「2024 APAF International Conference」

Comparison of the issuance cost of bond tokens compared to traditional bonds

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2024. 07. 10.

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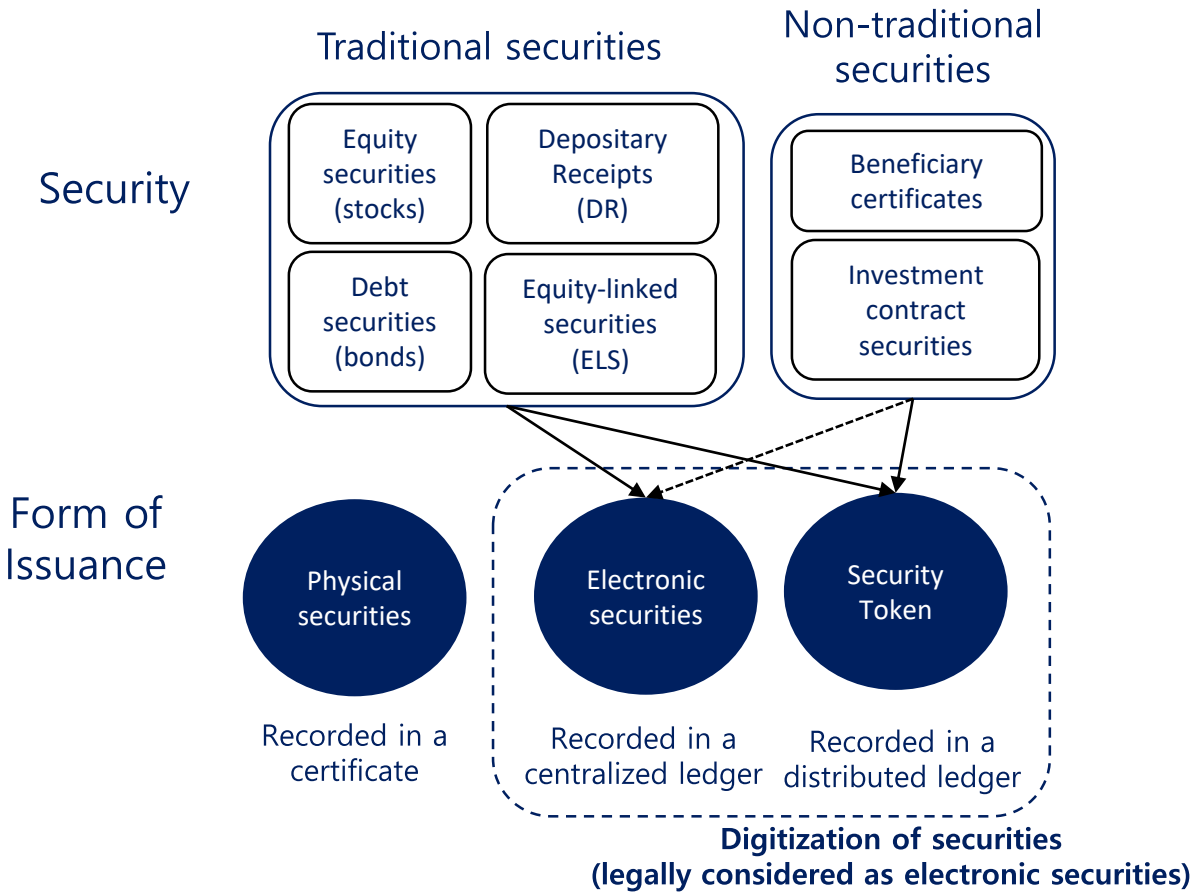
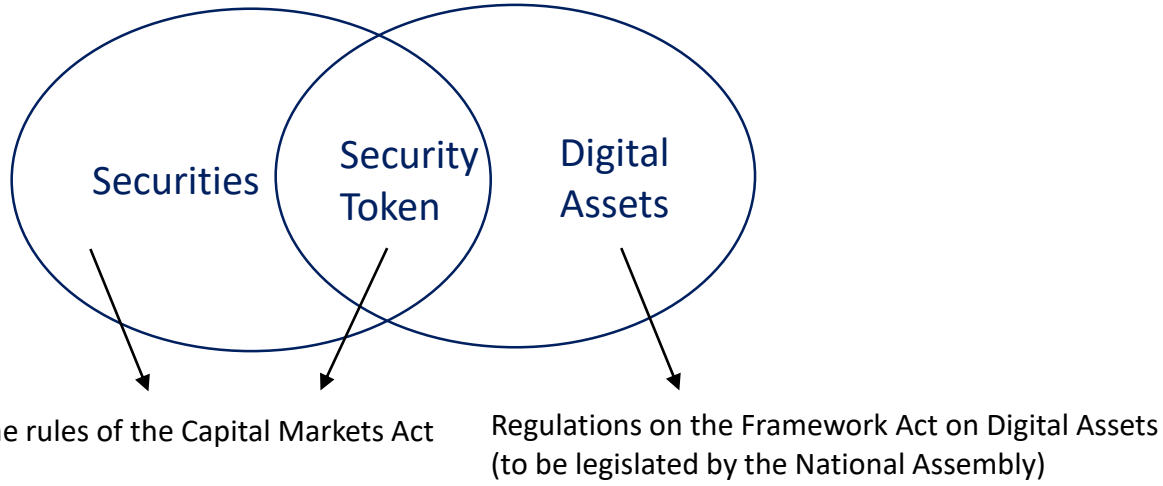
Definition of Security Token

- Security tokens refer to the digitalization of securities under the Capital Markets Act using Distributed Ledger Technology (DLT).(Financial Services Commission, 2023)



Issuance and Distribution of Security Tokens

- STO – Security Token Offering
- Since security tokens are essentially securities, they are subject to the same regulations under the Capital Markets Act(Financial Services Commission, 2023)

