SolChain

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A Blockchain Based P2P Solar Energy Sharing Microgrid System

By Team GreyDevs

Abstract

SolChain is a decentralized solar microgrid platform that leverages **blockchain**, **IoT**, and **AI** to enable secure, peer-to-peer (P2P) energy trading in regions with unstable grid infrastructure. Built on a **Proof-of-Stake (PoS)** sidechain, SolChain ensures **low-latency** and **high-throughput** transaction processing while periodically anchoring **Merkle roots** to a Layer-1 blockchain (e.g., Ethereum) for auditability and regulatory compliance. **Smart contracts** manage tokenized microtransactions denominated in SolarTokens (ST), enabling real-time settlement and enforcement of trade agreements. **Zero-knowledge proofs (ZK-proofs)** ensure user data privacy, while **smart meters** with **LPWAN (e.g., LoRa)** connectivity allow low-cost deployment in off-grid or weak-grid rural areas. Integrated **AI/ML modules** perform decentralized pricing, anomaly detection, and demand forecasting using **distributed edge intelligence**. This paper details SolChain's technical architecture, decentralized governance (via DAO), and deployment strategy, establishing a robust, scalable model for community-driven clean energy access in emerging markets.

1. Introduction

The global energy sector is at a pivotal juncture, transitioning from a reliance on centralized fossil fuel-based power generation to a more distributed and sustainable model. This shift is driven by increasing energy demand, environmental concerns, and the desire for greater energy independence and resilience. Solar power, as a clean and abundant renewable energy source, is at the forefront of this transition, offering a viable alternative to conventional energy sources. However, the effective integration and management of solar energy, particularly in decentralized settings, present unique challenges that traditional grid infrastructures are often ill-equipped to handle.

1.1. Solar Power and Energy Sharing

Solar power harnesses the sun's energy to generate electricity, offering a clean, sustainable, and increasingly cost-effective solution to meet growing energy demands. Its decentralized nature allows for energy generation at the point of consumption, reducing transmission losses and enhancing local energy security. The concept of "energy sharing" or peer-to-peer (P2P) energy trading emerges as a natural evolution of decentralized solar power. In this model, individuals or communities equipped with solar photovoltaic (PV) systems, often referred to as "prosumers," can not only consume the energy they generate but also share or sell their surplus electricity directly to their neighbors or other participants within a localized network. This paradigm fundamentally transforms the energy consumer into an active participant in the energy market, fostering self-sufficiency and economic benefits. Decentralized energy generation, through microgrids, offers significant advantages over traditional centralized power grids, including enhanced reliability, reduced energy costs, improved energy security, positive environmental impacts, and increased operational flexibility. Such systems can operate autonomously in "Island Mode" or seamlessly integrate with the main grid, bolstering overall grid resilience, particularly in regions prone to instability or natural disasters.

1.2. Why BlockChain?

Blockchain is a decentralized, transparent, and secure ledger system that enables peer-to-peer transactions without the need for a central authority. Its core features—**decentralization**, **transparency**, and **immutability**—ensure that all transactions are visible, tamper-proof, and controlled collectively by the network. A key component is **smart contracts**, which are self-executing protocols that automate operations based on predefined rules. In energy systems, they enable real-time, reliable energy management without third-party involvement. Blockchain holds significant promise for the energy sector by addressing inefficiencies, reducing costs, and simplifying the integration of renewables. As adoption grows, its role in creating secure and efficient energy markets continues to expand.

The rest of this paper is structured as follows: Section 2 reviews related work on blockchain in energy systems, especially peer-to-peer trading and microgrids. Section 3 outlines the current issues SolChain addresses. Section 4 presents the SolChain architecture and its operational model.

2. Related Works

Blockchain technology has inspired numerous innovations across various sectors, demonstrating its appealing advantages in creating secure, transparent, and efficient systems. Its application extends beyond digital cryptocurrencies to areas such as healthcare, supply chain management, and land registration, where it offers robust data security and transparent ledger systems. In the energy sector, blockchain is emerging as a transformative force, particularly in enabling decentralized energy markets and peer-to-peer (P2P) energy trading.

2.1. Blockchain for Peer-to-Peer (P2P) Energy Trading

Peer-to-peer (P2P) energy trading allows consumers and producers—known as prosumers—to trade energy directly, bypassing traditional utilities. Enabled by blockchain and smart contracts, this model ensures secure, transparent, and automatic transactions based on predefined conditions like price or quantity. Prosumers with solar panels, for example, can sell excess energy to neighbors, with every transaction recorded on a tamper-proof ledger. Real-time monitoring of supply and demand enables efficient, localized energy use while minimizing waste. The benefits include lower transaction costs, greater transparency, improved security, and stronger integration of renewable energy sources—ultimately promoting a more sustainable and decentralized energy future.

2.2. Case Studies of Blockchain-Integrated Microgrids

The feasibility and benefits of blockchain-based P2P energy markets are being actively explored through numerous pilot projects and research initiatives worldwide. These endeavors provide invaluable insights into the technical complexities, regulatory challenges, and economic viability of such systems. Collectively, these projects demonstrate how blockchain technology effectively addresses issues of accountability, security, and efficiency within the energy sector.

