TU Delft

Adopting Digital Green Bonds

Master thesis presentation | Pier Haagsma

2-7-2025

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You are a Real Estate investor and want to acquire capital whilst signalling you care about sustainability

One way to do this is through issuing a *green bond.*

Green Bond

Sustainable

Loan

What is a ‘green’ bond?

- Any bond instrument where the proceeds are applied to finance eligible green projects[2]

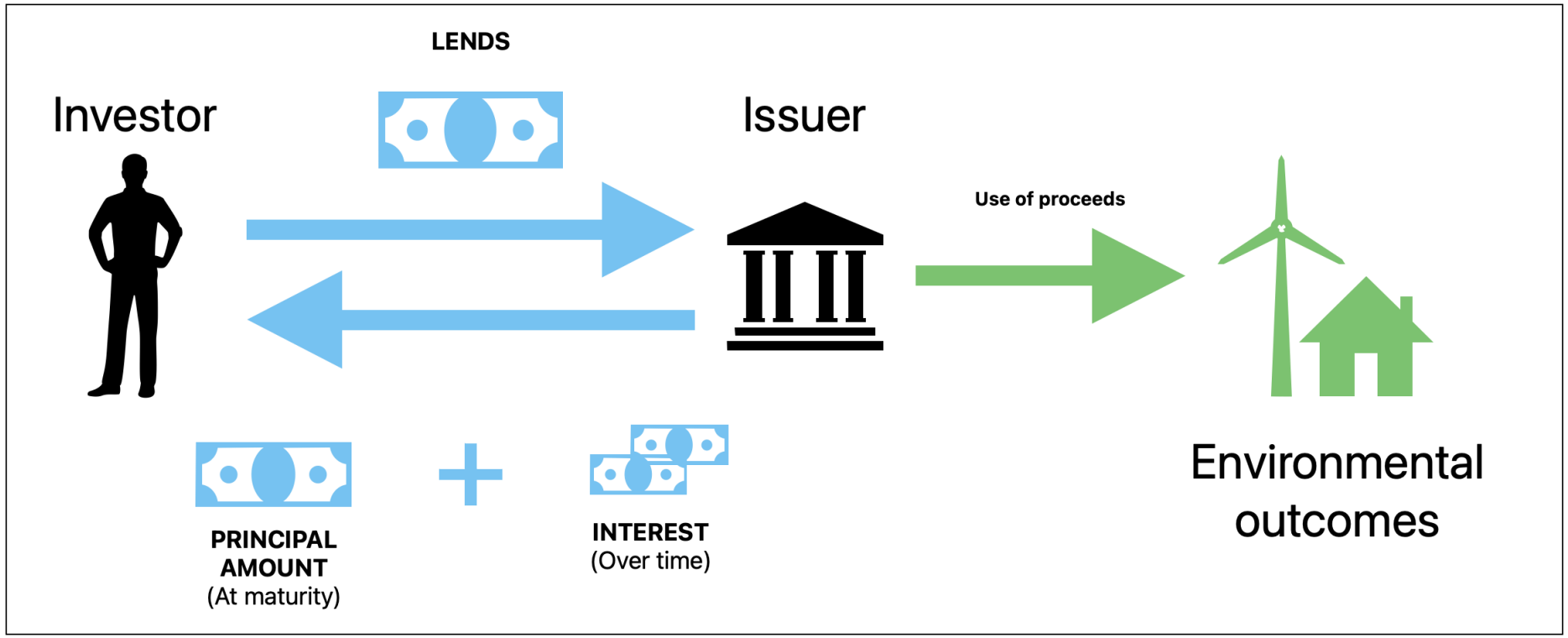


Figure 3: Own work.

'Green projects' in Real Estate

- Green Buildings (construction, renovation and/or acquisition)
- Sustainable Building Certifications:
  - BREEAM-NL
  - LEED
  - GPR Building
  - Energy label

Figure: HAUT, a BREEAM Outstanding building (Amsterdam)

Figure: Shell C30 renovation, LEED Platinum (The Hague)

Green bond challenges (literature)

Regulatory

- Lack of enforcable standards

Market

- High investment thresholds
- Inaccessible for smaller investors
- Lack of liquidity

Financial

- Intermediary heavy
- Complex process
- High issuance costs

Capacity

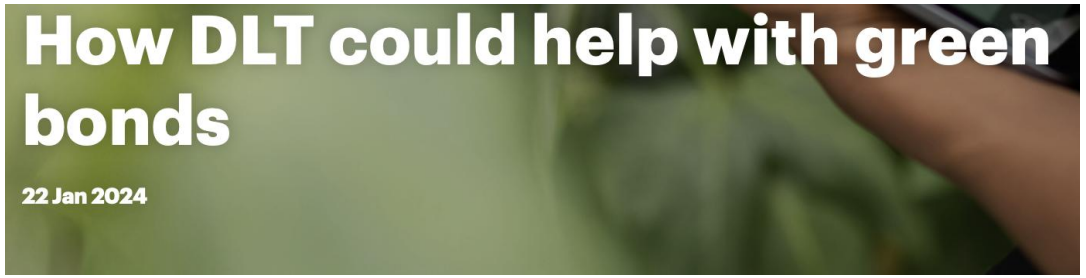
- Lack of skills

Awareness

- Risk of greenwashing

Green bonds and the blockchain: a new way forward?

Blockchain technology could provide the platform for reliable, accessible and updated data on sustainability-linked deals



Blockchain / DLT

Digital Green Bonds

Sustainable

Loan

What is a digital green bond?

- A debt instrument whose register of ownership is stored using distributed ledger technology (DLT), and the proceeds positively impact the environment
- These instruments operate via auto executing smart contracts on a blockchain

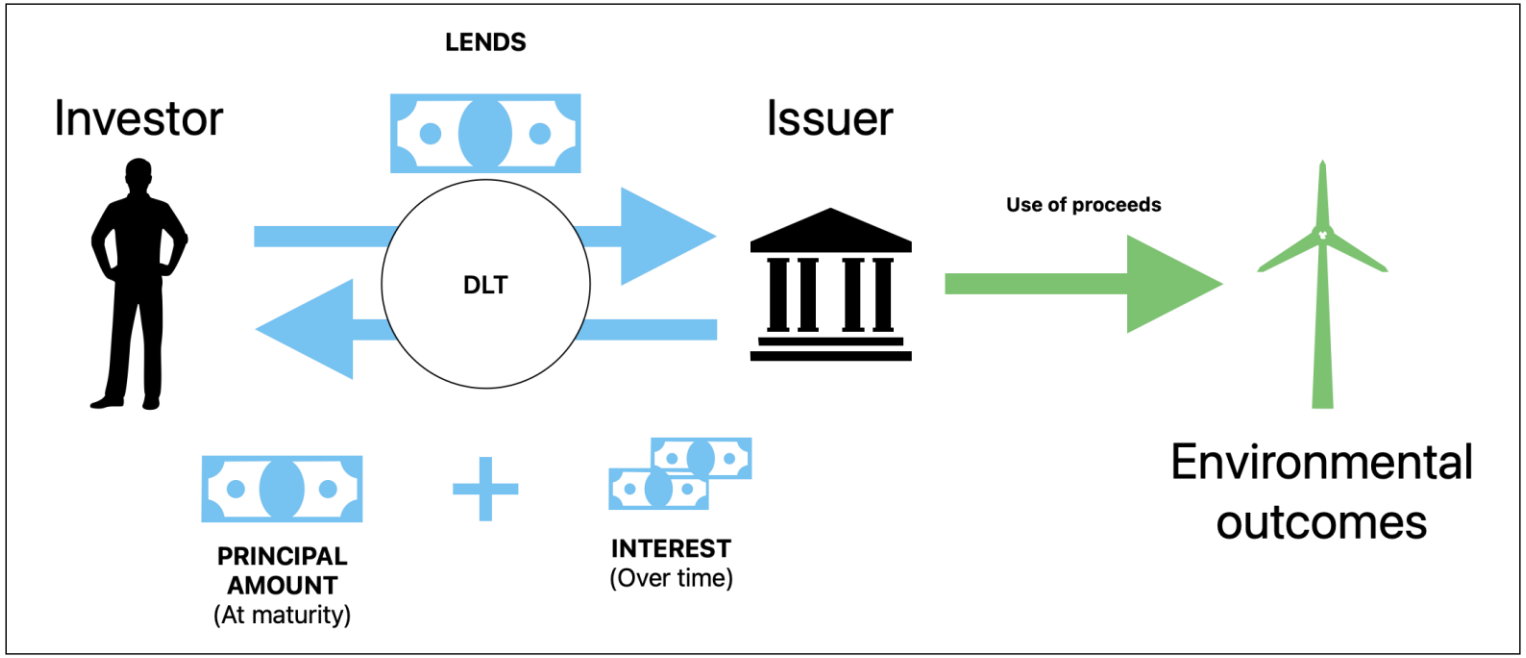


Figure 3: Own work.

