BLOCKCHAIN BASED ENERGY TRANSACTION CONSIDERING PRIORITY SCHEDULING

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This work ensures transparent and affordable power transactions through a prepaid scheme that allocates electricity based on consumer priority and demand. It introduces a fuzzy-based priority scheduling technique and a simplified block-generating algorithm for secure and clear energy transactions.

Keywords: energy transaction, fuzzy based priority scheduling, lowest possible tariff, blockchain based ledger

1. Introduction

Blockchain connects conventional and renewable energy sources through secure, transparent, and instant transactions. By using cryptographic verification, it enhances efficiency, reliability, and trust in modern energy systems.

Several studies support this progress: a new energy trading platform [1], an algorithmic market-making framework [2], and a permissioned blockchain with artificial agents [3]. Case studies in [4] validate such trading through Australian energy units, while [5] presents a local energy market on Ethereum. Governance and decentralization issues are analyzed in [6], pricing mechanisms in [7], and market efficiency in [8]. Further, [9] explores blockchain-enabled smart microgrids, and [10] integrates blockchain into decentralized payment systems.

Unlike [11,13], which rely on manual bidding, the proposed fuzzy logic approach uses membership functions for automatic energy allocation. It ensures the lowest dynamic price through fuzzy inference, replacing fixed tariffs or manual bidding methods. The system enables fast and transparent transactions by maintaining synchronized local and global memory records. It is also simpler and faster than multi-stage P2P systems [12], making it suitable for small and medium grids. Additionally, it encourages competition by prioritizing low-tariff generators without explicit bidding. Overall, the method emphasizes automation, cost

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efficiency, and transparency, effectively bridging intelligent control with practical energy market operations.

The models that are currently available on the market are contrasted with our proposed system in Table 1.

Table 1

Reference	Reference Approach	Proposed Application
[11]	Quartierstrom microgrid uses SBC-based blockchain for dynamic pricing.	Generation units set prices; lower prices gain priority without bidding.
[12]	Five-stage blockchain ensures efficient peer-to-peer energy trading.	Simple, transparent system with user-accessible history.
[13]	Uses hourly double auction with secure Ethereum transactions.	Uses local-global memory and fuzzy scheduling to prioritize lowest-price generators.
[14]	A blockchain-based system enables energy trading among all stakeholders.	Fuzzy scheduling ensures fair, simple energy allocation without complex bidding.

2. Proposed methodology

Electricity transactions are scheduled by demand and priority using small-scale lab setups for real-time validation. The followings are the main parts of the proposed scheme.

2.1 The consumers

Consumers draw energy from available sources based on priority; higher-weight users like medical units get preference. Loads (fans, bulbs, pumps) have digital meters, and an app enables flexible energy requests.

2.2 The generation unit

It might be a source of renewable energy or conventional power plant. For various plants, the tariff could vary. In this work the batteries with different capacities are used as source to check the reliability of the scheme within laboratory.

2.3 The priority setting unit

A fuzzy logic–based priority unit (Fig. 1) assigns each consumer a weighted static priority and determines energy flow based on static priority, demand sequence, and required energy. These factors generate a dynamic priority, which, combined with the static one, forms the membership function in the fuzzy algorithm to decide source selection and transaction order. The fuzzy controller rules are developed and verified through simulation.

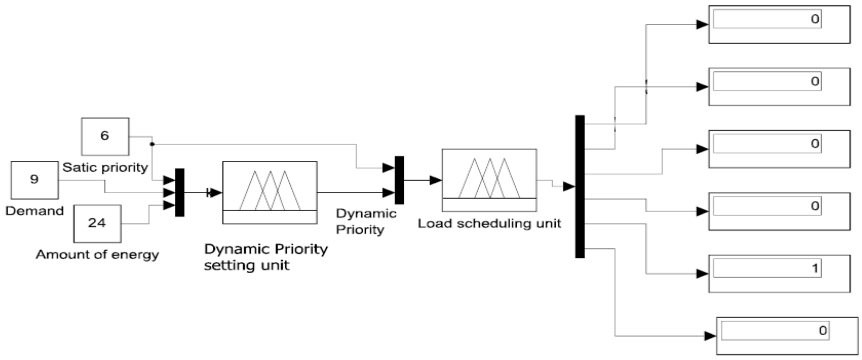

Fig. 1. Proposed scheme's blockchain-based power distribution using MATLAB-SIMULINK model