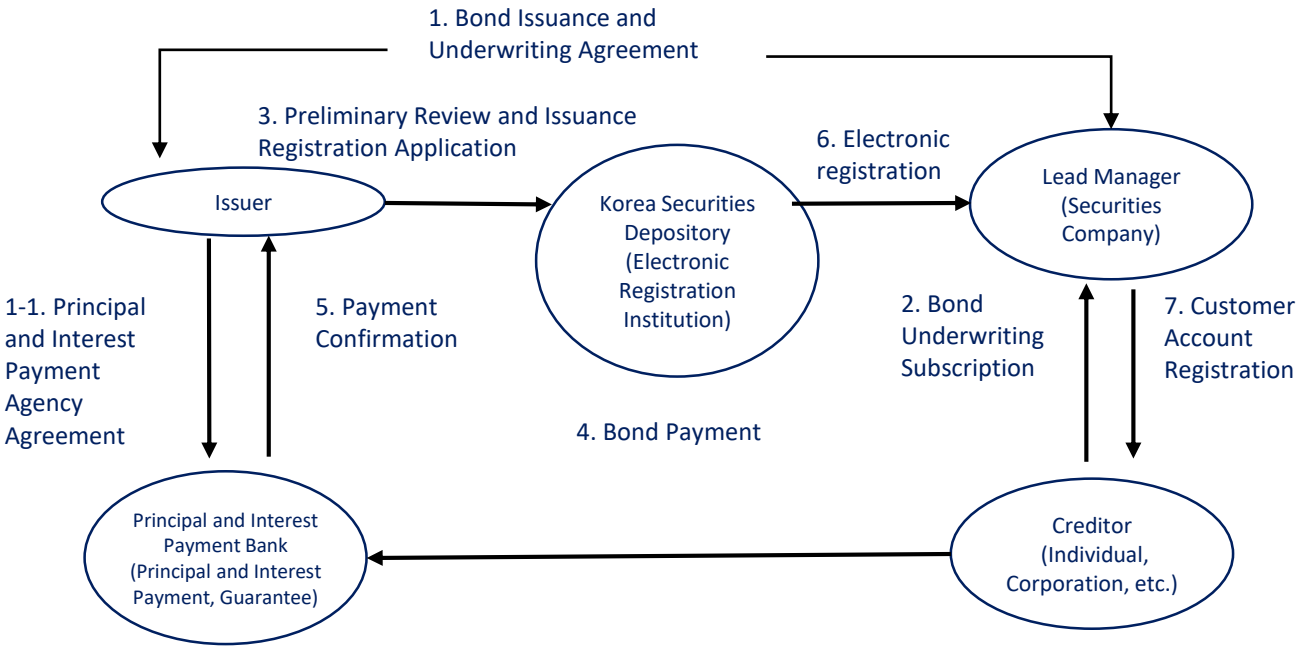


- **Due to the nature of tokens, it is easy to split and transfer transaction units.**
- **Increasing efficiency and convenience of issuing and trading securities through distributed ledger technology.**
- **Provision of new securities products to meet the diverse demands of small investors**

Bond Electronic Securities Issuance Process

- According to the current bond electronic securities issuance process, the following fees are incurred at each stage.
  - Asset Due Diligence Fee, Credit Rating Fee, Underwriting Fee,
  - Listing Fee, Electronic Bidding Agency Fee, Issuance Registration Fee

<Full process of electronic bond registration, Korea Securities Depository>

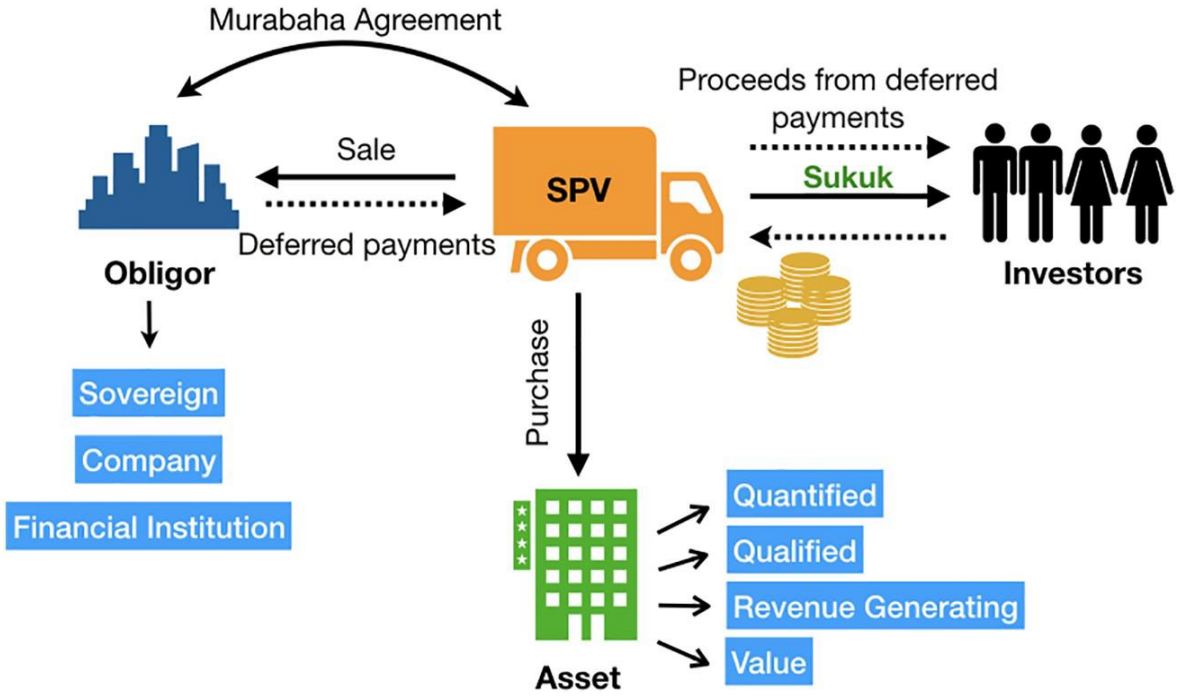


STO Process(Khan et al, 2022)

- Khan et al. (2022) explored the potential for the tokenization of Sukuk (traditional Islamic bonds).

  Comparison of bond issuance costs: Conventional Sukuk vs. Sukuk Tokenization (STO)

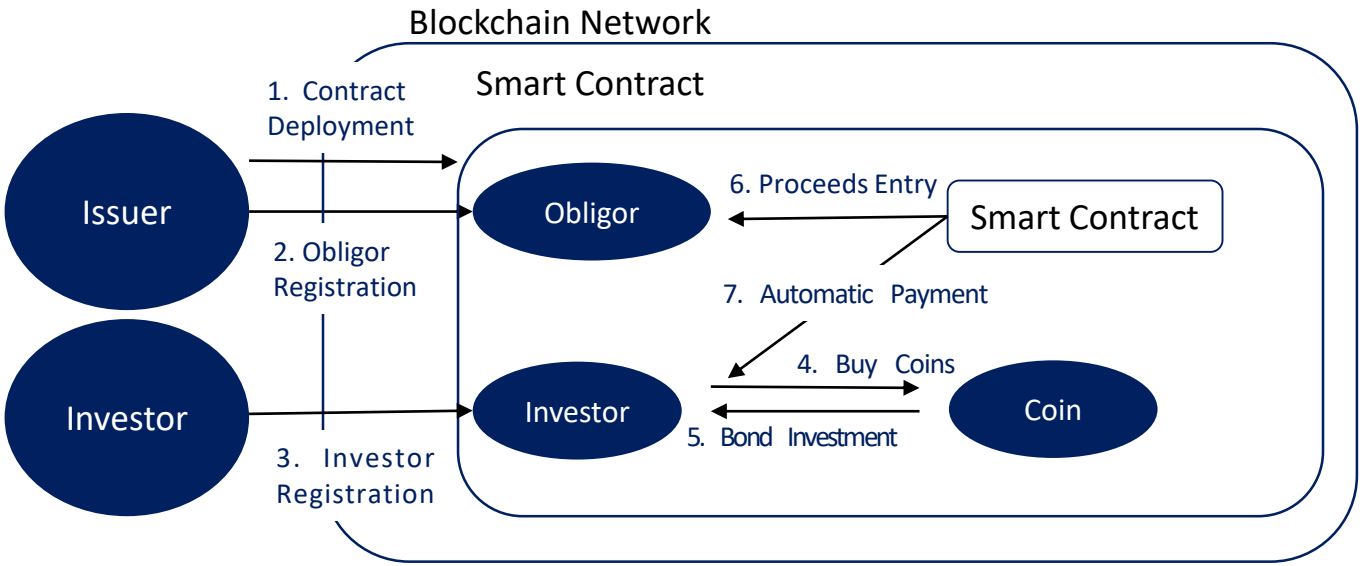
  1. Slow Process
  2. Lack of Standardization



