



# DEYE-NTU CO-LABORATORY FOR REAL-WORLD ASSET (RWA) RESEARCH COLLABORATION

BUILDING EXPLAINABLE, RISK-AWARE DECISION  
CAPABILITY FOR ENERGY ASSET DIGITALIZATION

# Key Observations

RWA challenges are no longer technical, BUT analytical and structural

Technology feasibility is largely proven



→ Together determines **success**

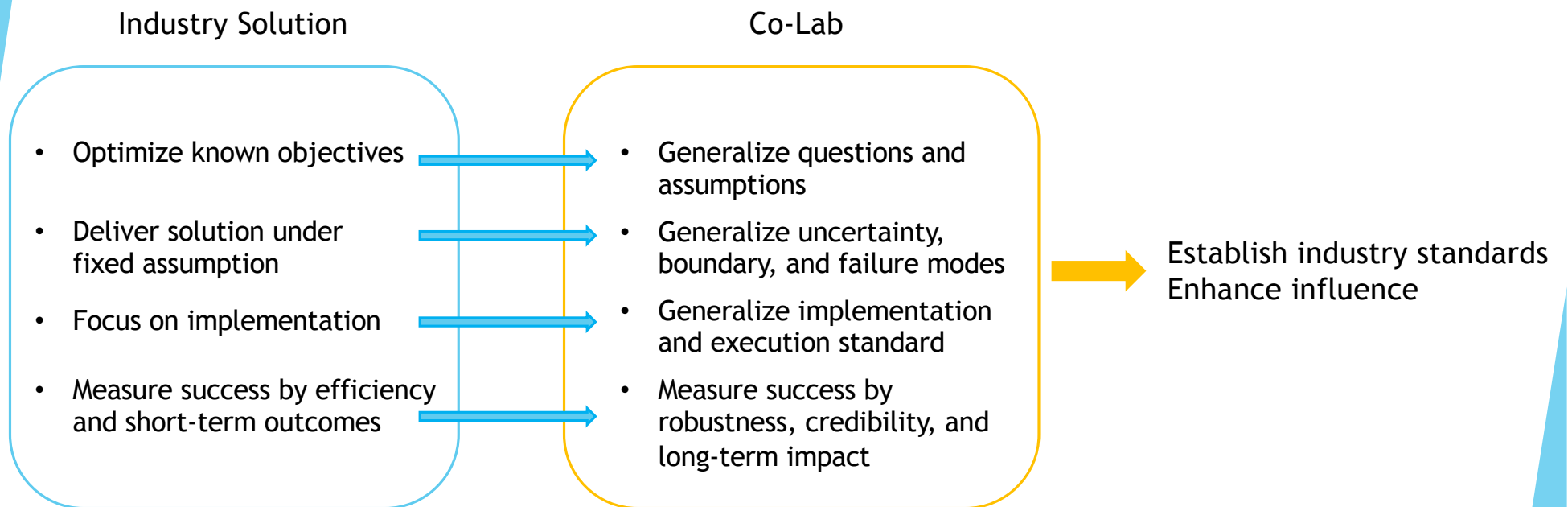
Asset and data  
credibility ?

Cash-flow uncertainty and  
downside risk ?