A Mamdani FIS with triangular membership functions calculates dynamic priority based on static priority, demand order, and energy need—favoring early, short requests. A second Mamdani FIS controls six switches (S11–S23), ensuring only one operates at a time using static and dynamic priorities.

2.4 The block generation unit

A key part of the scheme uses a time-intensive algorithm to generate sequential blockchain blocks with user and energy data. When a client requests energy at time T1, the transaction is processed using the SHA-256 hash function, converting input data into a unique 160-bit message digest for secure identification. The block generation unit then creates a new block containing transaction details, the current hash, and the previous hash, linking them securely. For the next request at T2 (T1 < T2), the same process repeats, adding the next block in sequence, as shown in Fig. 2 and 3.

```
============ the genesis transcation begin ============
0Genesis Block

ans =

  Block with properties:

            index: 0
             data: 'Genesis Block'
     previousHash: []
         selfHash: '353756d574bd5a7ffb7006e7946f1f310805c002'
            nonce: []

============ the genesis transcation end ============
============ the first transcation begin ============
00000434159b8839355dcfdd80c2f4ab
Elapsed time is 0.658729 seconds.
```

```
ans =

  Block with properties:

           index: 1
            data: 'ABABC200'
    previousHash: '353756d574bd5a7ffb7006e7946f1f310805c002'
        selfHash: '00000434159b8839355dcfdd80c2f4ab'
           nonce: 1823

============ the first transcation end ============