BROOKLYN MICROGRID **Brooklyn Microgrid (BMG)**	The Brooklyn Microgrid (BMG) is a community-based energy system in New York that uses blockchain (via the Exergy platform) to let residents trade locally produced solar power. Prosumers sell excess energy to nearby consumers through an app that supports real-time transactions and budgeting. Launched in 2016, BMG promotes local economic growth, lowers emissions, and enhances energy control, efficiency, and sustainability

Power Ledger is a blockchain-based platform enabling transparent P2P renewable energy trading. It uses a dual-token system (POWR and Sparkz) and combines Ethereum with faster chains like EcoChain or Solana. Smart contracts automate energy settlement. Real-world use includes India (Tata Power-DDL), Austria (Energie Steiermark), and Thailand (TDED), where it connected smart meters and allowed local energy exchange. The platform lowers energy costs, promotes renewable use, improves grid resilience, and empowers communities to manage their energy more efficiently and independently.

Power Ledger

Grid Singularity.

Grid Singularity is an open-source innovator in peer-to-peer energy exchange and co-founder of the Energy Web Foundation. It offers tools like the Social Community Manager and Singularity Map to support and simulate local energy markets. The platform promotes secure, scalable blockchain-based trading across energy communities, aiming to influence EU policies.

An analysis of 26 global microgrid case studies shows 93% use solar PV and energy storage, offering benefits like greater renewable integration, resiliency, utility savings, and lower emissions. A Saudi case study proposes a blockchain-based microgrid managing all aspects, including P2P and decentralized trading. It highlights blockchain's role in enabling secure, immutable, trusted, and fast energy transactions for efficient energy management.

General Microgrid Projects

3. Existing Issues and Proposed Solutions

In many developing regions, local communities often lack control over their own natural energy resources. For instance, the **Kaptai Hydroelectric Power Station** in Rangamati, Bangladesh, generates substantial electricity, yet much of it is supplied to urban centers like Dhaka and Chattogram, leaving many locals in the hill tracts without reliable access. This illustrates how government or corporate monopolies control energy generation and distribution, limiting local empowerment. Moreover, **energy pricing** is typically dictated by centralized authorities. For example, in some African countries like Nigeria, grid energy prices are set by government agencies, leading to inflated costs and unreliable service. If a decentralized model were implemented, where local prosumers could trade energy on a blockchain-based platform, **no single entity could unfairly alter prices or manipulate credits**—eliminating risks like hacking or fraud. **Traceability** would ensure every transaction is visible and verifiable. In India, pilot blockchain projects like in Uttar Pradesh are allowing transparent peer-to-peer solar energy trading, ensuring clarity on who owns how much power and what price it deserves. Using **LAN-based communication instead of internet** can cut infrastructure costs. For example, rural microgrid projects in Nepal and Kenya use local wireless mesh networks to manage electricity without relying on costly internet. Finally, **a modular and scalable system** allows gradual deployment—from one neighborhood to entire cities—like **Power Ledger's**

pilot in Western Australia, where individual households began trading solar energy locally before scaling across the region.

Problem	Proposed Solution
Lack of control over energy resources	Give people direct control over their energy (e.g. through smart contracts/grid)
Pricing controlled by government/large corporations	Implement decentralized pricing mechanisms to ensure fairness
Possibility of hacking or tampering with credits/prices	Ensure tamper-proof pricing and credit systems using blockchain security
No visibility of energy ownership/distribution	Enable traceability — the system will track how much energy each person has
High internet/implementation cost	Use LAN for local communication to reduce cost; make it internet-optional
Need for flexible deployment	Design system to be modular and scalable

	**Lack of control over energy resources** ***Problem:*** In many rural or semi-urban regions, even when renewable energy plants like hydroelectric or solar farms exist locally, the electricity is routed to major cities. Local people have no say in how energy is distributed. ***Solution:*** Give people direct control over their energy through smart contracts and smart grids. For example, in Nepal, villages near hydro plants often don't receive electricity. A blockchain-based local energy market would let residents manage generation and distribution autonomously.
	**Pricing controlled by government/large corporations** ***Problem:*** Energy prices are often dictated by central authorities or large corporations, ignoring local production costs or surplus. ***Solution:*** Implement decentralized pricing mechanisms so users can set fair prices based on local demand/supply. In parts of Germany, local solar producers use peer-to-peer platforms to sell energy directly, bypassing big utilities.
	**Possibility of hacking or tampering with credits/prices** ***Problem:*** Centralized systems can be manipulated—people may lose credits, or prices can be unfairly adjusted. ***Solution:*** Use blockchain to create tamper-proof pricing and credit systems. Estonia, for example, uses blockchain in several national systems to prevent tampering and ensure trust in digital transactions.
	**No visibility of energy ownership/distribution** ***Problem:*** People can't track how much energy they produce, consume, or share—leading to disputes or inefficiencies. ***Solution:*** Enable traceability of energy using blockchain ledgers. Projects like Power Ledger in Australia track energy flows between homes with solar panels, promoting transparency.

	**High internet/implementation cost** ***Problem:*** Continuous internet access for smart energy systems can be expensive in remote areas. ***Solution:*** Use Local Area Networks (LAN) for communication, reducing internet dependency and cost. For instance, many off-grid solar microgrids in Kenya operate using local networks and mobile devices to track usage.
	**Need for flexible deployment** ***Problem:*** One-size-fits-all energy systems don't work well across different regions. ***Solution:*** Design a modular and scalable system so it can work in small villages or large towns. Projects like India's Smart Power India deploy modular microgrids that grow with community needs.

4. Proposed Blockchain-Based Architecture & Governance

To address the multifaceted energy challenges in Bangladesh and capitalize on its renewable energy potential, SolChain proposes a robust and transformative blockchain-based architecture for decentralized solar power microgrids. This architecture leverages the inherent strengths of blockchain—decentralization, transparency, and immutability—to create a secure, efficient, and equitable energy ecosystem, as illustrated in the SolChain architecture diagram.