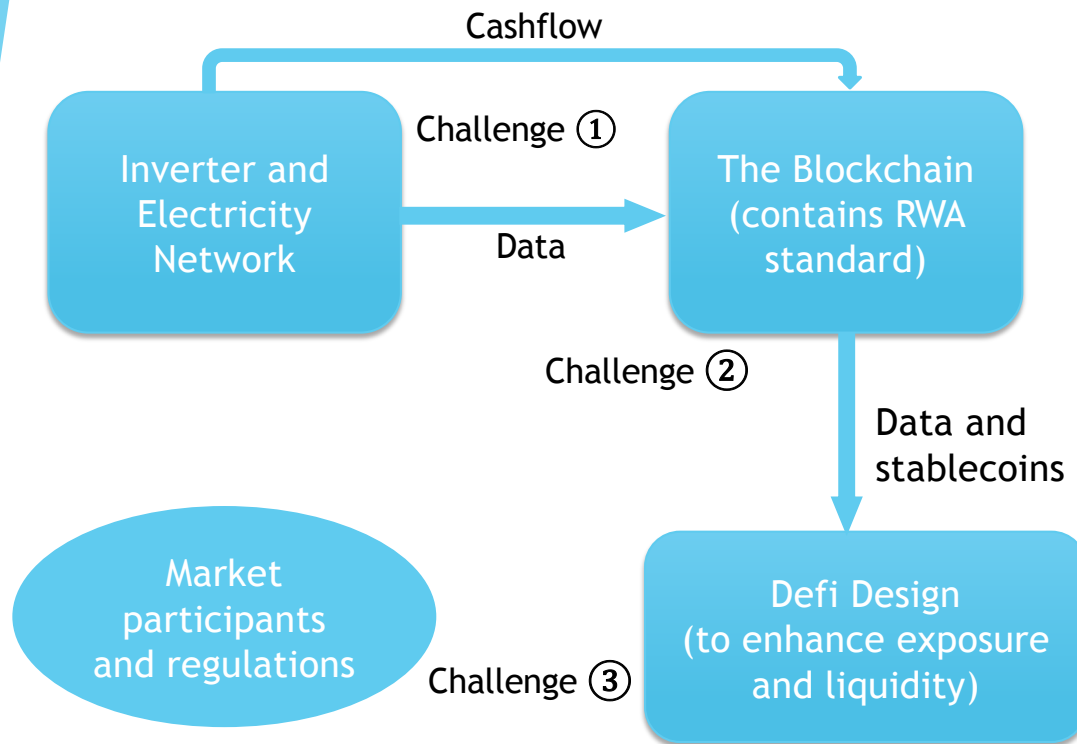
Structural robustness and  
stopping conditions ?

These issues require **research-driven judgment**, not only engineering

# Co-Lab: Beyond the Industry Solution



# Components of Implementation and Challenges



## Co-Lab addresses the challenges

- ①: Trust and Audit for Energy-RWA Data
- ②: Cashflow Structuring and Risk Pricing
- ③: Liquidity and Price Discovery in a Restricted (Compliant) Market

# Research Direction 1: Trust and Audit for Energy- RWA Data

**Importance:** The project only works if everyone can trust the energy data behind the tokens from multiple sources

- **Asset Data Trust Score (device → portfolio)**  
Fuse multi-source consistency checks with robust anomaly detection to flag missingness, manipulation, and sensor faults, then aggregate evidence into an explainable trust score from each device up to the full portfolio—usable both for oracle commitments and for operations triage.
- **Adaptive Verification Economics (cost-risk frontier)**  
Use risk-adaptive sampling and sequential verification to allocate audit effort dynamically—auditing “more and deeper” when trust deteriorates—so verification cost is minimized while payout-error/manipulation risk stays below a pre-set bound, producing implementable policies and clear cost-risk curves.
- **Digital-Twin State Machine (contract-consumable rules)**  
Combine digital-twin signals with formal state-machine rules so each device transitions deterministically across states (e.g., normal / suspect / paused / recovery), with each state automatically governing eligibility, payout weights, holds/escrow, and correction workflows in an audit-readable, contract-consumable specification.

## Research Direction 2: Cashflow Structuring and Risk Pricing

**Importance:** Energy-RWA financing scales only when future cashflows can be forecast, stress-tested, and protected against downside risk.

- **Distributional Cashflow Forecasting (multi-source)**  
Fuse production history, weather signals, tariff/settlement logic, and device-state evidence into probabilistic cashflow forecasts (not point estimates), using AI models that learn non-linear patterns and generate scenario-based downside reports for term-sheet decisions.
- **Quality-Controlled Pooling (adverse selection)**  
Prevent weak assets from diluting strong ones by enforcing quality-aware vault rules—risk-adjusted NAV, dynamic admission/fees, and optional segmentation—so contributors face fair pricing and the pool remains stable as heterogeneity scales.
- **Rule-Based Credit Enhancement (auditable triggers)**  
Design non-discretionary protection mechanisms—reserves and parametric-style triggers—where trigger conditions are learned from tail-event patterns yet remain objectively verifiable, minimizing capital lock-up while covering extreme underperformance and settlement shortfalls.

## Research Direction 3: Liquidity and Price Discovery in a Restricted (Compliant) Market

**Importance:** KYC/whitelist constraints can thin liquidity and distort price discovery, so compliant trading rules and mint/redeem design must jointly stabilize spreads and prices.