============ the second transcation begin ============
0008b3821ab9eee8f02fad767b182198
Elapsed time is 0.189575 seconds.


ans =

  Block with properties:

           index: 2
            data: 'BCGHI300'
    previousHash: '00000434159b8839355dcfdd80c2f4ab'
        selfHash: '0008b3821ab9eee8f02fad767b182198'
           nonce: 935

============ the second transcation end ============
============ the third transcation begin ============
0009f932c8c440b2bb4b8aff63bee3ec
Elapsed time is 0.227824 seconds.

ans =


  Block with properties:

           index: 3
            data: 'CACDE700'
    previousHash: '0008b3821ab9eee8f02fad767b182198'
        selfHash: '0009f932c8c440b2bb4b8aff63bee3ec'
           nonce: 1106

============ the third transcation end ============
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Fig. 2. Blocks for three subsequent transactions

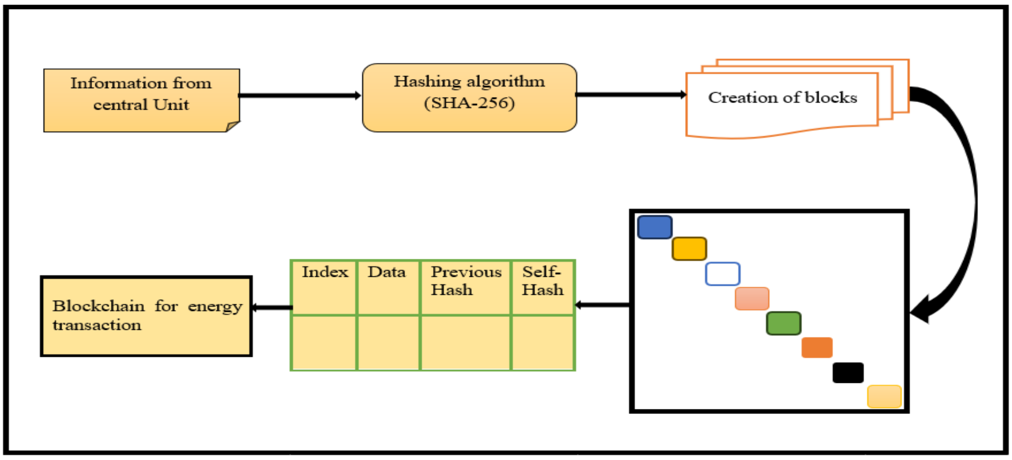

Fig. 3. Proposed block generating unit

2.4.1 Blockchain Architecture

For secure and transparent energy transactions, the system uses a PoW-based consensus with SHA-256 hashing, forming a tamper-proof ledger. Table 2 demonstrates key aspects of the used blockchain.

Table 2

Aspect	Description
Type of Consensus	Proof-of-Work (PoW) ensures data security and immutability by verifying each transaction before adding a block.
Block Generation	SHA-256 processes user ID, energy, and time into a 160-bit hash; a new block links to the previous one.
Block Time	Depends on task complexity, typically a few seconds to minutes.
Scalability	Limited due to high computational effort in PoW as transaction volume increases.