STO Process(Khan et al, 2022)

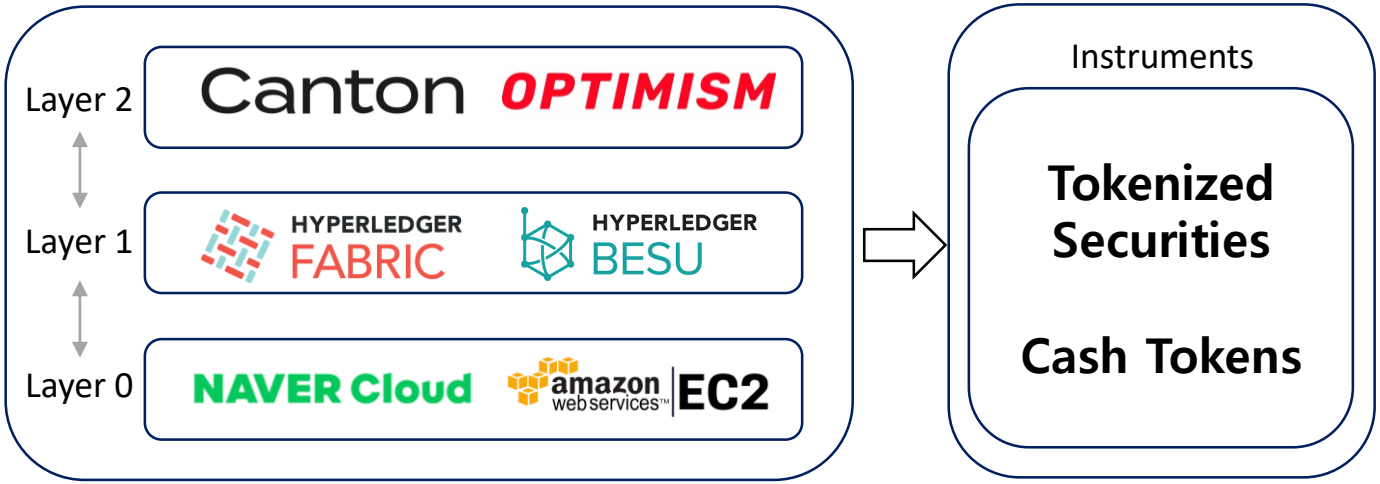
- According to the bond STO issuance process, the following fees are incurred at each stage
  - Contract Deployment Fee, Obligor Registration Fee, Investor Registration Fee
  - Coin Purchase Fee, Bond Investment Fee, Proceeds Entry Fee, Automatic Payment Fee
  - **In a private/consortium network, fees can be adjusted at each stage of the process**

<Full process of bond STO issuance, Khan et al, 2022, secondary citation>



STO Process(Khan et al, 2022)

- **To establish a Private/Consortium network, the roles of each layer must be defined, and blockchain services should be enabled on these layers**
  - Layer 0 : The layer that provides server computing resources, centered around nodes in each region (e.g., Amazon EC2)
  - Layer 1: The platform layer that forms the network on top of Layer 0 (e.g., Hyperledger Fabric, R3 Corda).
  - Layer 2: The platform layer that requires additional measures such as personal data security



<The architecture of Digital Platform used for STO, Bond Tokenization in Hong Kong, 2023.8, secondary citation>

STO Process(Khan et al, 2022)

https://doi.org/10.1016/j.gfj.2020.100539

- Khan et al. (2022) explored the potential for the tokenization of Sukuk (traditional Islamic bonds)

Comparison of Bond Issuance Costs : Conventional sukuk vs Sukuk tokenization(STO)

<Cost components for sukuk tokenization on public Ethereum, Khan et al, 2022>

Sukuk component			USD	
Amount			$500,000,000	
Issuance			$498,590,000 (Issuance Price : $1,410,000)	
Total Fee Cost			**$2,266,316**	
Issuance Price - Fee			$496,323,684	
Fee Deduction Rate			0.45%	
Detailed Fee Items			Item Description	USD
Fee	Total Transaction Fee	Smart contract deployment	contract deployment	$0.35
		Fee: registerObligor	registerObligor	$0.01
		Fees: newInvestor & buyCoins	newInvestor & buyCoins	$102,130
		Fee: investInSukuk	investInSukuk(bonds)	$124,725
		Fee: enterProceeds	enterProceeds	$0.14
		Fee: automaticPayment	automaticPayment	$16,646
	Additional evaluation fee	Independent advisor	Estimated Additional Evaluation Costs in Islamic Culture (Fees deducted as a percentage of issuance size)	$99,718(0.020%)
		Legal expenses		$149,577(0.030%)
		Bond rating		$498,590(0.100%)
		Rating costs		$24,929.50(0.005%)
		Shariah advisory fee		$1,250,000(0.25%)
	Total Fee Cost			**$2,266,316**

STO Process(Khan et al, 2022)

https://doi.org/10.1016/j.gfj.2020.100539

- The bond issuance costs on a private/consortium Ethereum network using the Sukuk case