Distributed Ledger Technology (DLT)

- Also known as **Blockchain**

- A digital record
- Transactions are recorded in a chain of blocks
- Each block: list of transactions which are verified by eachother

- Therefore, the record is:

- Almost trustless

Immutable

Transparent

Decentralised

Digital Green Bond potential (literature)

Market

Access to broader investor base

- Fractionalise investments
- 24/7 market access
- Worlwide, borderless market

Financial

Lower costs

- Remove intemediaries
- Automate processes

Awareness

Reduce greenwashing risks

- Real time performance monitoring
- Trustless reporting

Problem statement

Problem

Digital green bonds are promising, but their adoption has stayed low.

- Global green bond market (2024): €492 billion
- Global digital green bond market: €483 **million** (2024)
- **(±0,1% of GB market)**

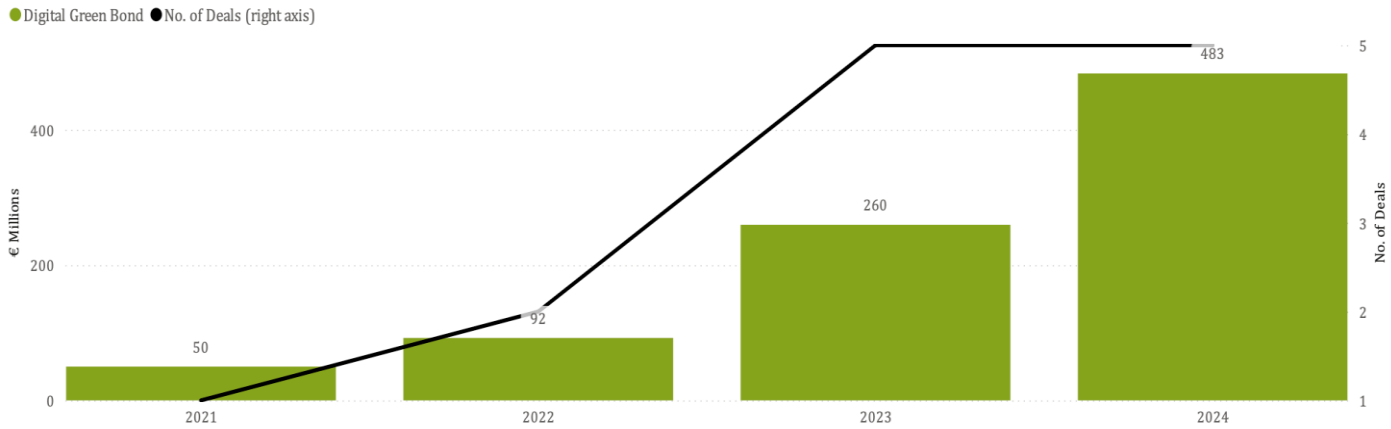


Figure 5: Global Issuance of Digital Green Bonds: AFME (2024)

As Digital Green Bonds have such potential in theory, why aren’t they adopted?

Research goal(s) & RQ

1. Identify the main challenges in traditional green bond processes (in practice)
2. Explore the potential impact of Digital Green Bonds (in practice)
3. Identify the barriers faced by stakeholders in adopting Digital Green Bonds (in practice)
4. Identify potential solutions to these adoption barriers (in practice)

RQ: How can the adoption of Digital Green Bonds be accelerated?

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Methodology

- Qualitative research
  - 10 Semi-structured interviews

- Exploratory case study
  - Digital Green Bond Use Case

- **Test literature through a practical use case**

Case Study

Vesteda’s 2023 Digital Green Bond Issuance

Transaction information:

- First and only digital green bond issuance in the Netherlands
- Proof-of-concept transaction
- € 5 million

Why this case:

- Vast market, low adoption = high insight in potential barriers

ABN AMRO registers first digital green bond on the public blockchain

Press release 12 September 2023 17:30 pm

Innovation Share

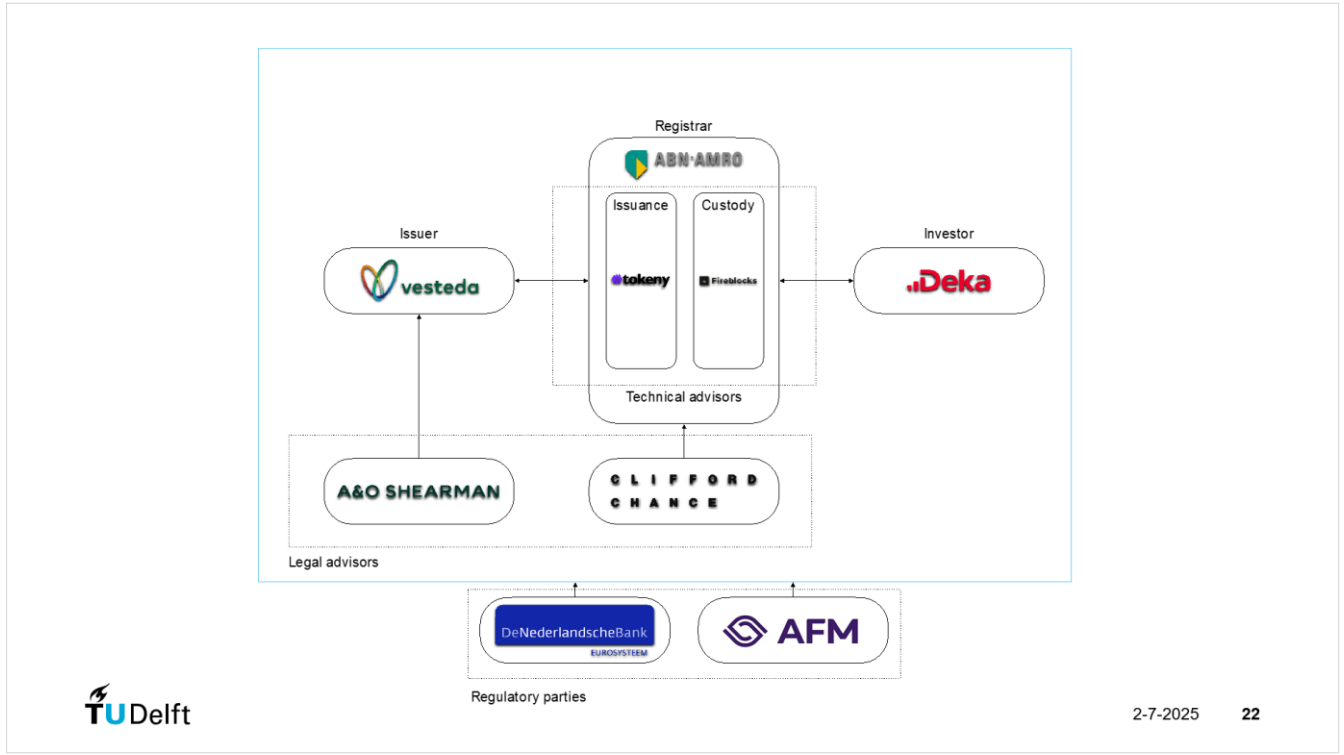
ABN AMRO is the first Dutch bank to register a digital green bond on the public blockchain. With this innovative bond, Vesteda raised EUR 5 million from DekaBank. The proceeds of the transaction will be used to (re-)finance Green Assets, in line with Vesteda's Green Finance Framework.