Node Architecture	Full nodes verify, generators create, clients request; all linked via decentralized P2P network.

2.5 The central control unit

This core unit stores total available energy, consumer priorities, and demand order. It periodically updates data and calculates the most economical energy distribution among consumers.

2.6 Global Memory

The Global memory of the system receives data from the central unit. Also, it keeps the record of every consumer, their energy usage, and the tariffs they pay. Only the administrator has access to it.

2.7 Local Memory

Each consumer, in this scheme has access on the previous and on-going transaction made by them. The information regarding particular consumer is uploaded to the local memory of concerned consumer from the central unit. Thus, the energy transaction is clarified from the user end. The flowchart of the proposed scheme is demonstrated in following Fig. 4.

Step 1: Consumer requests energy via app; data sent to fuzzy priority unit.

Step 2: Dynamic priority is calculated, and energy source selected.

Step 3: Block generation unit uses SHA-256 to create a unique, secure hash for the transaction.

Step 4: Central unit receives data and source capacity details.

Step 5: After energy delivery, the central unit updates each source's capacity.

Step 6: Updated data is stored in global memory with transaction details.

Step 7: Local memory of the consumer records the transaction.

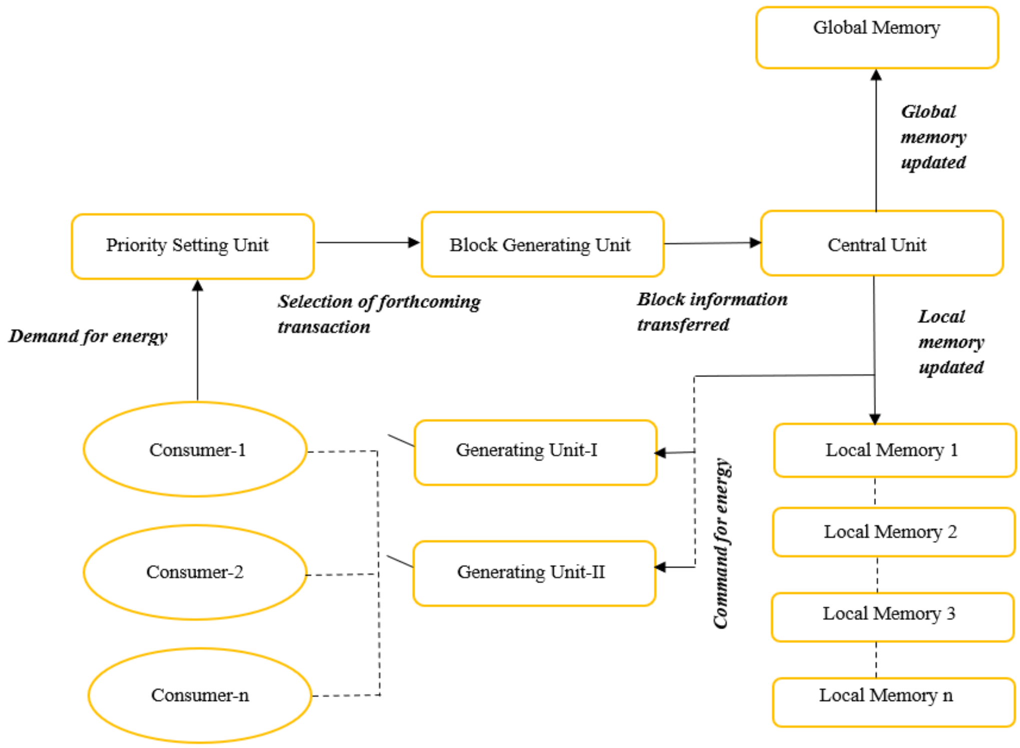

Fig. 4. Flow-chart of the proposed scheme

3. Results and discussions