<Cost components for sukuk tokenization on private/consortium Ethereum, Khan et al, 2022>

component			USD	
Amount			$500,000,000	
Issuance			$498,590,000 (Issuance Price : $1,410,000)	
Total Fee Cost			**$2,033,734**	
Issuance Price - Fee			$496,556,267	
Fee Deduction Rate			0.40789%	
Detailed Fee Items			Item Description	USD
Fee	Total Transaction Fee	Smart contract deployment	contract deployment	$0
		Fee: registerObligor	registerObligor	$0
		Fees: newInvestor & buyCoins	newInvestor & buyCoins	$0
		Fee: investInSukuk	investInSukuk(bonds)	$0
		Fee: enterProceeds	enterProceeds	$0
		Fee: automaticPayment	automaticPayment	$0
	Node Hosting Fee	Website Hosting	Paris : Website Hosting	$2737
		Blockchain Node Paris	Node located in Paris	$2737
		Blockchain Node Dubai	Node located in Dubai	$2856
		Blockchain Node Malaysia	Node located in Malaysia	$2589
	Additional evaluation fee	Independent advisor	Estimated Additional Evaluation Costs in Islamic Culture (Fees deducted as a percentage of issuance size)	$99,718(0.020%)
		Legal expenses		$149,577(0.030%)
		Bond rating		$498,590(0.100%)
		Rating costs		$24,929.50(0.005%)
		Shariah advisory fee		$1,250,000(0.25%)
	Total Fee Cost			**$2,033,734**

STO Process(Khan et al, 2022)

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- Using the Sukuk case, the bond issuance costs on an internal blockchain (free node hosting)

Sukuk component			USD	
Amount			$500,000,000	
Issuance			$498,590,000 (Issuance Price: $1,410,000)	
Total Fee Cost			**$2,022,815**	
Issuance Price - Deducting Fees			$496,567,186	
Fee Deduction Rate			0.40570%	
Detailed Fee Items			Item Description	USD
Fee	Total Transaction Fee	Smart contract deployment	contract deployment	$0
		Fee: registerObligor	registerObligor	$0
		Fees: newInvestor & buyCoins	newInvestor & buyCoins	$0
		Fee: investInSukuk	investInSukuk(bonds)	$0
		Fee: enterProceeds	enterProceeds	$0
		Fee: automaticPayment	automaticPayment	$0
	Node Hosting Fee	Website Hosting	Paris : Website Hosting	$0
		Blockchain Node Paris	Node located in Paris	$0
		Blockchain Node Dubai	Node located in Dubai	$0
		Blockchain Node Malaysia	Node located in Malaysia	$0
	Additional evaluation fee	Independent advisor	Estimated Additional Evaluation Costs in Islamic Culture (Fees deducted as a percentage of issuance size)	$99,718(0.020%)
		Legal expenses		$149,577(0.030%)
		Bond rating		$498,590(0.100%)
		Rating costs		$24,929.50(0.005%)
		Shariah advisory fee		$1,250,000(0.25%)
	Total Fee Cost			**$2,022,815**

STO Process(Khan et al, 2022)

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- Khan et al. (2022) explored the potential for the tokenization of Sukuk (traditional Islamic bonds)

  Comparison of Bond Issuance Costs : Conventional sukuk vs Sukuk tokenization(STO)

Sukuk issuance type	Total cost = Fees and Expenses + Issue price	**Fees and Expenses**
Conventional issuance	$7,165,532 (1.4311%)	**115.11bp** $5,755,532 (1.1511%)
Tokenization on public Ethereum	$3,676,316 (0.7433%)	**45.33bp** $2,266,316 (0.4533%)
Tokenization on consortium blockchain	$3,443,734 (0.6907%)	**40.78bp** $2,033,734 (0.40789%)
Tokenization on internal blockchain	$3,432,815 (0.6885%)	**40.57bp** $2,022,815(0.40570%)

Layer0&1 : Private/Consortium Blockchain Network

- Layer 1 : Hyperledger Fabric, Hyperledger Besu, R3 Corda, Ethereum

Network	Pros	Cons
Hyperledger Fabric	• **Modular and plug-compatible structure for easy network expansion** • **Privacy and confidentiality** • **High scalability through support for various consensus mechanisms**	• **Increased complexity as expansion continues** • **Limited network participation**
Hyperledger Besu	• Compatibility with the Ethereum ecosystem • Configurable efficient consensus mechanisms	• Insufficient support for a variety of programming languages compared to Fabric • Concerns about service compatibility due to lower popularity
R3 Corda	• Transaction privacy • Facilitates inter-industry collaboration in the Corda network	• Limited application scope (primarily finance) • Unique design philosophy • Restricted network participation
Ethereum	• Decentralized applications • Support for diverse frameworks through a large and active developer community	• Increased network complexity due to high usage • Sensitivity to transaction cost risks based on Ethereum prices

Layer0&1 : Private/Consortium Blockchain Network

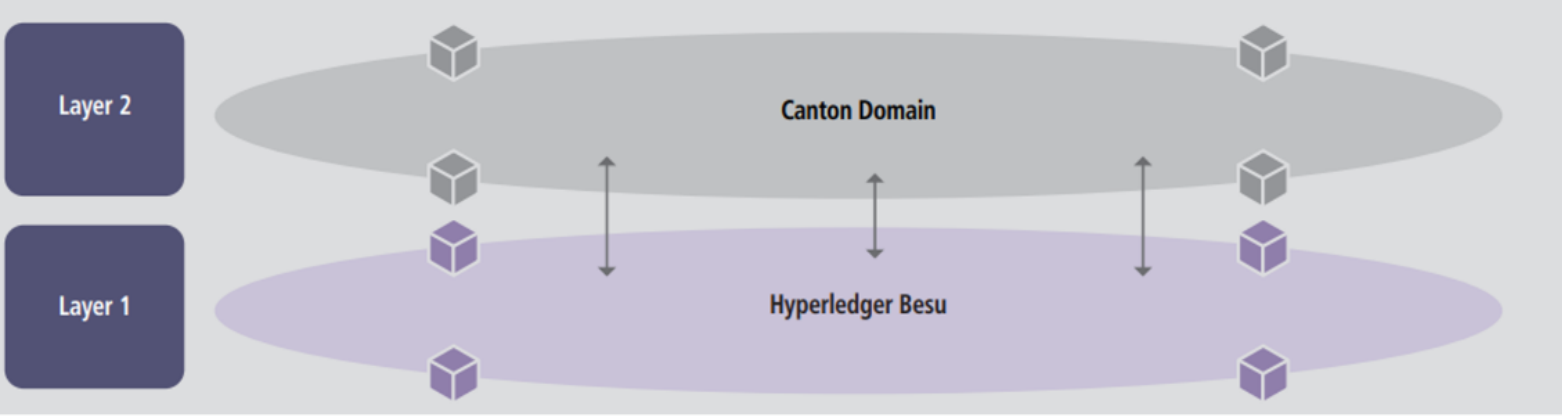
- Layer 1 : Hyperledger Fabric, Hyperledger Besu