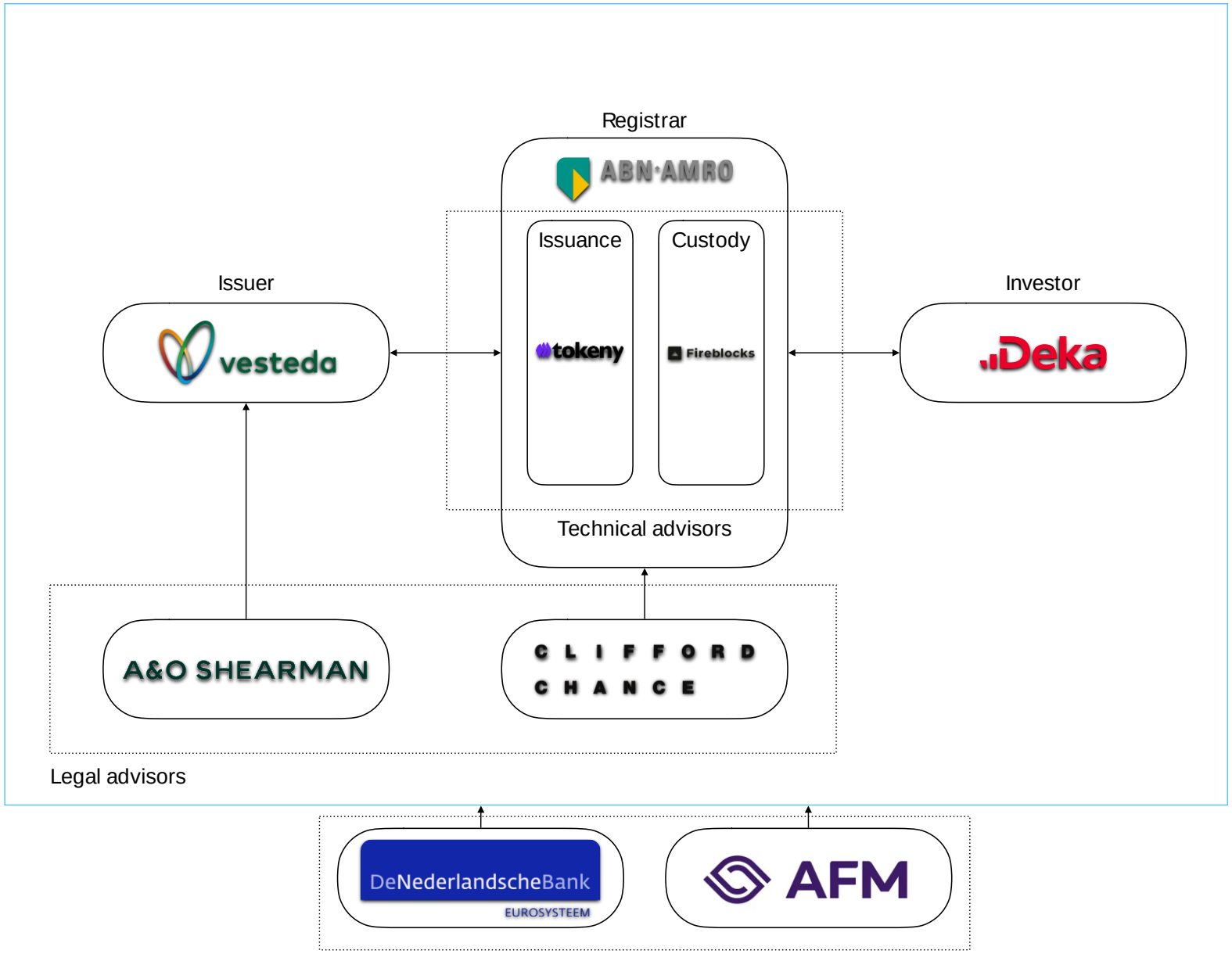
The entire process of preparing, placing and documenting of the bond was digital. Ownership was recorded on the blockchain in the form of tokens that the investor acquired after they had paid for the bond. To ensure custody and security of the investors' unique keys, ABN AMRO uses

Issuer information:

- Vesteda:
  - Real Estate Investment Fund
  - Focus on social and sustainability aspects
  - Portfolio of 28.000 homes

- Vesteda's Green Finance framework
  - Used to finance or refinance new or existing residential buildings with at least an EPC label A.




Registrar
ABN·AMRO
Issuance
Custody
Issuer
Investor
vesteda
tokeny
Fireblocks
Deka
Technical advisors
A&O SHEARMAN
CLIFFORD CHANCE
Legal advisors
DeNederlandscheBank
EUROSYSTEEM
AFM
Regulatory parties

Interviews

- Semi-structured interviews
- 45-60 minutes

- All roles within the Green Bond lifecycle (from issuance to reporting)

#	Company	Role	Expertise
1	**ABN AMRO 1**	Issuer	Digital Assets (‘DLT’)
2	**ABN AMRO 2**	Issuer	Sustainable Markets (‘Green’)
3	**ABN AMRO Clearing Bank**	Custody	Clearing, Custody & Settlement Expert (Innovation)
4	**Vesteda**	Client	Real Estate (Treasury)
5	**DekaBank**	Investor	Digital Assets
6	**Tokeny**	DLT Provider	DLT (Fintech)
7	**A&O Shearman**	Client’s legal advisor	Policy (Capital Markets)
8	**Clifford Chance**	Issuer’s legal advisor	Policy (Capital Markets)
9	**Authoriteit Financiele Markten (AFM)**	Market regulator	Policy
10	**De Nederlansche Bank (DNB)**	Market regulator	Policy (Digital Assets)

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SQ1/SQ2: Digital Green Bond's Potential

SQ1: Green Bond Barriers
Main findings

Policy
(Barriers): No legal consequences

Market: **Market inaccessibility**

→ *"A minimum amount is required… 500 million. That is a problem for small businesses"* – issuer

Financial: **High issuance costs**

→ *"The auditor, lawyer, bank, all must be paid… quickly looking at €2 million cost"* – issuer

Capacity: Lack of technical skills

Awareness: **No transparency in sustainable performance reporting**

→ *"Everyone wants to see how the funds are used, this is what it delivers for that building, and this is the resulting saving."* - issuer

SQ2: Digital Green Bond Potential
Main findings

Policy potential: not mentioned

Market potential: Fractionalization
24/7 market access

Financial potential: Disintermediation
Automatization

Capacity potential: not mentioned

Awareness potential: Performance reporting
Ownership tracking

"Traditionally, the costs are too high to do it in small chunks… with this technology, I can do small transactions." – ABN AMRO 1

"… reduce those costs, so you need the banks less, and essentially make such a loan cheaper." – Issuer

"… where we currently have a settlement period of 5 days, the settlement (of digital green bonds) takes place on the same day." – Issuer.

"We can also supercharge the token with data concerning ESG data"- DLT provider

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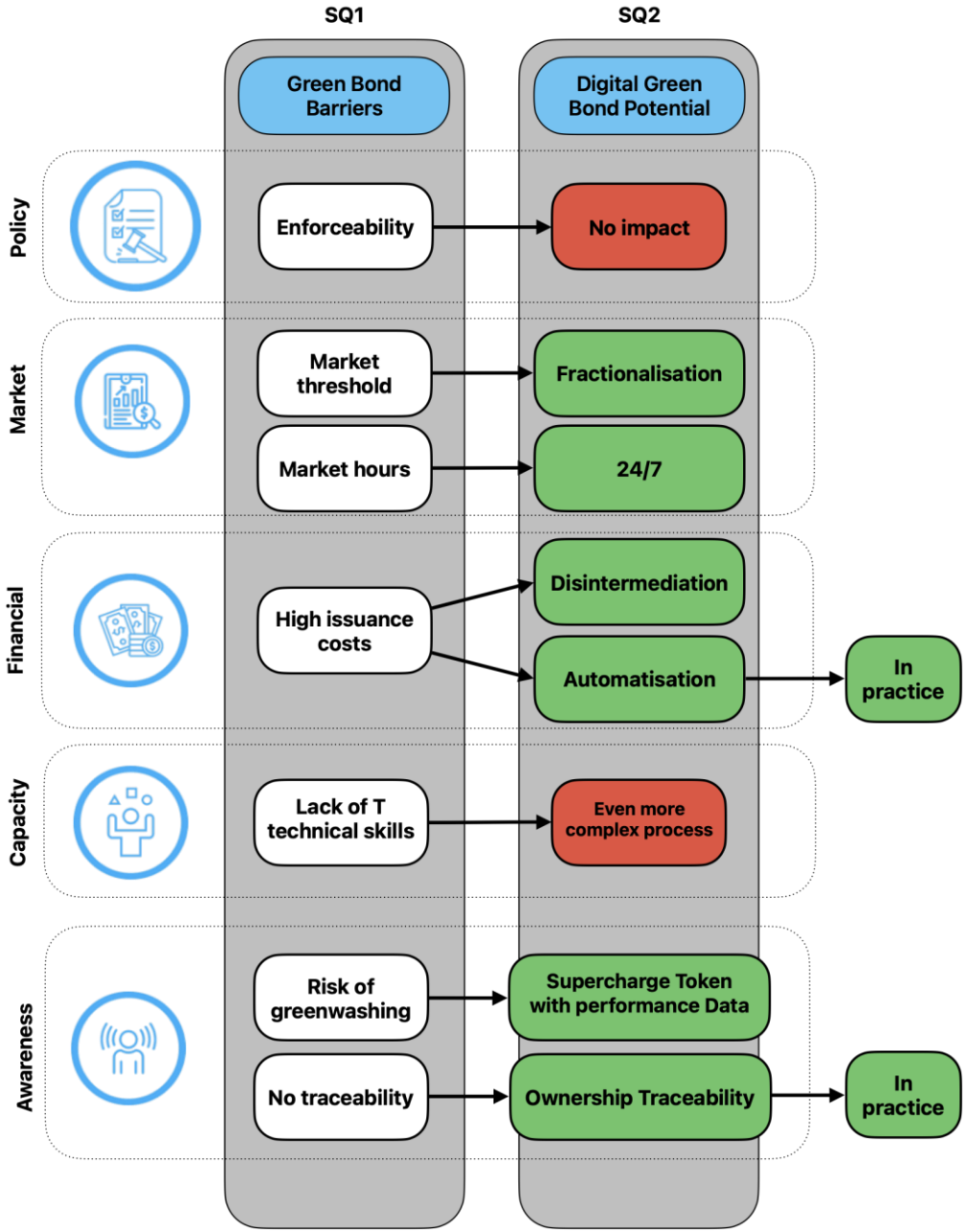
SQ1/SQ2 Findings: Potential