A MATLAB-SIMULINK prototype of the proposed system includes two fuel cell sources and three consumers. It is assumed that Source 1 supplies energy at ₹5 per unit, and Source 2 at ₹8 per unit, making Source 1 the preferred choice. Among consumers, Consumer 3 (DC pump) has the highest static priority, followed by Consumer 2 (DC fan) and Consumer 1 (DC bulb).

Table 3

Comparative Performance Indicators for the Suggested Blockchain-Based Power Transaction System

Indicators	Expected Performance	Justification in Proposed Scheme
Latency	Moderate	Steps 3–5 verify and hash via SHA-256, enabling faster confirmation than Ethereum.
Throughput	Medium to High	Multiple users request energy; units verify in parallel before update (Steps 1-2).
Energy Efficiency	High	SHA-256 hashing is light; most energy is used in central updates and local processing (Steps 3–6).

Table 3

Comparative Performance Indicators for the Suggested Blockchain-Based Power Transaction System

Indicators	Expected Performance	Justification in Proposed Scheme
Security / Immutability	High	Step-3 guarantees that every transaction creates an unchangeable hash. Energy transaction records are tamper-proof.
Cost Reduction	Moderate to High	Costs associated with administration and middlemen are decreased by automating demand processing, source selection, and billing (Step 1–7).
Scalability	Moderate	The center unit serves as the scheme's validation.
Transparency	High	Steps 6–7 guarantee that the system and the customer can access the transaction history through global and local memories.

