price. The Genesis Group participants receive their Bei pro-rata based on the total BNB investment. This is irrespective of when they entered the group. The Bei price will use the oracle price at the end of the Genesis period. The Genesis Group will also receive the aforementioned portion of the BIBE supply pro-rata.

A portion of BIBE will be listed on Pancakeswap in an Initial DeFi Offering. This pair will be denominated in Bei and BIBE. The exchange rate will be determined as a multiple of the BNB raised in the Genesis Group. The protocol will set this relative to the fully diluted BIBE market cap. This will give immediate opportunity for price discovery and liquidity to both Bei and BIBE to all of DeFi. The Bei for this pool will be issued via mint and the Pancakeswap LP will be owned by the development team. These Pancakeswap LP tokens will vest over a four-year window to preserve the liquidity for the market. An additional amount of BIBE will be retained for the development team and investors.

The remaining BIBE will be held by the protocol as a DAO treasury. The community can distribute this as it sees fit as the protocol develops. This will come in the form of future governance proposals which can gift or delegate BIBE tokens to users or contracts.

## Bei Economic Security

The goal of the Bei Protocol is to maintain a liquid market in which BNB/Bei trades at approximately the BNB/USD price. This should be true even in adverse conditions. PCV allows the protocol to accomplish this goal. When trading activity does not support the peg for extended periods, Bei Protocol spends some of the PCV to reweight the price. We define the *liquidity ratio* as  $PCV / Bei_u$ . This is similar to a collateralization ratio. The difference is the PCV is deployed as liquidity rather than directly as collateral.

The liquidity ratio is a measure of how many reweights and corresponding selloff events the protocol can support. If it is less than 1, the protocol is effectively undercollateralized. However, under normal circumstances the protocol would still maintain the ability to repay all outstanding Bei with the collateral. This is a function of the dynamic burn incentives in low demand.

Overcollateralization for every single position simultaneously is inefficient. Bei Protocol pools the would-be collateral into a single liquidity pool for any user to redeem. This pool can be either over- or undercollateralized. If it is undercollateralized, it relies on the assumption that not every user would want to sell at once. The protocol deters selling, which incentivizes holding to maintain a robust peg and protect against death spirals. The protocol is designed to improve the liquidity ratio under normal circumstances. This offsets risks associated with the under-collateralization inherent in the mechanism.

In this section we analyze how the liquidity ratio is impacted by trading activity and reweights. We then provide security analysis on the bounds within which the liquidity ratio improves over time.

## Liquidity Ratio Updates

A sequence of interactions with Bei Protocol would change the  $PCV$  or  $Bei_u$ , often in combination. For example, a purchase of Bei on Pancakeswap or the bonding curve would put BNB into the PCV liquidity pool, and increase the  $Bei_u$ . Conversely, a sale of Bei would decrease both values. Let the change in  $PCV$  associated with a user action be  $\Delta PCV$  and likewise  $\Delta Bei_u$  be the change in user-circulating Bei.

We can define the following update rule to the liquidity ratio for user actions:



$$L_{t+1} = \frac{PCV_{t+1}}{BEI_{u,t+1}} = \frac{PCV_t + \Delta PCV}{BEI_{u,t} + \Delta BEI_u}$$

Ideally  $L_{t+1} \geq L_t$ , i.e. the liquidity ratio improves over time. This property is true when the following inequality is true for positive  $\Delta PCV$ :

$$\frac{\Delta PCV}{\Delta BEI_u} \geq L_t$$

For negative  $\Delta PCV$ , we flip the sign. Let us call the ratio  $\frac{\Delta PCV}{\Delta BEI_u}$ . To summarize, when  $PCV$  and  $Bei_u$  are

increasing, we want the capital factor to be greater than the liquidity ratio. When they are decreasing, we want the capital factor to be less than the liquidity ratio.

### Effect of Activity on Liquidity Ratio

In this section we explore isolated activities and their effect on the liquidity ratio. Pancakeswap fees are ignored in the analysis. They are generally beneficial for the liquidity ratio by either increasing  $PCV$  or reducing the  $Bei_u$  of a trade.

### Bonding Curve

The bonding curve has the price of  $Bei$  increasing relative to  $BNB$  with each purchase. This means the capital factor is increasing. The reasoning is that the new  $Bei$  costs more than the previous  $Bei$  relative to the same amount of  $PCV$ . All else equal, the liquidity ratio must be lower than the capital factor. This is because all prior  $Bei$  had a lower liquidity ratio to enter circulation. Each new purchase improves the liquidity ratio and capital factor. Once Scale is reached, the capital factor would fix and the liquidity ratio would converge to it. This can work positively if the liquidity ratio is low and negatively if the liquidity ratio is high.

### Trading Activity

When analyzing trading activity, we assume we start at the peg with a certain liquidity ratio. First we look at what happens when  $Bei$  trades above the peg. The platform does not incentivize trading activity above the peg. Pure arbitrage should always bring the price down to  $\$1+b$ . Due to path independence on Pancakeswap, a return to the peg should return to the same liquidity ratio as when last at the peg.

More interesting is the case where  $Bei$  trades below the peg. Trading below the peg has a mint incentive  $I(x,t)$  and a burn incentive  $B(x)$ . The incentive function is capped at the corresponding burn function output. Therefore trading activity below and returning to the peg results in negative  $\Delta Bei_u$ , i.e. deflation. The amount of deflation is equal to  $B(x) - I(x,t)$ .