4.1. Architectural Components and Their Roles

Category	Component	Description
Users	Prosumers	Individuals or entities (e.g., households, SMEs) with solar PV who can generate, consume, store, or sell energy within the microgrid.
	Consumers	Users who primarily consume energy and purchase it from prosumers or the grid.
	Mobile App	Interface for users to monitor energy, trade P2P, set preferences, and manage usage.
Validators	Web3 Wallet	Integrated in the app; securely stores SolarTokens and facilitates blockchain transactions.
	Validator Nodes	Nodes that verify transactions, maintain blockchain integrity, and are incentivized with token rewards.

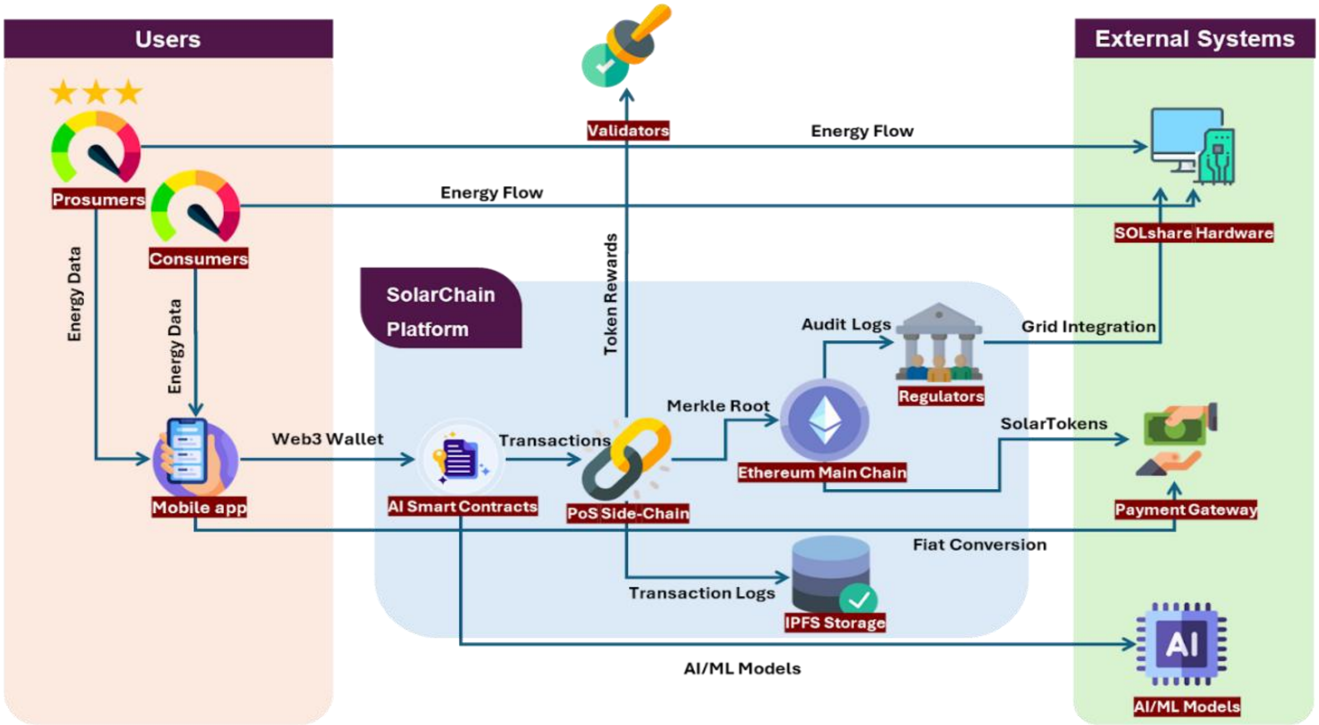


Fig : Architecture

SolChain Platform	AI Smart Contracts	Automate and govern energy transactions and management with potential AI for optimization (e.g., dynamic pricing, demand response).
	PoS Side-Chain	Handles most energy transactions using Proof-of-Stake for fast, low-cost processing.
	Merkle Root	Cryptographic hash summarizing transactions, used for data integrity and efficient verification.
	Ethereum Main Chain	Secure base layer anchoring key data (e.g., audit logs) for trust, transparency, and immutability.
	Transaction Logs (IPFS)	Off-chain storage for detailed transaction data, ensuring efficient and resilient record-keeping.
	AI/ML Models	Power analytics like demand prediction, anomaly detection, energy optimization, and cybersecurity enhancements.
External Systems	SOLshare Hardware	Integrated with existing SOLshare devices for compatibility with Bangladesh’s decentralized energy solutions.
	Grid Integration	Connects to the national grid to sell excess energy or draw power when needed, enhancing stability.
	SolarTokens	Native digital tokens representing energy; used for trading and validator rewards.
	Payment Gateway	Converts SolarTokens to/from fiat (e.g., BDT); supports financial transactions.
	Regulators	Have read-only access to logs on Ethereum, ensuring oversight and compliance with policies and standards (e.g., BREB, IRENA).