SQ3/SQ4: Digital Green Bond's Adoption

SQ3: Digital Green Bond Adoption Barriers
Main findings

Policy : Regulatory uncertainty
Regulatory arbitrage

”…there isn't a clear regulatory framework in NL for digital bonds, …the framework is open to interpretation, and that's the problem." - investor

Market: No secondary market
No market liqudity

“Currently there is no secondary market, and Digital (Green) Bonds cannot be traded” – ABN’s legal advisors

Financial: Dependence on intermediaries

“They (traditional market parties) might not want to digitalize, as they already make lots of money (with the traditional process). Why would they change?” – AFM

Capacity: Infrastructure interoperability
Programmability

"Banks need to link their systems to the blockchain, and those systems are sometimes 30-40 years old." – Dutch Central Bank

Awareness: Lack of familiarity

SQ4: Digital Green Bond Adoption Enablers
Main findings

Policy enabler:

- Technology-neutral regulation
- Clear regulation
- Harmonization

*"There simply needs to be clarity about the route that must be followed if you want to issue something like [a digital bond]. There should be no room for interpretation."- I*ssuer's legal adv.

Capacity enabler:

- Programmable settlement
- Interconnected systems

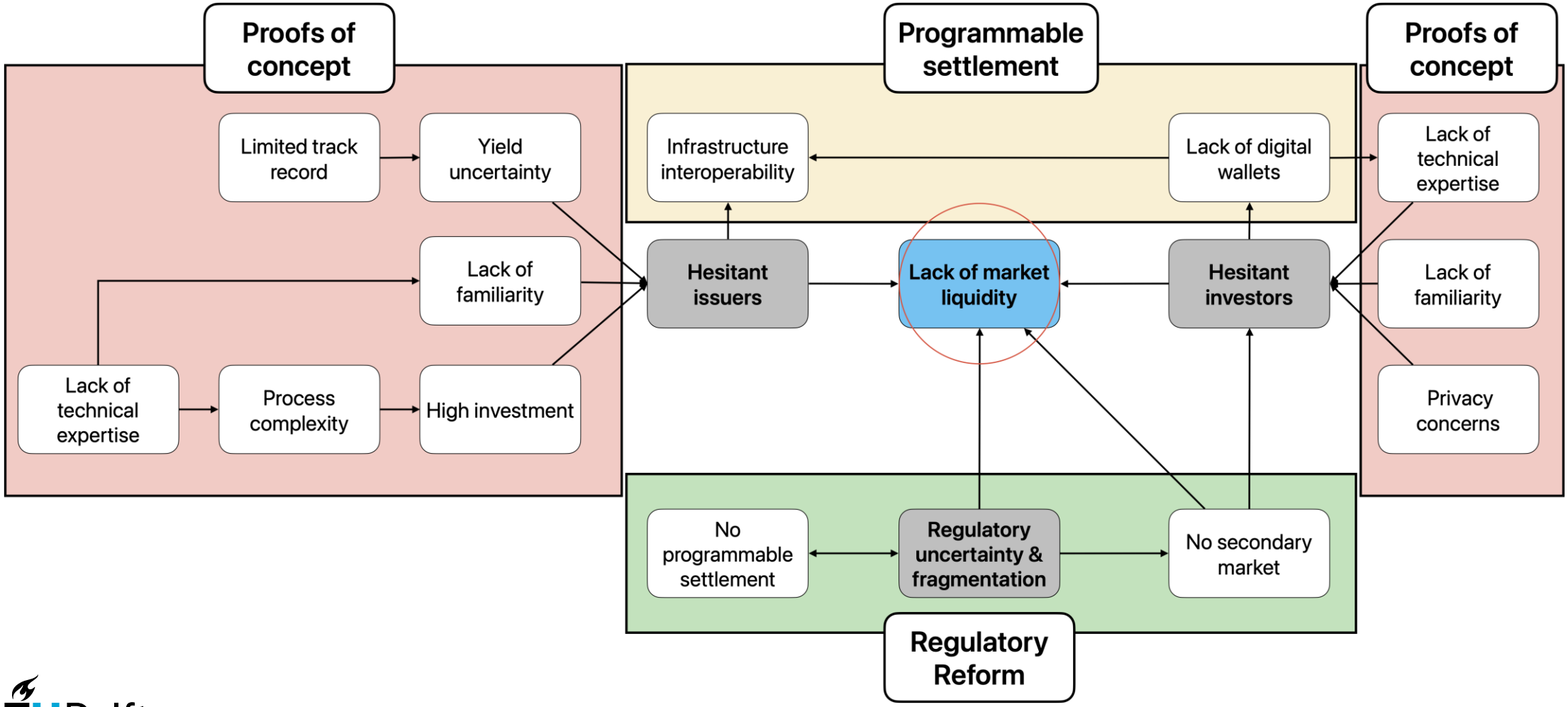
"To get all the power of the blockchain technology, it's important that also the cash is on chain so that you can trigger it. The interest of tokenization is that the asset is now a piece of code, so you can automate lots of things" – DLT Provider

Awareness enablers:

- Proofs of concept

"As more parties become familiar with it and awareness grows, more participants will want to get involved, and that's what its success depends on." – Issuer

SQ3/SQ4 Findings:
Adoption



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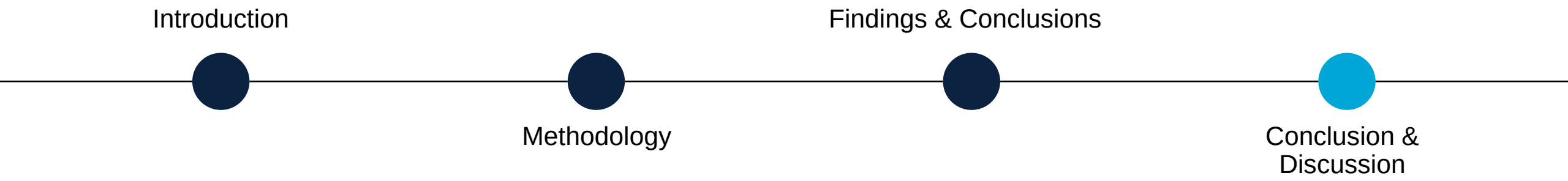

Main conclusion

Answer the main research question:

How can the adoption of Digital Green Bonds be accelerated?

- Regulatory reform: Technology-neutral, unambiguous, harmonized regulation
- Capacity building: Enable a secondary, digitalized DLT-trading market
- Signaling: Engage proofs of concept and invest in the technology, raise awareness, and grow the market.

Discussion

In theory, lots is possible.

In practice, only automation and transparency have been achieved (Dutch context).

The question should be more about **why** adopt Digital Green Bonds, and not **how.**

Therefore:

“DLT might be a solution looking for a problem” - ABN AMRO Clearing Bank

Questions?