	Issuance perspective		Distribution perspective	
Network	Pros	Cons	Pros	Cons
Hyperledger Fabric	• Easy network scalability (modular and plug-compatible • Privacy and confidentiality • High scalability (support for various consensus mechanisms)	• Increased complexity over time (with continued expansion) • Limited network participation	• High level of security • Processing speed and efficiency	• Network management complexity • Limitations on smart contracts
Hyperledger Besu	• Compatibility with the Ethereum ecosystem • Ability to configure efficient consensus mechanisms	• Insufficient support for a variety of programming languages compared to Fabric • Lack of service compatibility due to lower popularity	• Compatibility with Ethereum-based smart contracts • Support for both public and private networks	• Security risks of public blockchains • Excessive energy consumption

International STO Use Cases : Greenbond Case

- **HSBC's Blockchain Adoption Case for Sustainable Finance**
  - Expanding Ethereum Ecosystem Features with Hyperledger Besu
  - Enhancing Information Security and Scalability with Canton

<GreenBond Platform Structure, Bond Tokenisation in Hong Kong, 2023.8>



International STO Use Cases : Greenbond Case

- In the Hong Kong Green Bond case, the issuance process was conducted using blockchain
  - The adoption of blockchain led to cost reductions in specific items
  - issuance amount: $100,000,000

<Haahr, M.(2019), Blockchain—gateway for sustainability linked bonds. Green Digital Finance Alliance>

Process	Standard Process(USD)	**Blockchain Process(USD)**
Structuring, price setting, risk rating	1,000,000(100bp)	20,000(2bp)
Legal review	100,000(10bp)	40,000(4bp)
Investor whitelisting and matchmaking	500,000(50bp)	n/a
Internal review and green classification	50,000(5bp)	20,000(2bp)
Third party validation and green benchmarking	50,000(5bp)	5,000(0.5bp)
Registration and listing	15,000(1.5bp)	n/a
Brokerage and sales	1,500,000(150bp)	40,000(4bp)
Payment and settlement	84,000(8.4bp)	0
Custodianship	350,000(35bp)	2,000 (0.2bp)
Data gathering	1,200,000(120bp)	350,000 (35bp)
Data aggregation	400,000(40bp)	115,000 (11.5bp)
Reporting	1,200,000(120bp)	100,000 (10bp)
Total	**6,449,000(644.9bp)**	**692,000(69.2bp)**

<Case Study on Cost Reduction in Issuance through Blockchain Adoption>

Cases	Standard to Blockchain
HongKong Greenbond (2019)	**89.2% Cost Saving**
Enroeo Capital (2019)	**39.5% Cost Saving**
Finoa and Cashlink (2020)	**35%~65% Cost Saving**

Special Bonds: Actual DART Issuance Cost Analysis

- As of March 1, 2023, the balance of special bonds in Busan Financial Hub is KRW 181.72 trillion.
  - The balance of special bonds from the Korea Housing Finance Corporation is KRW 171.25 trillion.
  - Using the recent bond securitization case of the Korea Housing Finance,

    a comparison of issuance costs is conducted

Division	Amount (₩)	
Amount	694,100,000,000	
Total Fee Cost	71,616,300	
Issuance Price - Fee	694,028,383,700	
Division	Amount (₩)	**Source**
Asset due diligence fee	-	According to Service Agreement
Credit rating fee		
Underwriting Fee		
Listing Fee		
Electronic Bidding Agency Fee		
Issuance Registration Fee		
Total	71,616,300	

- **Fee relative to issuance size: 1.03bp (calculated as 0.0103%)**

Special Bonds: Actual DART Issuance Cost Analysis

- Benchmarking similar case fees issued by Corporation A and detailed fee amounts.
  - **Asset due diligence fee** and **credit rating fee** are included as **additional evaluation costs** in the STO issuance process.

Differentiation of fees	Amount (₩) (estimated)	Note	**Source**
Asset due diligence fee	52,416,300	-	Benchmarking similar cases
Credit rating fee		Total assets over 2 trillion won - 33,000,000	Korea Corporate Governance Evaluation appraisal fee
Underwriting Fee	10,000,000	-	Benchmarking similar cases
Listing Fee	1,700,000	Market capitalization exceeding 500 billion KRW	KRX listing fee
Electronic Bidding Agency Fee	7,000,000	Capital of at least 10 billion KRW	Commercial bank securities agency commission fee (Hana)
Issuance Registration Fee	500,000	Construction bonds exceeding 10 billion KRW	Korea Securities Depository

STO Issuance Process and Fee Estimation through Implementation with Remix IDE

- To implement the smart contract environment, Remix IDE is used with the Solidity language.
- Transaction fee estimations are conducted for both the Test Net and Main Net environments.

Component	Value
amount	₩ 694,100,000,000
coupon frequency	semiannually (twice a year)
annual profit	379.4bp(3.794%)
period	3years

- Implementation of Virtual Accounts (Ganache) and Integration (Metamask)
- Transaction Fee (ETH) : As of May 1, 2024
- Ethereum Price: As of May 1, 2024(₩ 4,186,000, Upbit)

```
pragma solidity >=0.4.22 <0.6.0;

//pragma solidity >=0.8.0;
contract BlockBusanCoin {
    address owner;
    uint maturity;
    uint faceValue;
    uint paymentFrequency;
    uint issueSize;
    uint BusanCoin;
    address obligor;
    string profitRate;
    string BusanBond;
    uint BCoin;

constructor() public {
    owner = msg.sender;
    faceValue = 1000000;
    issueSize = 694100000000;
    BusanCoin = 200000;
    profitRate = "3.794%";
    BusanBond= "BusanBond";
    BCoin= 694100000000;
    paymentFrequency = now + 3 minutes;
    maturity = now+ 3*365 days;
}
```

STO Issuance Process and Fee Estimation through Implementation with Remix IDE

- Calculation of Transaction Fees on the Test Net and Application of Bond Issuance Standards

< Calculation of Transaction Fee by Item>

Component	*(multiple)	Ethereum fee (ETH, 2024-05-01)	conversion to Korean Won (₩, 2024-05-01)
Contract Deployment	* 1 (one-time contract deployment)	0.00255057	10,676
Obligor Registration	* 1 (one obligor)	0.00008223	344
Investor Registration (1 person)	* 1 (number of investors)	0.00029593	1,238
Coin Purchase (minimum unit)	* 1 (one purchase per investor)	0.000401	1,678
Bond Investment (full amount)	* 1 (bond investment conversion per investor)	0.00030071	1,258
Proceeds Entry (semiannually)	* 2 * 3 (semiannually over three years)	0.00052968	2,217
Automatic Payment (1 time)	* 2 * 3 (semiannually for three years per investor)	0.00168678	7,060