4.2. Working Principle SolChain Operational Flow

1. **Energy Generation & Measurement**
   Prosumers generate electricity via solar PV systems. Smart meters and IoT devices capture real-time production and consumption data, which is securely collected for SolChain transmission.
2. **Data Transmission & Recording**
   Real-time data is sent to SolChain, where each DER connects to a blockchain node. Transactions—including energy metrics and device diagnostics—are recorded immutably on the PoS Side-Chain. Privacy is ensured via entity mapping, zero-knowledge proofs, and digital certificates. Logs are stored on IPFS for integrity and access.
3. **P2P Energy Trading via AI Smart Contracts**
   - ✓ **Surplus Detection:** Smart meters detect when generation exceeds consumption.
   - ✓ **Market Listing:** AI Smart Contracts list surplus energy on a local marketplace, accessible via mobile app.
   - ✓ **Demand Matching:** AI matches supply with demand using rules like dynamic pricing, quantity, and priority.
   - ✓ **Transaction & Settlement:** Trades are executed and settled automatically using SolarTokens, reducing costs and eliminating intermediaries.
   - ✓ **Energy Flow Control:** Smart contracts manage energy flow to storage or high-demand areas, ensuring efficient use.
4. **Consensus & Validation**
   Transactions are validated by PoS Validators, who earn SolarTokens. This permissioned blockchain ensures efficient, secure validation with high throughput.
5. **Grid Integration & Resilience**
   - ✓ **Grid-Connected Mode:** Through SOLshare hardware, the microgrid sells surplus to or draws power from the national grid, enhancing energy balance and renewable integration.
   - ✓ **Islanded Mode:** Operates independently when disconnected, ensuring local resilience.
6. **Autonomous Operation & Resilience**
   When disconnected from the grid, the microgrid operates independently, ensuring uninterrupted power. This boosts energy security—critical in disaster-prone, grid-unstable regions like Bangladesh.
7. **Auditability & Regulatory Oversight**
   Aggregated data (Merkle Roots) is periodically committed to Ethereum Main Chain, creating a transparent, tamper-proof record for regulators. This ensures oversight without revealing sensitive user-level data.
8. **AI/ML for Optimization & Security**
   AI/ML models analyze energy and transaction data to forecast demand, optimize dispatch, detect anomalies (e.g., theft), and enhance cybersecurity across the microgrid.
9. **Payments & Fiat Conversion**
   A payment gateway enables seamless conversion of SolarTokens to local currency, letting prosumers earn from surplus and consumers pay using familiar fiat methods.