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2-7-2025

Further research

- **Quantitative market impact assessments**
  - Qualitative research → quantitative
  - Digital Green Bonds' issuance costs vs Traditional Green Bonds in €

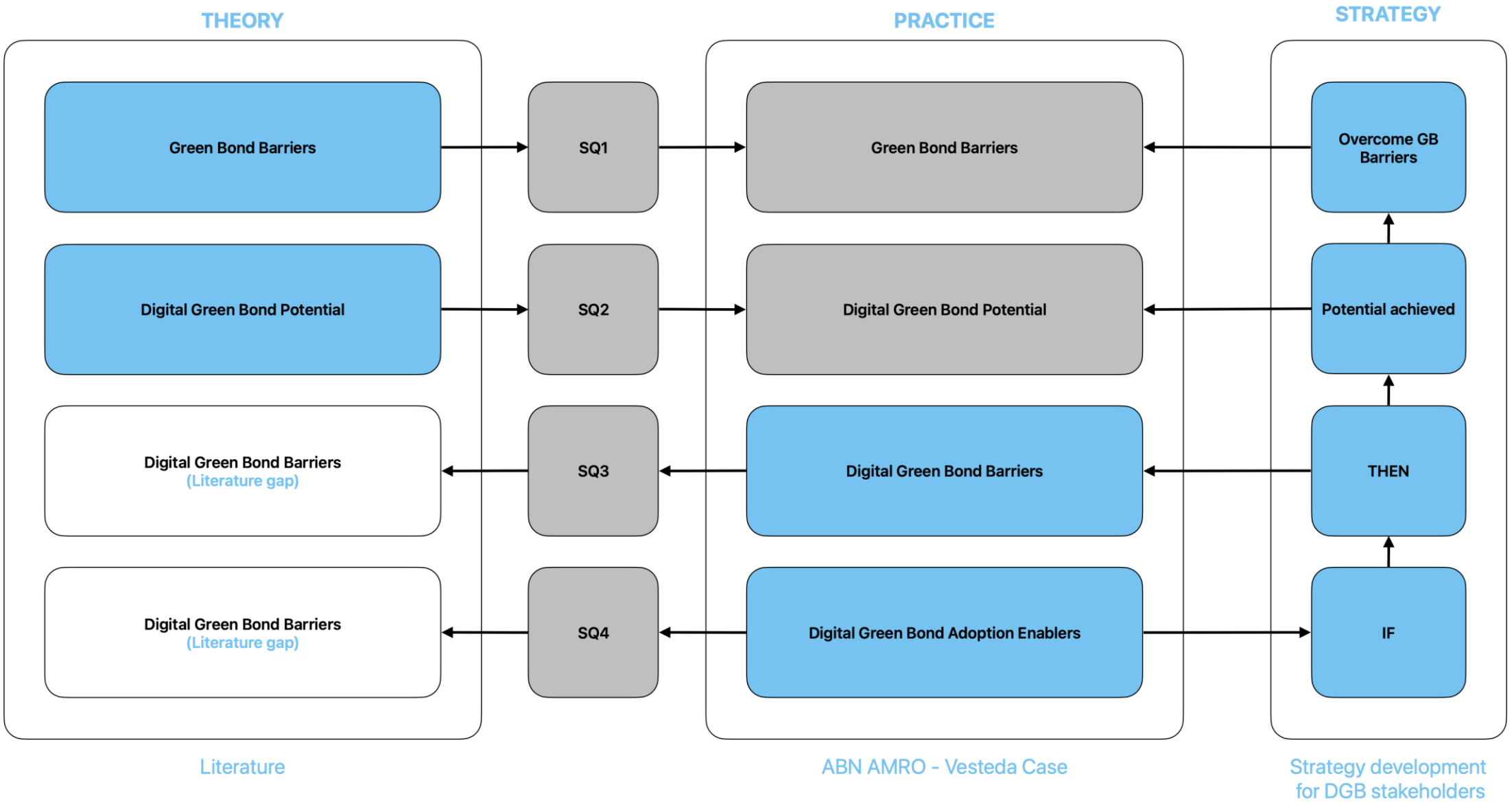
- **Investor preferences and pricing**
  - Risk assessment of Digital Green Bonds vs Traditional Green Bonds
  - Pricing differences due to risk

- **In short**
  - Find quantitative incentives and motivations to adopt Digital Green Bonds

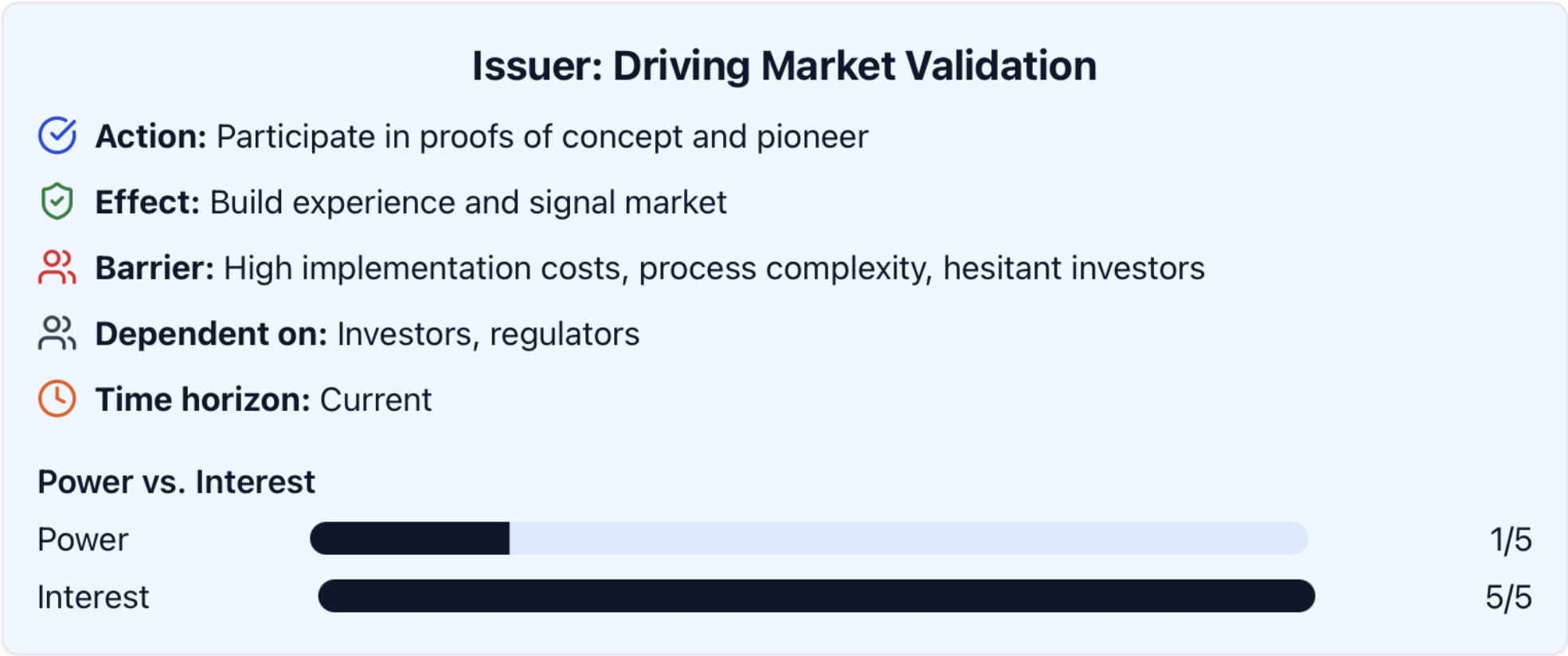
Research questions

RQ: How can the adoption of Digital Green Bonds be accelerated to help close the green finance gap?

- **SQ1:** What barriers do stakeholders identify in the issuance and management of traditional green bonds?
- **SQ2:** How can Distributed Ledger Technology (DLT) and the development of Digital Green Bonds potentially address the barriers found in traditional green bond processes?
- **SQ3:** Which barriers currently hinder the broader adoption of Digital Green Bonds in the financial market?
- **SQ4:** How can these barriers be addressed to facilitate the broader adoption of Digital Green Bonds?