STO Issuance Process and Fee Estimation through Implementation with Remix IDE

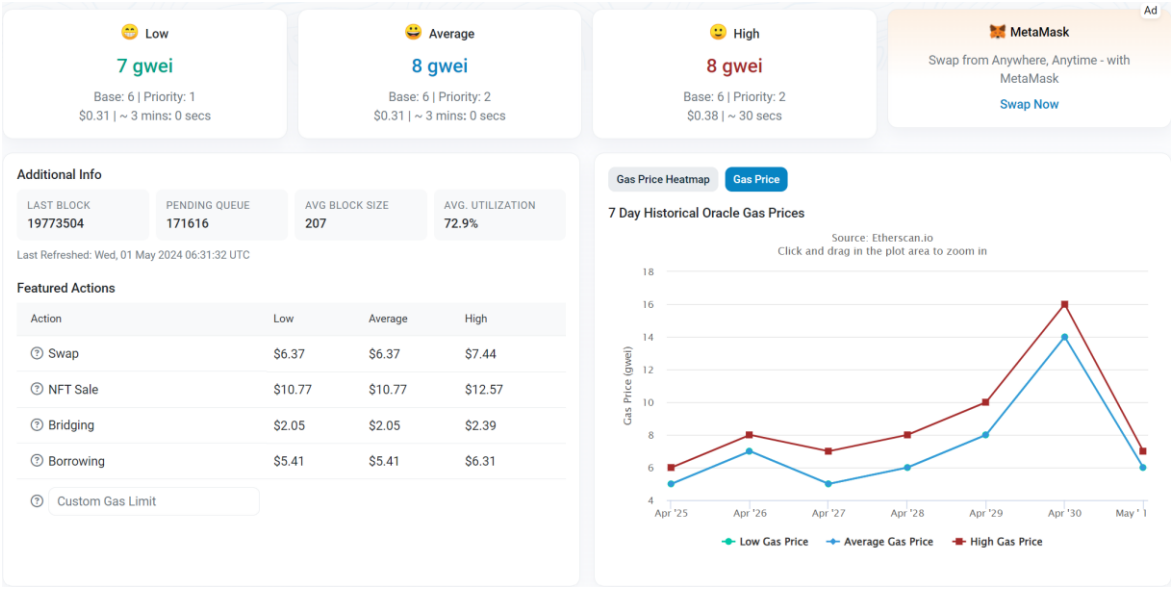
- Final Estimation of Transaction Fees on the Test Net

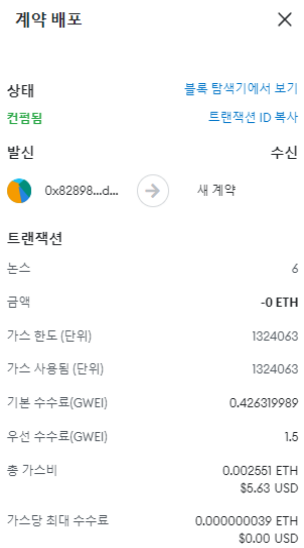
Component			conversion to Korean Won(2024-05-01)(₩)
Amount			694,100,000,000
Total Fee Cost			**52,440,771**
Issuance Price - Fee			694,047,559,229
Fee Deduction Rate			**0.0075552%**
Detailed Fee Items			conversion to Korean Won(2024-05-01)(₩)
Fee	Total Transaction Fee	Contract Deployment	10,676
		Obligor Registration	344
		Investor Registration	1,238
		Coin Purchase	1,678
		Bond Investment	1,258
		Proceeds Entry	2,217
		Automatic Payment	7,060
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**52,440,771**

STO Issuance Process and Fee Estimation through Implementation with Remix IDE

- Recalculate Transaction Fees by applying gas fees on the Main Net
  - Change to base fee (8 gwei) + priority fee (1.5 gwei) as of May 1, 2024

< Ethereum Gas Station : Main Net>





STO Issuance Process and Fee Estimation through Implementation with Remix IDE

- Recalculate Transaction Fees by applying gas fees on the Main Net

< Application of Main Net gas fee>

Component	*(multiple)	Ethereum fee (ETH,2024-05-01)	conversion to Korean Won (₩, 2024-05-01)
Contract Deployment	* 1 (one-time contract deployment)	0.012578599	52,654
Obligor Registration	* 1 (one obligor)	0.000412471	1,726
Investor Registration (1 person)	* 1 (number of investors)	0.001523439	6,377
Coin Purchase (minimum unit)	* 1 (one purchase per investor)	0.002112582	8,843
Bond Investment (full amount)	* 1 (bond investment conversion per investor)	0.001615095	6,760
Proceeds Entry (semiannually)	* 2 * 3 (semiannually over three years)	0.002897139	12,127
Automatic Payment (1 time)	* 2 * 3 (semiannually for three years per investor)	0.009542769	39,946

- Ethereum price: as of May 1, 2024 (₩4,186,000, Upbit)
- Gas fee : 9.5gwei

STO Issuance Process and Fee Estimation through Implementation with Remix IDE

- Recalculate Transaction Fees by applying gas fees on the Main Net

< Calculate Gas Fee + Sum of Additional Evaluation Costs>

Component			conversion to Korean Won(2024-05-01)(₩)
Amount			694,100,000,000
Total Fee Cost			**52,544,733**
Issuance Price - Fee			694,047,455,267
Fee Rate			**0.0075702%**
Detailed Fee Items			conversion to Korean Won(2024-05-01)(₩)
Fee	Total Transaction Fee	Contract Deployment	52,654
		Obligor Registration	1,726
		Investor Registration	6,377
		Coin Purchase	8,843
		Bond Investment	6,760
		Proceeds Entry	12,127
		Automatic Payment	39,946
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**52,544,733**

STO Issuance Process and Fee Estimation through Implementation with Remix IDE

- Final Fee Comparison Based on the Number of Investors

< 1 investor (minimum) > • **Fee 0.75702bp**

Component			conversion to Korean Won(2024-05-01)(₩)
Amount			694,100,000,000
Total Fee Cost			**52,544,733**
Issuance Price - Fee			694,047,455,267
Fee Rate			**0.0075702%**
Detailed Fee Items			
Fee	Total Transaction Fee	Contract Deployment	52,654
		Obligor Registration	1,726
		Investor Registration	6,377
		Coin Purchase	8,843
		Bond Investment	6,760
		Proceeds Entry	12,127
		Automatic Payment	39,946
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**52,544,733**

< 3 investors > • **Fee 0.75880bp**

Component			conversion to Korean Won(2024-05-01)(₩)
Amount			694,100,000,000
Total Fee Cost			**52,668,585**
Issuance Price - Fee			694,047,331,415
Fee Rate			**0.0075880%**
Detailed Fee Items			
Fee	Total Transaction Fee	Contract Deployment	52,654
		Obligor Registration	1,726
		Investor Registration	19,131
		Coin Purchase	26,529
		Bond Investment	20,280
		Proceeds Entry	12,127
		Automatic Payment	119,838
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**52,668,585**