### Reweights

A reweight by itself only burns  $Bei_p$  assuming no other Pancakeswap LPs. However, reweights must be coupled with a sell. Selling can have a positive or negative effect on the liquidity ratio depending on the current liquidity ratio, the size of the sell, and the associated burn.

Selling reduces  $Bei_u$  because the Bei leaves circulation to enter the protocol-owned Pancakeswap pool. The  $Bei_u$  is further reduced via the burn penalty. Likewise it decreases the PCV because BNB is leaving the pool. We need to have the capital factor be less than the liquidity ratio. For a sell amount of  $x$  Bei we need to have:

We know  $\Delta PCV / -x = 1$  because we are selling equivalent amounts of Bei and PCV.

Rearranging the formula and pulling out the  $x$  we get:

$$\Delta PCV \leq -L_t - x * L_t * (1 + m^2 * 100)$$

For  $L > 1$  this is always true. For lower liquidity ratios we would need a larger burn to hit the appropriate capital ratio. However, the burn formula starts at relatively low numbers. A series of sales coupled with reweights could worsen the liquidity ratio. This would happen when the corresponding burns are too low. The protocol would be relying on excess burning in the peg support case to offset the needed burns for reweights. We formalize this concept below.

### External LPs

External LPs are any non protocol actor who supplies liquidity in the incentivized pool. The PCV LP should greatly exceed user LP. This is because all circulating Bei was purchased by BNB which became PCV. User LP does negatively impact the liquidity ratio in the event of a reweight. Reweights would also cost the protocol some PCV if external LPs are in the pool. This is because it needs to execute a trade against the remaining LP to bring the price back up. The relative impact of this grows with the amount of external LP.

### PCV Volatility

Volatility in PCV directly affects the liquidity ratio. When the BNB PCV drops in value, traders would sell BNB to the Bei/BNB pool. This increases PCV in the sense that more BNB enters the protocol's control. However all of the other BNB already held as PCV dropped in value.

Conversely, appreciation in BNB will have a positive ultimate impact on the liquidity ratio. New bonding curves added to the protocol would diversify the PCV. Diversification would improve the robustness of the protocol because it would be less susceptible to volatility. This follows the same reasoning as traditional diversification of asset portfolios.

### Bei Economic Analysis

We have analyzed the effect of individual outcomes on the liquidity ratio. Now we can combine them to formalize the economic security bound of Bei Protocol. We have established the following relationships:

- Bonding curve purchases drive liquidity ratio towards 1
- Trading activity below peg improves liquidity ratio
- Reweight can hurt liquidity ratio when below 1
- External LP amplifies the effect of reweights
- Volatility affects the liquidity ratio

The two sources of direct negativity for the liquidity ratio are volatility and reweights. A sustainable

liquidity ratio requires that deflation due to trading activity offsets these sources of negativity.

We have already shown the necessary condition for a reweight to be net deflationary.

$$\Delta PCV \leq -L^*(x + B(x))$$

We can replace  $B(x)$  with a random variable  $B$  representing the amount of burn before the reweight. This new random variable includes all prior burning since the last reweight.

If we have the following as true, the protocol should always hold or improve its liquidity ratio.

$$E(B) \geq \frac{\Delta PCV}{L_t} - x$$

$E[B]$  is increased by two factors. The first is concrete burn penalties. Higher burns directly translate to a larger  $E[B]$ . The second is trader willingness to reweight the peg. More trader support of the peg means less reweights are necessary over time. Additionally, all volatility not resulting in a reweight positively impacts the liquidity ratio. At a sufficient willingness to support the peg, the protocol would never need to reweight. In the event of sustained sell pressure and low willingness to support the peg, governance is expected to intervene. It can adjust the burn formulas to a level which would improve the liquidity ratio.

Governance is incentivized to steward the liquidity ratio and protect the peg. By guarding the key protocol metrics, governance would improve fidelity in the system and grow the protocol. The flexible architecture allows multiple avenues through which governance can add dynamic and autonomous incentives.

## Conclusion

The Bei Protocol promotes the sustainable creation of a direct incentive stablecoin known as Bei. Bei issuance is controlled by Minters including one-sided bonding curves used to bootstrap the system. The price approaches the pegged oracle at Scale, after which new Bei can enter circulation seamlessly in direct proportion to demand. The bootstrapped funds are retained as Protocol Controlled Value (PCV) which is used to support the peg. This idea creates a "liquidity as collateral" concept. Value is strategically deployed to create liquidity and incentivize the peg for token holders. Additional direct minting rewards and burning penalties are overlaid on the Pancakeswap market. This further range bounds the peg. As the platform extends beyond Scale, the collateralization ratio generally increases due to trading activity.

Bei Protocol presents several key advantages over existing decentralized stablecoin models.

These include:

- high liquidity via PCV
- decentralized collateral
- capital efficiency
- strong peg

- fair distribution

Bei Protocol is a central bank-like infrastructure that could serve as a backbone to current and future DeFi applications.

## Appendix A – Definitions

The following define variables used by the formulas detailed above.

1.  $O_A(B)$  : the oracle price of A paid in B e.g.  $O_{BNB}(Bei) = 500 \text{ Bei/BNB}$
2.  $P_A(B)$  : the instantaneous price of A paid in B (contextually either on Pancakeswap or bonding curve)
3.  $S$  : the Scale target of a given bonding curve, in terms of  $Bei_b$
4.  $b$  : the buffer on the bonding curve peg price
5.  $m$  : the magnitude difference of a Pancakeswap price and oracle price defined as  $\frac{P_A(X) - O(X)}{O(X)}$

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