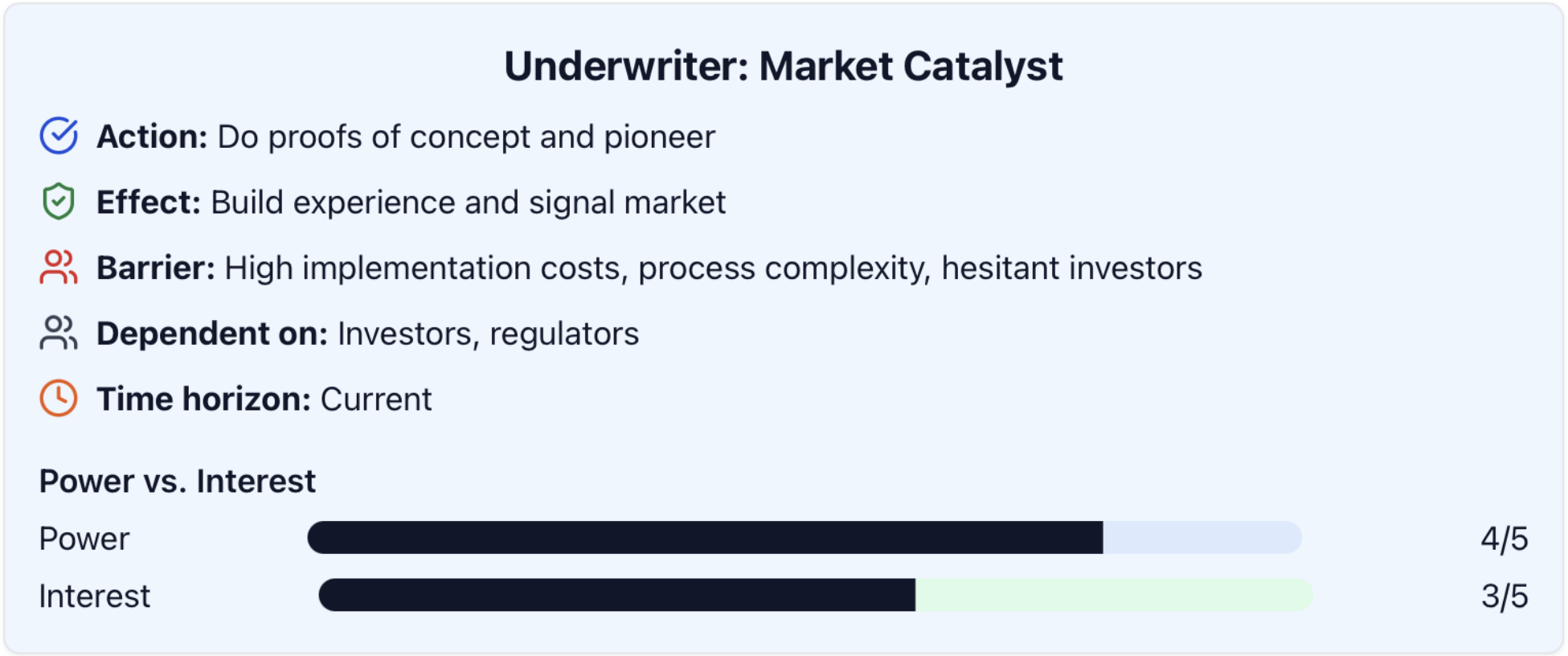

THEORY
PRACTICE
STRATEGY
Green Bond Barriers
Digital Green Bond Potential
Digital Green Bond Barriers
(Literature gap)
Digital Green Bond Barriers
(Literature gap)
SQ1
SQ2
SQ3
SQ4
Green Bond Barriers
Digital Green Bond Potential
Digital Green Bond Barriers
Digital Green Bond Adoption Enablers
Overcome GB Barriers
Potential achieved
THEN
IF
Literature
ABN AMRO - Vesteda Case
Strategy development for DGB stakeholders

Conclusions:
Issuer

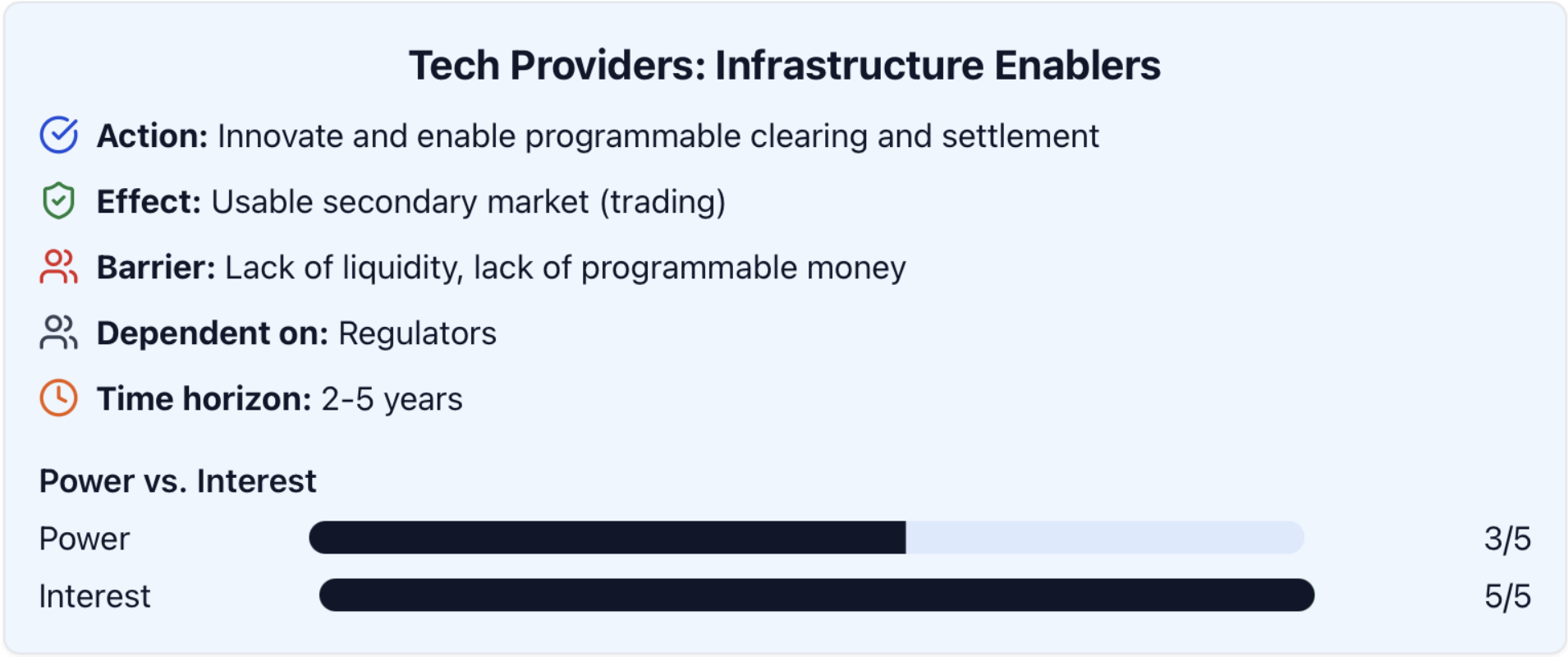


Conclusions:
Investor

Conclusions:
Underwriter



Conclusions:
Tech providers



Conclusions:
CSDs

CSDs: Digital Backbone

Action: Create interoperable systems for digital issuance and trading

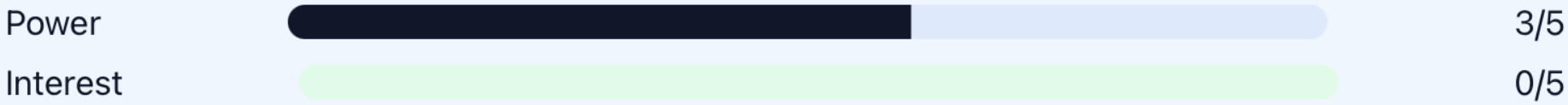
Effect: Usable secondary market (trading)