Layer 0 (L0) Cloud Computing Service Selection Process

- Layer 0: Assuming the occurrence of special bond situations, Node Hosting is assumed using Cloud Computing in major regions.
- Region: Seoul
  - Duration: 3 years
  - Cost: Calculated based on 2 Nodes
- Layer 0 : Cloud Computing Service Supplier List up, calculate costs every 3 years

Cloud Computing Service	Cost	Pros
AWS	**$2,007.8**	- **Support for various services** - **Global usability, easy compatibility** **- cost-effective**
Naver Cloud PLATFORM	₩ 5,093,280	- Easy setup and scalable - cost-efficient

- Among Cloud Computing Services, AWS has been selected for this cost estimation.
  - The ease of expanding physical service coverage through future node additions
  - Considering cost-efficiency compared to Naver Cloud Platform

Layer 1 (L1) Blockchain Network Selection Process

- Layer 1: Listing Hyperledger Fabric suppliers, calculating costs for 1 Node every 3 years

Hyperledger Fabric	Cost	Pros
IBM	$7,621.2	- Data immutability - Strong security features
Naver	**₩ 3,153,600**	- **Easy setup and scalability** - **Cost-effective**
Oracle - Enterprise	$11,303.0	- Swift setup - Robust security
Azure	$8,961.5	- Rapid deployment support
Amazon	$15,768	- Ease of setup - Efficient security networking

- Among Hyperledger Fabric services, Naver has been selected for this cost estimation
  - Ease of setup and scalability compared to other platforms
  - Convenient communication due to being a domestic big tech company
  - Cost-efficiency among platforms with service stability

Cost Estimation Based on Hyperledger Fabric (L0-Amazon)

- Fee Variations According to Layer 1 Platform (Hyperledger Fabric Fee)

<Cost for Private / Consortium on each Hyperledger Fabric platform>

Component			conversion to Korean Won(₩)				
Amount			694,100,000,000				
Total Fee Cost			**58,180,040**	**64,934,000**	**69,720,376**	**66,676,364**	**75,524,840**
Issuance Price - Fee			694,041,819,960	694,035,066,000	694,030,279,624	694,033,323,636	694,024,475,160
Fee Rate			**0.0083820%**	**0.0093551%**	**0.0100447%**	**0.0096061%**	**0.0108810%**
Operating company name of Layer 1 platform			**Naver**	**IBM**	**Oracle**	**Azure**	**Amazon**
Fee	Total Transaction Fee	Contract Deployment	0	0	0	0	0
		Obligor Registration	0	0	0	0	0
		Investor Registration	0	0	0	0	0
		Coin Purchase	0	0	0	0	0
		Bond Investment	0	0	0	0	0
		Proceeds Entry	0	0	0	0	0
		Automatic Payment	0	0	0	0	0
	Node Hosting Fee	Website Hosting	1,305,070	1,305,070	1,305,070	1,305,070	1,305,070
		Blockchain Node Seoul	1,305,070	1,305,070	1,305,070	1,305,070	1,305,070
		Hyperledger Fabric Cost	3,153,600	9,907,560	14,693,936	11,649,924	20,498,400
	Additional evaluation fee	credit rating fee	52,416,300	52,416,300	52,416,300	52,416,300	52,416,300
		Asset Due Diligence Fee					
	Total Fee Cost		**58,180,040**	**64,934,000**	**69,720,376**	**66,676,364**	**75,524,840**

Cost Estimation Based on Hyperledger Fabric (L0-Amazon + L1-Naver)

< Total Private/Consortium Costs >

Component			conversion to Korean Won(₩)
Amount			694,100,000,000
Total Fee Cost			**58,180,040**
Issuance Price - Fee			694,041,819,960
Fee Deduction Rate			**0.0083820%**
Detailed Fee Items			conversion to Korean Won(2024-05-01)(₩)
Fee	Total Transaction Fee	Contract Deployment	0
		Obligor Registration	0
		Investor Registration	0
		Coin Purchase	0
		Bond Investment	0
		Proceeds Entry	0
		Automatic Payment	0
	Node Hosting Fee	Website Hosting	1,305,070
		Blockchain Node Seoul	1,305,070
		Naver Blockchain	3,153,600
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**58,180,040**

Comparison of Advantages and Disadvantages of Public, Private, and Consortium Process

Type	Advantages	Disadvantages	Appropriate situation
Public Blockchain	• Transparency: Transaction records are publicly available • Scalability: Anyone can participate and conduct transactions	• Processing Speed: Concerns about transaction processing speed due to high user demand • Cost: Transaction fees vary significantly based on the value of linked assets	• When comprehensive transparency is required • When there is a need to maximize decentralization • When participation in an open-source community is crucial
Private & Consortium Blockchain	• Efficiency: Transactions are processed quickly due to a limited number of participants • Privacy: Information is disclosed only to restricted individuals	• Transparency: Limited network participants make external verification difficult • Participant Restriction: Access to the network is restricted	• When collaboration with restricted participants is important • When high security and data privacy are required • When regulatory compliance is crucial • When efficient processing speed is required • When interoperability and network effects are important

Comparison of Advantages and Disadvantages of Public, Private, and Consortium Process

< Public 1 investor (minimum) >

- **Fee 0.75702bp**

Component			conversion to Korean Won (2024-05-01)(₩)
Amount			694,100,000,000
Total Fee Cost			**52,544,733**
Issuance Price - Fee			694,047,455,267
Fee Rate			**0.0075702%**
Detailed Fee Items			
Fee	Total Transaction Fee	Contract Deployment	52,654
		Obligor Registration	1,726
		Investor Registration	6,377
		Coin Purchase	8,843
		Bond Investment	6,760
		Proceeds Entry	12,127
		Automatic Payment	39,946
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**52,544,733**

< Public 3 investors >

- **Fee 0.75880bp**

Component			conversion to Korean Won (2024-05-01)(₩)
Amount			694,100,000,000
Total Fee Cost			**52,668,585**
Issuance Price - Fee			694,047,331,415
Fee Rate			**0.0075880%**
Detailed Fee Items			
Fee	Total Transaction Fee	Contract Deployment	52,654
		Obligor Registration	1,726
		Investor Registration	19,131
		Coin Purchase	26,529
		Bond Investment	20,280
		Proceeds Entry	12,127
		Automatic Payment	119,838
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**52,668,585**

< Private / Consortium>

- **Fee 0.83820bp**

Component			conversion to Korean Won (2024-05-01)(₩)
Amount			694,100,000,000
Total Fee Cost			**58,180,040**
Issuance Price - Fee			694,041,819,960
Fee Rate			**0.0083820%**
Detailed Fee Items			
Fee	Node Hosting Fee	Website Hosting	1,305,070
		Blockchain Node Seoul	1,305,070
		Naver Blockchain	3,153,600
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**58,180,040**