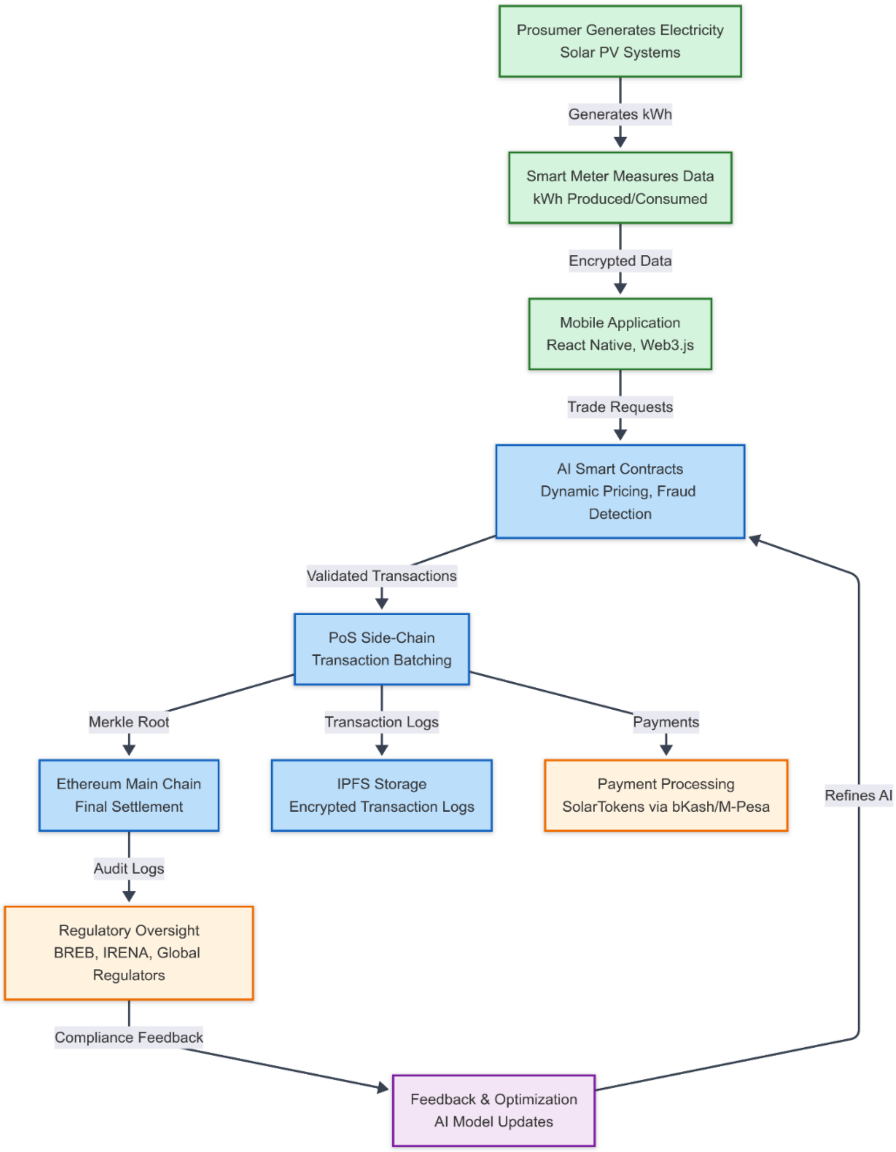


Fig: Working Principle

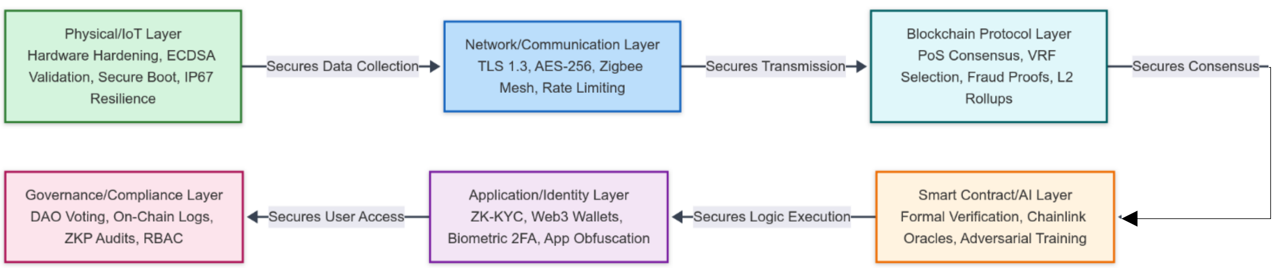


Fig: Threat Protection

4.3 Governance

SolarChain uses a decentralized governance model to keep things transparent, fair, and compliant, both in Bangladesh and for future global expansion. It's built to manage who joins the network, how trades are run, and how the tech stays secure and up-to-date. Below, we outline the key governance areas and include a table summarizing the structure.

4.3.1 Network Membership Governance

Category	Details
Joining/Leaving	Users sign up via mobile app with KYC (BREB in Bangladesh, Aadhaar/others abroad). To leave, they close smart contracts and withdraw SolarTokens.
Regulatory Oversight	BREB accesses encrypted logs for compliance. IRENA and other international regulators use APIs to ensure global standards are met.
Permissions	Prosumers/consumers can trade and view history. Validators stake tokens to verify transactions. Regulators have read-only access.
Operations	Community nodes (by prosumers/partners) maintain decentralized side-chains. Validator roles rotate based on stake, with AI monitoring performance.

4.3.2 Business Network Governance

	Charter	Minimum trade of 0.1 kWh; AI-driven pricing; disputes resolved via smart contracts; global DAO manages cross-border rules.
	Services	AI handles pricing, fraud detection, demand forecasting; IPFS ensures secure data sharing for international pilots.
	SLAs & Compliance	99.9% uptime and 24-hour dispute resolution; compliant with BREB (Bangladesh) and IRENA (global) regulations.

4.3.3 Technology Infrastructure Governance

	Distributed IT	Nodes hosted by prosumers, BREB, SOLshare, and international partners (e.g. Power Ledger).
	Tech Updates	AI models updated via Google Cloud; Solidity smart contracts regularly upgraded; exploring future support for Polygon blockchain.
	Data Services	On-chain logs (Merkle roots, balances) for auditability; off-chain data stored on IPFS with zero-knowledge encryption for privacy.
	Risk Mitigation	AI detects fraud reducing it by ~15%; PoS side-chains prevent congestion; bonded fraud proofs and homomorphic encryption ensure security.

4.3.3 Asset Tokenization

	SolarTokens	Each token represents 1 kWh of energy, issued on Ethereum for P2P trading.
	Exchange Mechanism	In Bangladesh, tokens convert to BDT via bKash; globally, use local currency gateways (e.g. INR, NGN, M-Pesa).
	Incentive Structure	Prosumers receive BDT 10/kWh, consumers pay BDT 8/kWh; validators earn 0.5% of transaction fees.
	Global Standardization	SolarTokens are standardized for international trading; local partners set adjusted rates per market.

4.3.4 Why This Governance?

Our governance ensures *SolarChain* is scalable (10,000+ transactions/second), secure (AI fraud detection, encryption), and decentralized (community nodes, DAO). It complies with BREB and global regulations, and APIs connect seamlessly with local (bKash, SOLshare) and international systems (M-Pesa, DISCOMs).

4.3.5 Governance Structure Table

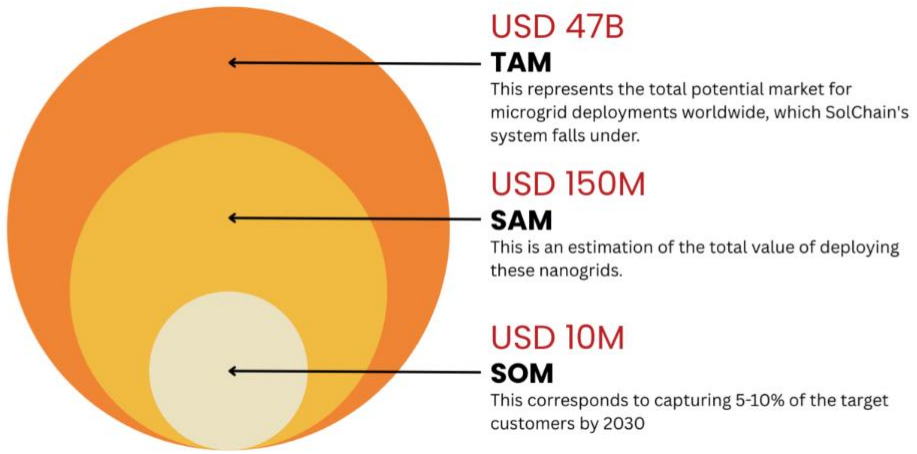
The table below summarizes *SolarChain*'s governance, designed for clarity in the whitepaper and poster.