Barrier: Reliance on traditional systems, lack of liquidity

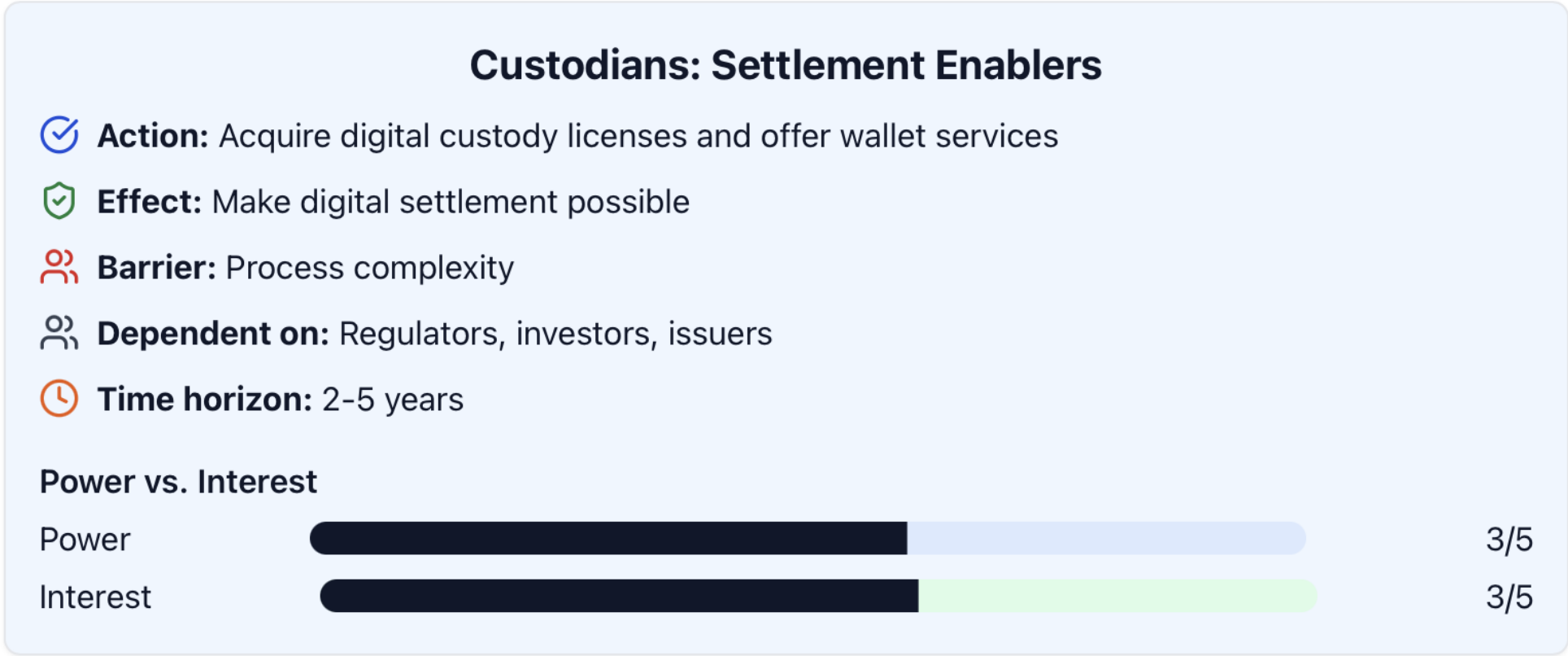
Dependent on: Collaboration

Time horizon: 5+ years

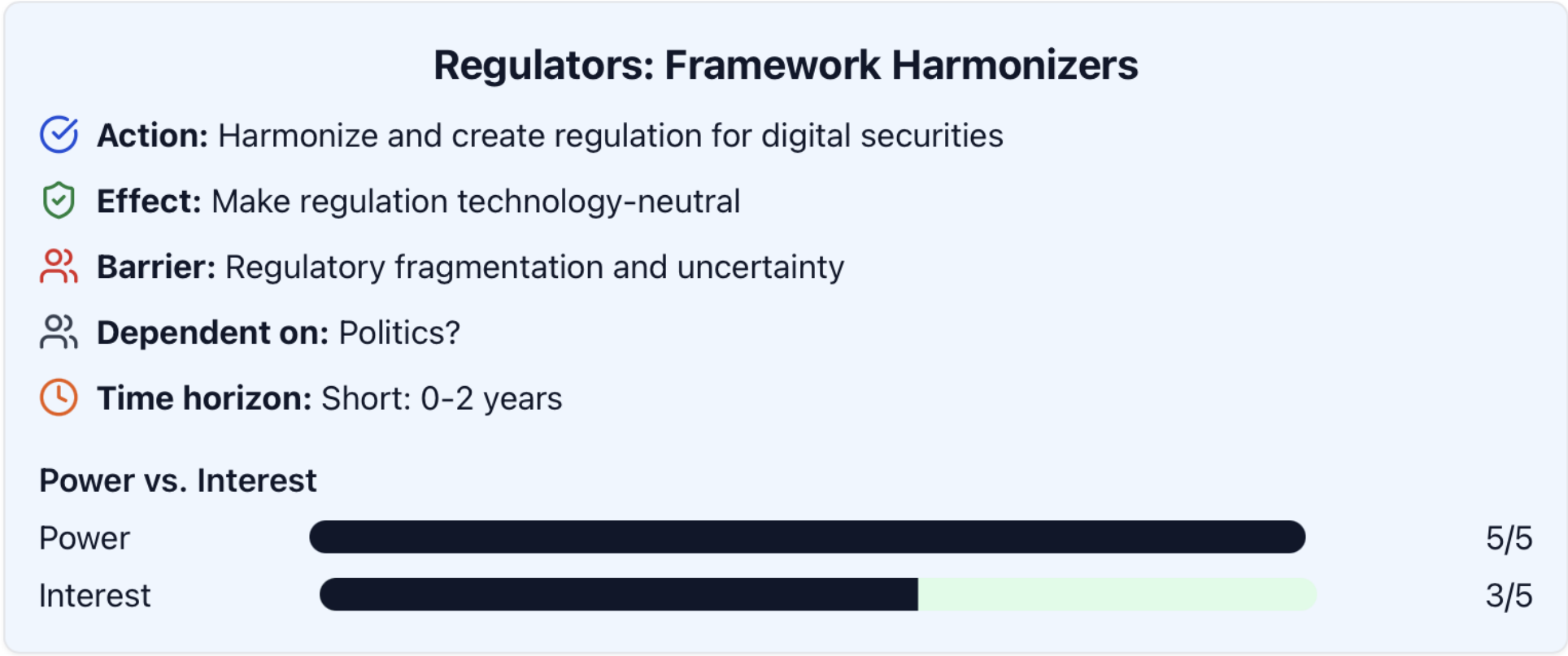
Power vs. Interest



Conclusions:
Custodians



Conclusions:
Regulators



Conclusions:
ALL

All Stakeholders: Standardization

Action: Collaborate on industry standards and interoperability

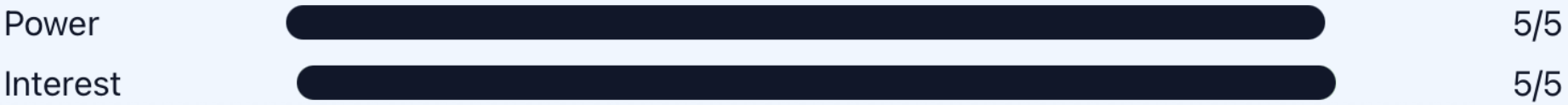
Effect: Reduced fragmentation

Barrier: Market illiquidity

Dependent on: Collaboration

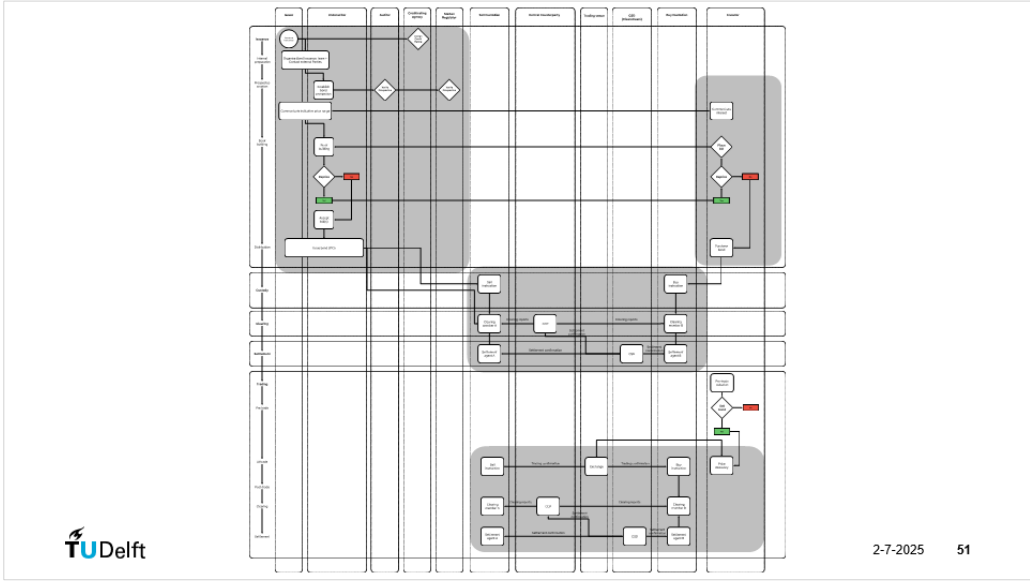
Time horizon: 5+ years

Power vs. Interest



Traditional Green Bond Process

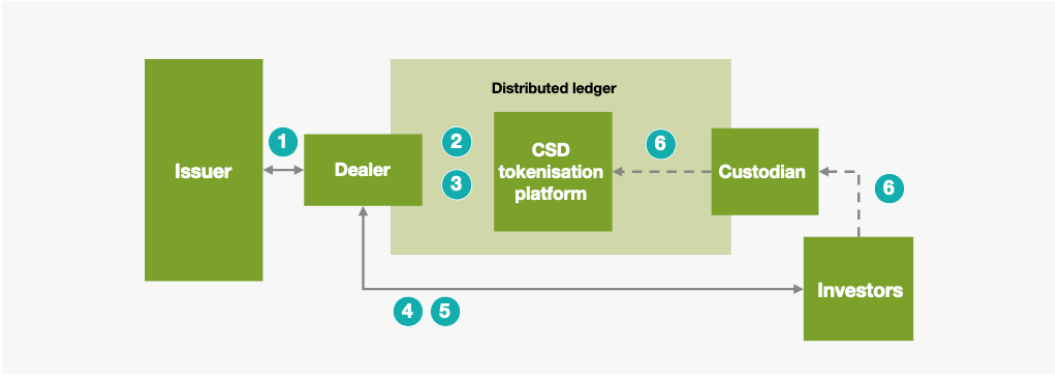
- Issuance: Motivation for issuing, Pricing, Distribution [2]
- Clearing: validates and confirms transaction details before settlement [3]
- Settlement: actual exchange of assets or cash and the transference of ownership of those assets and money [4]
- Custody: the safekeeping of securities in physical or electronic form. [1]



Sources: Berry-Johnson (2025) [1], Choudhry (2001) [2], Loader (2020) [3], Loader (2019)

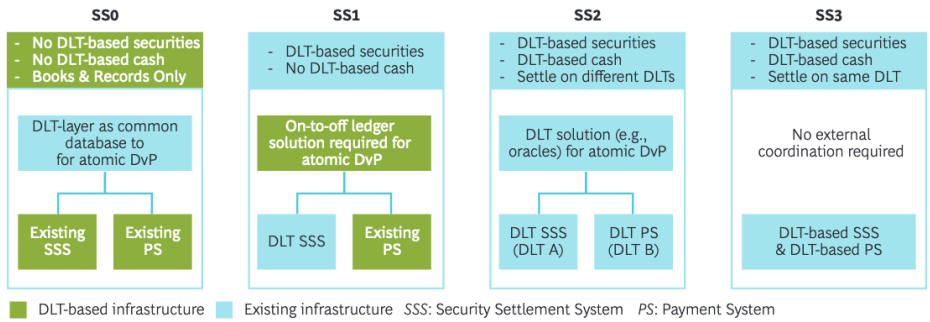
Digital Green Bond Process

Dependent on: Digital Twin or Digital Native Bond.

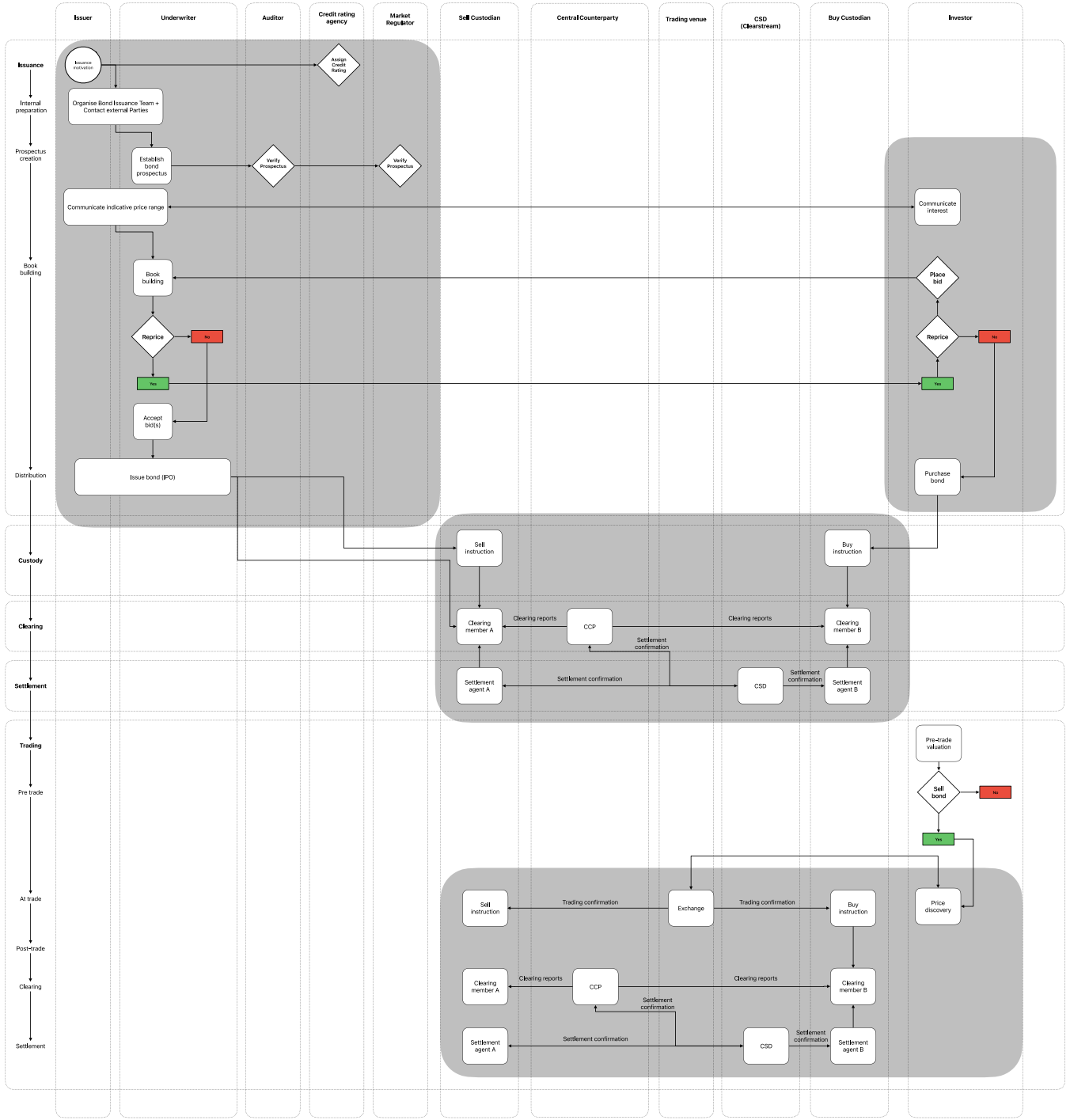


Differences with traditional (Digital Native):

- Issuance: on a blockchain, accessed through Custodians with wallets