- **Whitelist-Optimized Automatic-Market-Maker (AMM) Design**  
Calibrate AMM fees, curves, and incentive schedules for a KYC-only market, using agent-based simulations and learning-based market-maker response models to keep spreads, slippage, and price impact low under thin participation.
- **NAV Anchoring and Discount/Premium Control**  
Engineer mint/redeem access, redemption queues, and dynamic fee rules so the traded token price stays anchored to vault NAV, stress-testing the anchoring band under settlement frictions and adverse order flow.
- **Selective Disclosure with Verifiable Privacy**  
Build a tiered disclosure standard (board / funder / regulator / public) and implement selective, proof-backed reporting—so due diligence is satisfied while sensitive operational data remains protected and participation incentives are preserved.
- **LLM-Based Compliance Audit Automation**  
Train a jurisdiction-aware compliance LLM with agent workflows that automatically collect required evidence<sup>6</sup> across countries and generate standardized audit reports directly from the system's data and smart-contract code.

# Scope of University Contribution

Area	University Contribution
Asset and Data Credibility	Credibility metrics, anomaly detection
Cash Flow and Risk	Risk ranges, scenario analysis
RWA Structure	Structural comparison, failure conditions
Token Design (Research)	Pricing logic, incentive compatibility
Compliance Research Support	Risk identification, path comparison
Simulation and Prototyping	Mechanism simulation, research PoC



# Research Timeline

Year	Deployment focus	System milestone	Research focus (what the lab delivers)
Y1	Stage 1: Pilot (restricted investors)	Pilot architecture specification; telemetry ingestion, off-chain commitment, oracle, on-chain record; reward funding/claim dry-run	Track 1 (Trust & Audit): baseline anomaly detection and trust score prototype; sampling baseline; state machine v1 mapped to payout holds/weights
Y2	Stage 1: Pilot execution	Pilot live monitoring dashboards; monthly audit package; first external-style audit rehearsal; stable daily/periodic updates	Track 1 deepening: multi-source consistency (meter/weather/settlement); cost-risk curve for sampling; dispute/correction workflow; publishable empirical results on data integrity + audit economics
Y3	Stage 2 prep: Defi design and restricted trading sandbox	Defi specification (RWA NAV/share, mint/redeem policy, fee/reserve logic); restricted trading simulation environment (no public AMM yet)	Track 2 (Cashflow Structuring): distributional cashflow forecast and scenario library; pooling/adverse selection mechanism proposals; reserve sizing and parametric trigger candidates
Y4	Stage 2: Controlled market launch	Compliant vault and (permissioned) AMM launch plan; NAV anchoring rules (queue/delay/dynamic fees); disclosure tiers; market monitoring KPIs	Track 3 (Restricted market microstructure): whitelist-constrained AMM parameter optimizer; NAV anchoring stability analysis; disclosure-privacy policy templates and proof-backed reporting; stress tests for discount/premium stability
Y5	Stage 2: Scale and optimization	Parameter refinement loop (fee/incentives/redemption policy) based on observed KPIs; maturity playbook for replication across sites	Consolidated “design handbook” (1/2/3 outputs to implementable parameters); final academic outputs (papers, open-source tools if allowed); performance evaluation against KPIs (slippage/spread/discount stability/audit cost reduction)

# Budget Structure

Cost category (SGD '000)	Year 1	Year 2	Year 3	Year 4	Year 5
PI/Co-PI time buyout (partial)	60	60	60	60	60
Research staff (Postdoc/RA/Engineer)	220	260	300	320	320
Student support (PhD/MSc project stipends)	40	60	80	80	80
Data & infrastructure (cloud, storage, pipelines)	50	60	80	80	70
Simulation & tooling (market microstructure + stress test)	30	40	60	70	60
On-chain testing & ops (testnet/mainnet gas, infra)	20	30	50	60	60
Oracle/DON integration budget (requests, node services, monitoring)	20	30	40	50	50
Security & audits (smart contracts + data pipeline review)	40	60	120	120	80
Legal/compliance interface (KYC design, policy templates, advisory)	30	40	60	70	70
Workshops / travel / joint seminars / dissemination	20	20	30	30	40
Contingency ( $\approx 10\%$ )	51	60	88	94	89
Total (SGD '000)	561	660	868	934	879



Thank you!