Aspect	Network Membership	Business Network	Technology Infrastructure
Key Features	• Open signup with KYC (BREB, Aadhaar) • Exit via smart contract closure • Regulators (BREB, IRENA) access logs • Roles: prosumers, consumers, validators	• Charter: 0.1 kWh minimum, AI pricing • DAO for global operations • AI services: pricing, fraud, forecasting • 99.9% uptime, BREB/IRENA compliance	• Nodes: prosumers, BREB, global partners • Updates: AI, Solidity, new blockchains • Data: on-chain (Merkle roots), off-chain (IPFS) • AI fraud detection, encryption
Stakeholders	Prosumers, consumers, validators, regulators	Users, DAO, regulators	Nodes, developers, regulators
International Perspective	Local KYC adapts to global systems (e.g., Aadhaar, M-Pesa)	DAO standardizes cross-border rules	Global nodes and IPFS ensure scalability

5. Market Size and Partners

5.1. Market Size

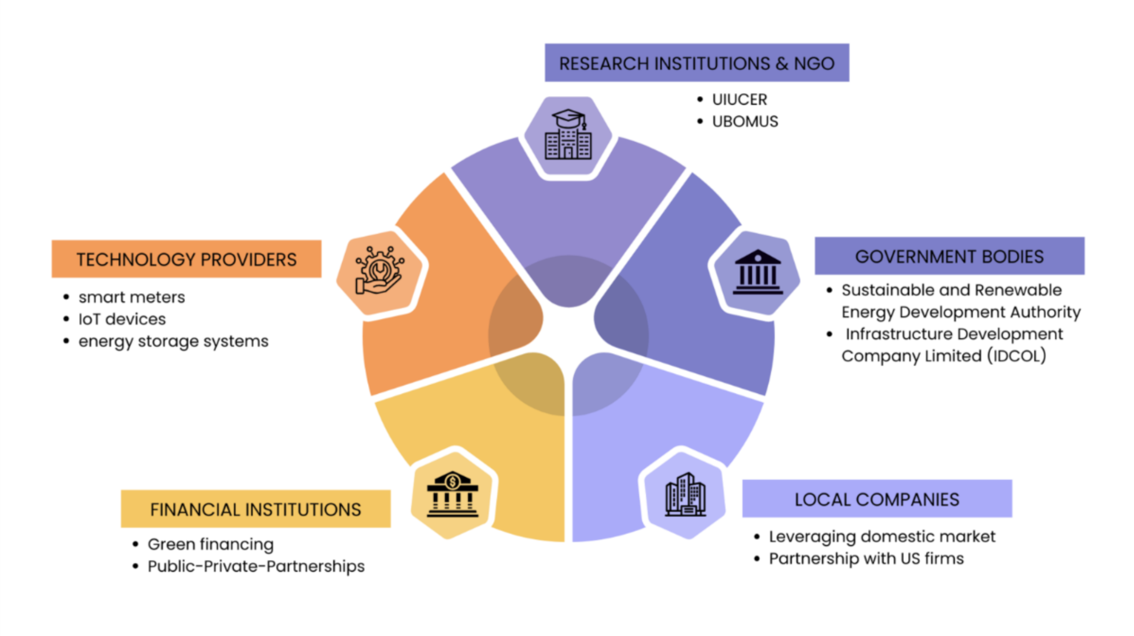
Bangladesh presents a significant and rapidly expanding market for renewable energy, particularly solar power and microgrids. As of 2024, renewable energy constitutes 4.5% of Bangladesh's total installed power capacity of 22,215 MW, with solar power accounting for 80% of the 1,183 MW renewable capacity. The government has set ambitious targets to increase the share of renewables to 15% by 2030, 40% by 2041, and 100% by 2050.



The solar energy market in Bangladesh is projected for substantial growth. Estimated at 0.76 GW in 2025, it is expected to reach 3.90 GW by 2030, demonstrating a Compound Annual Growth Rate (CAGR) of 38.6% during this forecast period. The government aims to generate **over 4,100 MW** from renewable sources by 2030, with solar power expected to account for half of this.

While global microgrid market size has a CAGR of 17.85% , this expansive market is projected to reach approximately **$47 billion by 2030**, reflecting the total demand for solutions like SolChain if it were to capture the entire sector. However, a more realistic target is the market segment that SolChain can effectively serve with its current business model and geographical focus on Bangladesh. This Serviceable Available Market (SAM), which represents the total value of deploying decentralized solar microgrids and P2P energy trading systems in the region, is estimated at **$150 million**. Bangladesh specifically demonstrates the economic viability of renewables-only microgrid designs. Over 6 million solar home systems have already been installed across the country, providing reliable electricity to more than 16 million people in off-grid remote areas. Considering the challenges of market entry, regulatory hurdles, and scaling in the short term, we estimate to capture approximately **$10 million** market which reflects a strategic, gradual market penetration as the company establishes its pilot projects, builds a customer base, and scales its operations.