- Clearing & Settlement: Clearing fully on chain, Settlement possible off-chain/separate payment ledger/same DLT ledger
- Custody: through digital wallets and keys
- Trading: through an on-chain decentralized trading venue



Sources: BCG (2023), Parry (2024).


Issuer
Underwriter
Auditor
Credit rating agency
Market Regulator
Sell Custodian
Central Counterparty
Trading venue
CSD (Clearstream)
Buy Custodian
Investor
Issuance
Internal preparation
Prospectus creation
Book building
Distribution
Custody
Clearing
Settlement
Trading
Pre trade
At trade
Post-trade
Clearing
Settlement
Issuance motivation
Assign Credit Rating
Organise Bond Issuance Team + Contact external Parties
Establish bond prospectus
Verify Prospectus
Verify Prospectus
Communicate indicative price range
Communicate interest
Book building
Place bid
Reprice
No
Yes
Reprice
No
Yes
Accept bid(s)
Issue bond (IPO)
Purchase bond
Sell instruction
Buy instruction
Clearing member A
Clearing reports
CCP
Clearing reports
Clearing member B
Settlement confirmation
Settlement agent A
Settlement confirmation
CSD
Settlement confirmation
Settlement agent B
Pre-trade valuation
Sell bond
No
Yes
Sell instruction
Trading confirmation
Exchange
Trading confirmation
Buy instruction
Price discovery
Clearing member A
Clearing reports
CCP
Clearing reports
Clearing member B
Settlement confirmation
Settlement agent A
Settlement confirmation
CSD
Settlement confirmation
Settlement agent B