In the Private/Consortium Process, excluding intermediary fees :No additional costs are incurred aside from evaluation fees

< Excluding brokerage fees >

- **Fee 0.75516bp**

Component			conversion to Korean Won
Amount			694,100,000,000
Total Fee Cost			**52,416,300**
Issuance Price - Fee			694,047,583,700
Fee Rate			**0.0075516%**
Detailed Fee Items			
Fee	Total Transaction Fee	Contract Deployment	0
		Obligor Registration	
		Investor Registration	
		Coin Purchase	
		Bond Investment	
		Proceeds Entry	
		Automatic Payment	
	Additional evaluation fee	credit rating fee	52,416,300
		Asset Due Diligence Fee	
	Total Fee Cost		**14,200,000**

Final Estimated Cost Comparison

- Recently (23.12.12), the Korea Housing Finance Corporation raised 694.1 billion KRW.

Issuance method	Fee	**commission rate**
Traditional issuance method	₩ 71,616,300	**1.03719bp**
Tokenization on public Ethereum(3 investors)	₩ 52,668,585	**0.75880bp**
Tokenization on private/consortium blockchain	₩ 58,180,040	**0.83820bp**
Tokenization on internal blockchain	₩ 52,416,300	**0.75516bp**

- Public, Private/Consortium, Internal Blockchain STO cost function
- Public = $f(Investor\ count, interest\ payment\ frequency, Ethereum\ price, Gas\ cost, external\ evaluation\ cost)$
- Private/Consortium = $f(L0\ operating\ costs, L1\ operating\ costs, external\ evaluation\ costs)$
- Internal = $f(External\ evaluation\ costs)$

✓ In blockchain, issuance price and interest rate do not affect transaction costs.

Contributions

- **Cost savings :** Reduction in fees compared to traditional assets when applying STO using blockchain technology.
  (Standard: 1.0372bp -> Public: 0.7588bp -> Internal: 0.7552bp)
- **Transparent investment tracking and reporting :** Since all transactions are recorded on the blockchain, it allows for precise tracking and reporting of investment flows and performance.
- **Improved risk management :** Using digital asset management platforms, issuers can monitor and manage risks in real-time.
- **Automation and streamlining of processes :** Relevant processes in the issuance process can be automated and streamlined using smart contracts.
- **Cost savings in audits :** Utilizing smart contracts enables automation and simplification of both external and internal audits, leading to reduced audit costs.
  (Haahr, M.(2019), Blockchain—gateway for sustainability linked bonds. Green Digital Finance Alliance)
- **Reduction in personnel costs :** Leveraging smart contracts can decrease the personnel costs associated with issuance.

Limitations

- We have not accounted for additional fees such as annual issuance fees related to bond issuance.
- Only basic functionalities necessary for issuance have been coded, and factors such as identity verification, balance requirements, conversion from fiat currency to cryptocurrency, and security and privacy measures have not been considered.
- Actual guidelines are not specified, so changes are expected based on future regulations.
- For public scenarios, costs may fluctuate based on Ethereum's gas fees and prices.
- In private scenarios, costs may vary depending on agreements with L0 and L1 operating companies.
- Additional security measures (L2) are necessary to address potential financial crimes using STO platforms.
- Developing internal systems and processes for regulatory compliance requires cost and effort.
- Resolving technical compatibility issues between various blockchain platforms is also essential.

(Reference) Korean Use Cases: Green Bond Case

- In Korea, Green Bonds are being issued,
  but the process is similar to that of traditional bond issuance.
  - Korean Green Bonds are included in Socially Responsible Investment (SRI) bonds.
  - The traditional bond issuance process includes an audit stage by external agencies to perform a 'suitability assessment'.

<Social Impact Investment Bonds Issuance Status, 2024, KRX>

Bond Type	Number of Issuing Institutions	Number of Issues	Listed Amount (Million KRW)
Green Bonds	90	279	26,080,818
Social Bonds	116	1,531	205,086,864
Sustainability Bonds	57	257	17,833,000
Sustainability-Linked Bonds	1	4	210,000
Total	222 (264)*	2,071	249,210,682

* Number of unique institutions (cumulative count of issuing institutions)

(Reference) Korean Use Cases: Green Bond Case

<Comparison of Issuance Procedures: Conventional Bonds vs. SRI Bonds>

<General Bonds Issuance>

Procedure	Target Organization	Schedule
Issuance of Request for Proposal (RFP)	Issuing Company - Financial Investment Company	D-17~20
Report on Signing of Underwriting Agreement	Lead Manager and Financial Investment Association	D-14
Credit Rating Evaluation	Credit Rating Agency	D-14~10
Due Diligence	-	D-13~6
Board Resolution	Issuing Company	D-1~2
Submission of Securities Registration Statement	Financial Supervisory Service	D
Demand Forecast	Financial Investment Association	D+1~2
Application for Listing of Bonds	Korea Exchange	D+7
Effectiveness of Securities Registration Statement	Financial Supervisory Service	D+10
Issuance of Bond Certificate	Korea Securities Depository	D+10
Subscription and Payment	-	D+10
Submission of Bond Issuance Report	Financial Supervisory Service	D+11
Listing of Bonds	Korea Exchange	D+11~

<SRI Bonds Issuance>

Procedure	Target Organization	Schedule
Decision to Issue SRI Bonds	Issuing Company	D-40
Preparation of SRI Bond Issuance Plan	Issuing Company	D-30~5
External Evaluation	External Evaluation Agency	D-30~5
Issuance of Request for Proposal (RFP)	Issuing Company - Financial Investment Company	D-17~20
Report on Signing of Underwriting Agreement	Lead Manager and Financial Investment Association	D-14
Credit Rating Evaluation	Credit Rating Agency	D-14~10
Due Diligence	-	D-13~6
Board Resolution	Issuing Company	D-1~2
Completion of External Evaluation (Issuance of Evaluation Report)	External Evaluation Agency	D-1
Submission of Securities Registration Statement	Financial Supervisory Service	D
Demand Forecast	Financial Investment Association	D+1~2
Application for Listing of Bonds	Korea Exchange	D+7
Effectiveness of Securities Registration Statement	Financial Supervisory Service	D+10
Issuance of Bond Certificate	Korea Securities Depository	D+10
Subscription and Payment	-	D+10
Submission of Bond Issuance Report	Financial Supervisory Service	D+11
Listing of Bonds	Korea Exchange	D+11~
Post-Issuance Reporting (Use of Funds Status and Environmental/Social Impact, etc.)	Issuing Company	D+35~52