5.2. Potential Partners



Successful implementation and scaling of SolChain will require strategic partnerships across various sectors:

- **Government Bodies:** Collaboration with key government entities is crucial for policy alignment, regulatory support, and project authorization. Relevant bodies include the Ministry of Power, Sustainable and Renewable Energy Development Authority (SREDA), Bangladesh Energy Regulatory Commission (BERC), Bangladesh Power Development Board (BPDB), and Infrastructure Development Company Limited (IDCOL). The government's interest in combating corruption and reforming the energy sector aligns with SolChain's transparency features.
- **Local Companies:** Partnering with local firms is essential for navigating the domestic market, leveraging local expertise, and facilitating on-the-ground implementation. There is a strong preference in Bangladesh for local companies to partner with U.S. firms on tenders, valuing higher quality solutions.
- **NGOs and Research Institutions:** Organizations like UBOMUS and United International University-Centre for Energy Research, which have partnered with SOLshare, can provide valuable community engagement, implementation support, and research insights.
- **Financial Institutions:** Securing timely funding and investment is critical. This includes engaging with international financial institutions (e.g., Asian Development Bank, which has financed solar PV plants in Bangladesh), and exploring green financing mechanisms like green bonds. Public-Private Partnerships (PPPs) are also encouraged by the government to mobilize private capital for renewable energy projects.
- **Technology Providers:** Given the need for advanced energy storage solutions and smart grid technologies , partnerships with technology providers for smart meters, IoT devices, and energy storage systems will be vital. Integration with existing solutions like SOLshare hardware is also a consideration.

6. Revenue and Distribution

SolChain's model is designed to create a self-sustaining ecosystem with a diverse set of revenue streams and a transparent, efficient distribution of value. This ensures not only the project's financial viability but also incentivizes participation from all stakeholders.

6.1. Revenue Streams

SolChain will generate income from a mix of transactional and recurring revenue models.

- **Transactional Fee on Energy Trades:** This is the core revenue stream. A small, predefined percentage fee (e.g., 2-5%) will be automatically deducted from each P2P energy transaction facilitated by the SolChain platform's smart contracts.

- **Hardware and Infrastructure Sales:** Selling hardware is a key revenue source. This includes not only the solar panels but also the entire SolChain "nanogrid kit" which would include smart meters, battery storage systems, inverters, and the blockchain-enabled control unit. This provides a significant upfront revenue source during the deployment phase.

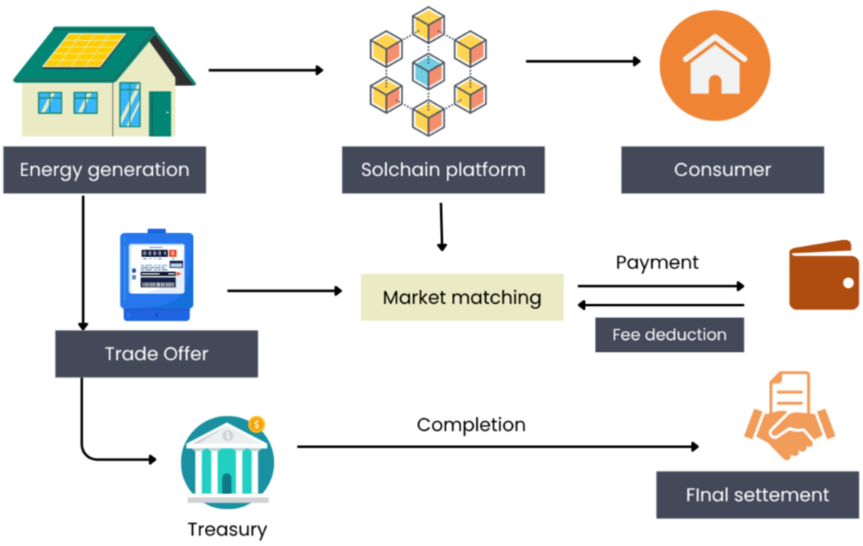
- **Installation and Maintenance Services:** Beyond selling the hardware, SolChain will offer professional installation, setup, and ongoing maintenance services for the nanogrids. This is a crucial service-based revenue stream that ensures the systems are operational and provides long-term customer support.

6.2 Deployment Phases

	Phase 1 Prototype & Pilot	Phase 2 Regional Expansion	Phase 3 Global Rollout
Timeline	Q1–Q4 2026	Q1–Q4 2027	Q1 2028–Onward
Objectives	• Develop & test prototype • Pilot in 10 rural communities • Validate technical & business feasibility	• Scale to 50 communities • Integrate with BREB & bKash • Enhance AI for pricing & fraud	• Nationwide rollout in Bangladesh (100K users) • Establish global P2P model • Support SDG 7 & SDG 13
Activities	• Develop app (React Native, Web3.js) • AI-enhanced smart contracts (Solidity) • PoS side-chains, SOLshare integration • Pilot 500 households • Collect transaction data	• Expand to 5,000 users • API integration with BREB & bKash • Optimize AI (LSTM, Isolation Forest) • Run NGO campaigns	• Scale to 100K users, 1M kWh/month • Advanced AI for pricing & fraud • Partner with installers & regulators • Advocate for policy via IRENA, BREB
Key Deliverables	• Mobile app + blockchain backend • 10,000 kWh traded • 95–98% cost savings analysis	• 5,000-user regional deployment • BREB certification • bKash integration • Enhanced AI (15% cheaper, 20% faster)	• 100K users platform • BDT 500M annual revenue • SDG impact report • Scalable system (10,000+ tx/sec)
International Perspective	• Collaborate with Solar Sister • Study frameworks in IN & KE • Present at IRENA Assembly	• Deploy in Nepal, Rwanda • Work with Power Ledger, ENGIE • Cross-border IPFS protocols	• Launch in 10+ countries (PK, NG, PH...) • Collaborate with World Bank, SEforALL • Establish SolarChain DAO

6.3 Distribution Process

The SolChain distribution process begins with a **Prosumer** generating excess solar energy, which is measured by a smart meter. This meter sends a **trade offer** to the **SolChain Platform**, where a smart contract **automatically matches** the offer with a **Consumer** in need of energy.



Once matched, the energy physically flows from the Prosumer to the Consumer, while a **digital payment** flows from the Consumer's wallet through SolChain. A **transaction fee** is deducted and sent to the **SolChain Treasury**, and the **remaining payment** is transferred to the Prosumer's digital wallet, completing the **peer-to-peer energy and value exchange**.

7. Market Competition and Business Risks

7.1 Market Competition

SolChain operates at the convergence of energy, blockchain technology, and decentralized finance (DeFi)—three rapidly evolving sectors driving global innovation. Within this dynamic landscape, SolChain faces both direct and indirect competition from established national and international entities.

7.1 Competition

Region	Competitor	Strengths	Limitations
Bangladesh	SOLshare	Leading P2P player; strong local presence; hardware integration.	Lacks blockchain/token economy.
	IDCOL Projects	Govt-backed; widespread rural coverage.	No real-time traceability, P2P flexibility, or open pricing.

	NGO/University Pilots	Active microgrid pilots (e.g., UBOMUS, UIU).	Centralized, grant-dependent; not scalable or blockchain-enabled.
International	Power Ledger (Australia)	Advanced P2P blockchain platform; dual tokens; fast sidechains.	Competitive architecture, but SolChain offers localized enhancements.
	Brooklyn Microgrid (USA)	Pioneered community P2P trading; urban-focused.	Operates under very different regulations and socioeconomics.
	Grid Singularity (EU)	Focuses on policy, simulation tools, and energy communities.	Not transaction-focused; limited direct market implementation.

While the global and local landscape of blockchain-enabled energy solutions is increasingly competitive, SolChain distinguishes itself through its deep contextual alignment with the socioeconomic and infrastructural realities of Bangladesh and similar emerging markets. Unlike many international platforms optimized for urban or high-connectivity regions, SolChain's modular architecture, offline-capable design, and local currency integration position it uniquely for scalable deployment in underserved rural areas. By leveraging partnerships, regulatory alignment, and purpose-built technology, SolChain is not only prepared to coexist with global players—it is positioned to lead a new class of decentralized energy solutions purpose-built for the Global South.

7.2 Business Risks

Despite the promising architecture and market potential, SolChain faces several risks across **regulatory**, **technological**, **financial**, and **operational** domains.

	**Uncertain Blockchain Policy**: Bangladesh has not yet fully regulated the use of blockchain or tokenized assets in the energy sector. Sudden regulatory changes could affect token usage, peer-to-peer trading legality, or data privacy laws. **Grid Integration Approval**: Securing grid connection rights, especially for backfeeding surplus energy, involves bureaucratic processes and may face resistance from traditional utilities.
	**Token Volatility**: While SolarTokens are pegged to energy units (kWh), their fiat exchange rate could fluctuate if demand varies, impacting user trust and platform stability. **High Capital Expenditure (CapEx)**: Initial investment for solar panels, smart meters, batteries, and blockchain infrastructure may delay ROI, particularly in low-income communities unless subsidized or financed effectively.
	**Cybersecurity Threats**: Although blockchain offers immutability, smart contracts and IoT integration can be vulnerable to exploits if not properly secured and regularly updated. **Scalability Bottlenecks**: As user volume grows, even sidechains can experience performance issues unless continuously optimized. AI models must also be retrained with accurate local data to maintain relevance.

	**Technical Adoption Barriers**: End-users in rural areas may face challenges in using mobile apps, wallets, or smart contracts due to low digital literacy. Without proper training and UX design, adoption may stagnate. **Maintenance & Support**: Decentralized systems require robust local support networks for hardware maintenance. Delays or failures in servicing can erode community trust in the system.
	**Competition from Subsidized Utilities**: In some regions, heavily subsidized grid electricity may undercut the local trading price of solar power, discouraging prosumer participation. **Technology Fatigue or Mistrust**: Previous failures in tech-driven development projects may lead to initial skepticism from rural communities or NGOs unless early successes are well documented and communicated.

7.3 Mitigation Strategy

SolChain incorporates **modularity, AI-driven fraud detection**, and **regulatory auditability** to reduce risks. The governance model ensures **compliance with local (BREB)** and **international (IRENA)** standards. Strategic partnerships with **financial institutions, NGOs, and local energy agencies** will help offset CapEx and support long-term adoption.

By remaining agile, regulatory-aware, and community-focused, SolChain is positioned to navigate the evolving energy landscape—both in **Bangladesh** and beyond.

Conclusion

SolChain introduces a resilient, modular architecture for decentralized energy exchange by combining PoS-based blockchain consensus, ZK-privacy, and AI-enhanced edge analytics within local solar microgrids. Its LAN-first design and use of lightweight protocols (e.g., MQTT, LoRa) optimize performance in bandwidth-constrained environments, while IPFS-backed off-chain storage ensures immutable transaction logs without compromising latency. The governance model incorporates validator nodes, prosumer participation, and regulatory oracles, facilitating real-time oversight without central control. While scalability, regulatory clarity, and hardware standardization pose ongoing challenges, SolChain's smart contract interoperability, tokenized incentives, and plug-and-play hardware model enable phased rollout and rapid replication. The system positions itself not merely as an energy trading tool but as an infrastructure layer for climate-resilient, digitally sovereign, and economically inclusive energy ecosystems.

Team Name: GreyDevs

Team ID: 68923e7908f3d

Team Size: 4 Members

Project Category: Blockchain

Project Type: Other

Project Name:

SolChain - A Blockchain Based P2P Solar Energy Sharing Microgrid System

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