At regular intervals, each consumer requests energy from the lowest-cost source based on demand and priority. Transactions are sequentially recorded on the blockchain and managed by the central unit. Global (private) and local (user-specific) data are uploaded to the cloud through ThingSpeak. The proposed scheme is validated through three test cases.

3.1 Case-I

Consumer 2 requests a small amount of energy, and the fuzzy unit assigns a dynamic priority. Based on this and its medium static priority, circuit breaker S12 closes, supplying power from Source 1 at ₹5 per unit. Usage and transaction data are then uploaded to the cloud via Consumer 2’s ThingSpeak channel (Fig. 5–6).

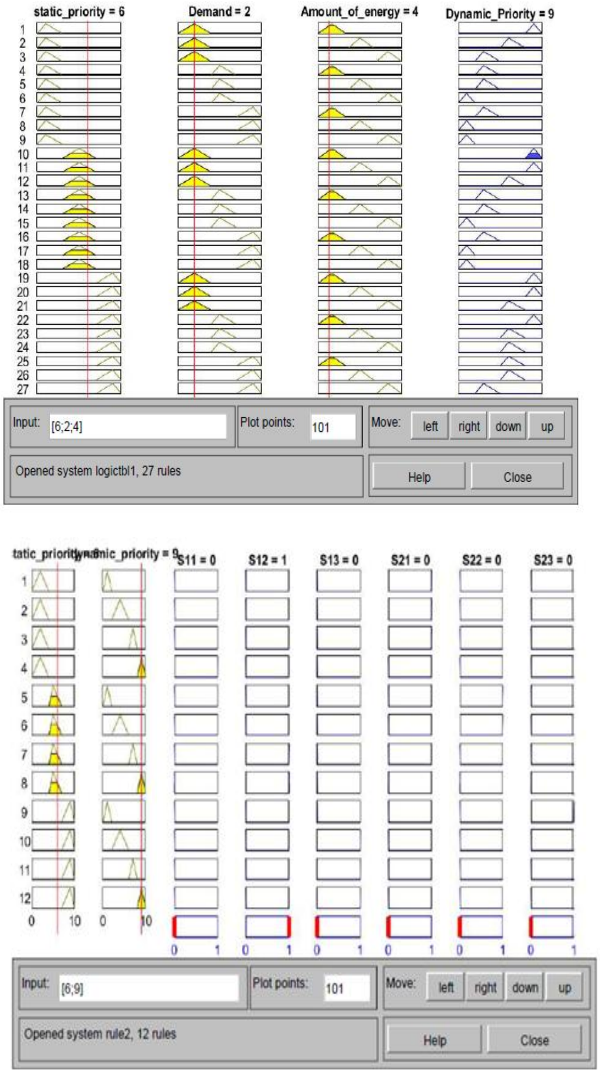

Fig. 5. Dynamic Priority and Switch position for case-I,

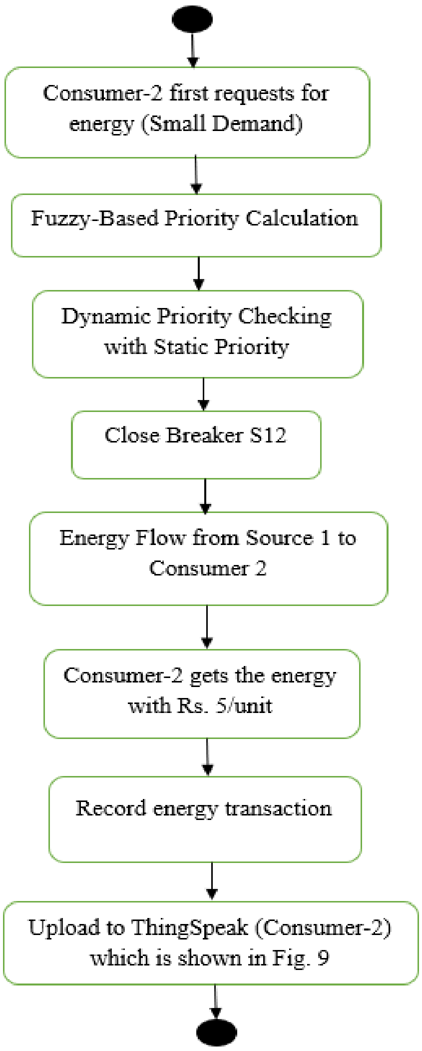

Fig. 6. Flowchart for case-I

3.2 Case-II

Soon after, Consumer 3 makes a small energy request processed through the same steps as Consumer 2. Based on the priority assessment, circuit breaker S13 closes, allowing power flow from Source 1 at ₹5 per unit (Fig. 7). Usage and transaction data are uploaded to Consumer 3's ThingSpeak channel, with the process shown in Fig. 8.

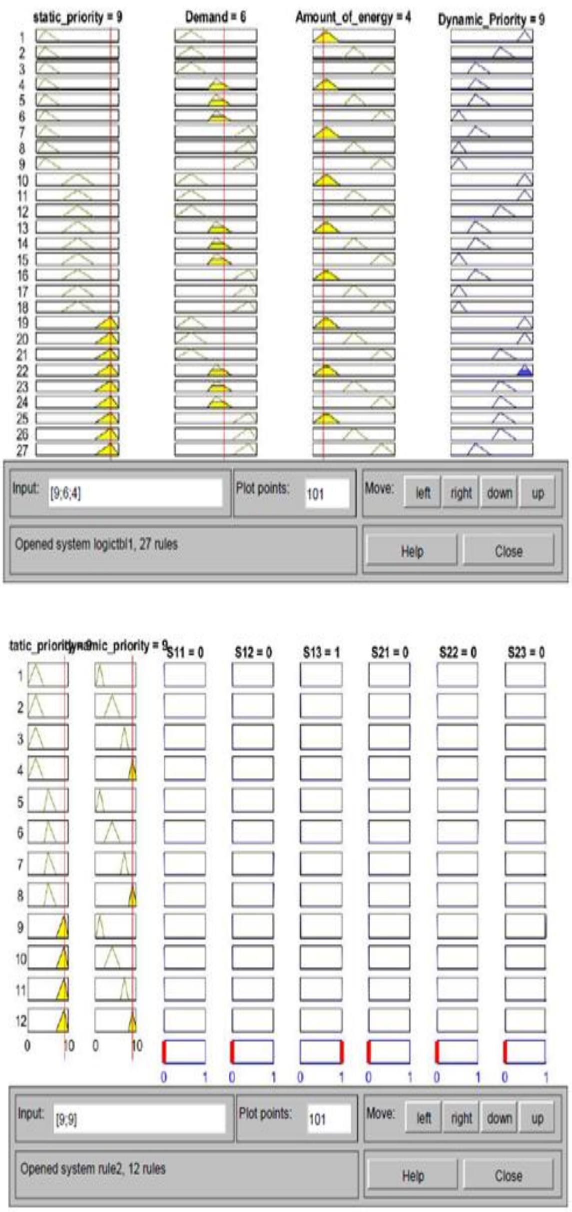

Fig. 7. Dynamic Priority and Switch position for case-II

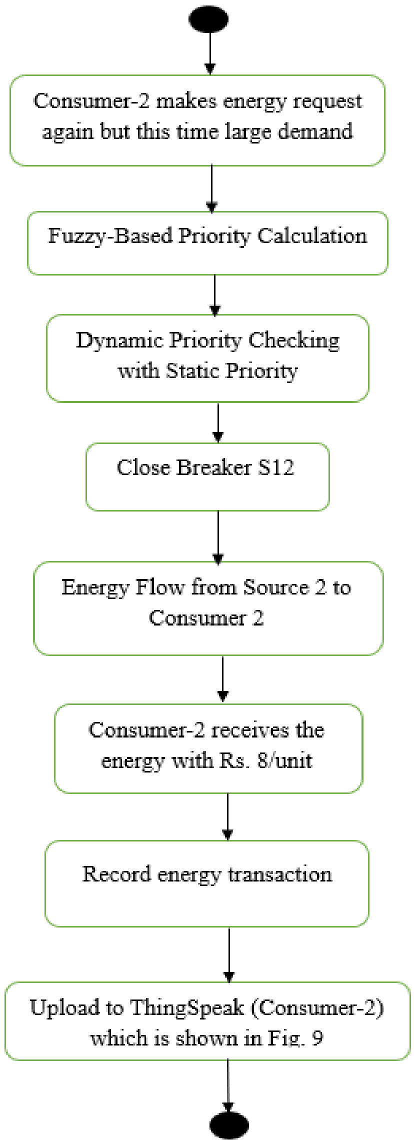

Fig. 8. Flowchart for case-II

3.3 Case-III

Consumer 2 then makes a larger energy request, which the fuzzy unit evaluates to assign a dynamic priority. Based on this, energy is supplied from Source 2 at ₹8 per unit (Fig. 9). All related transaction data are stored in Consumer 2's local memory for recordkeeping. A flowchart representing the execution procedure is shown in Fig. 10.

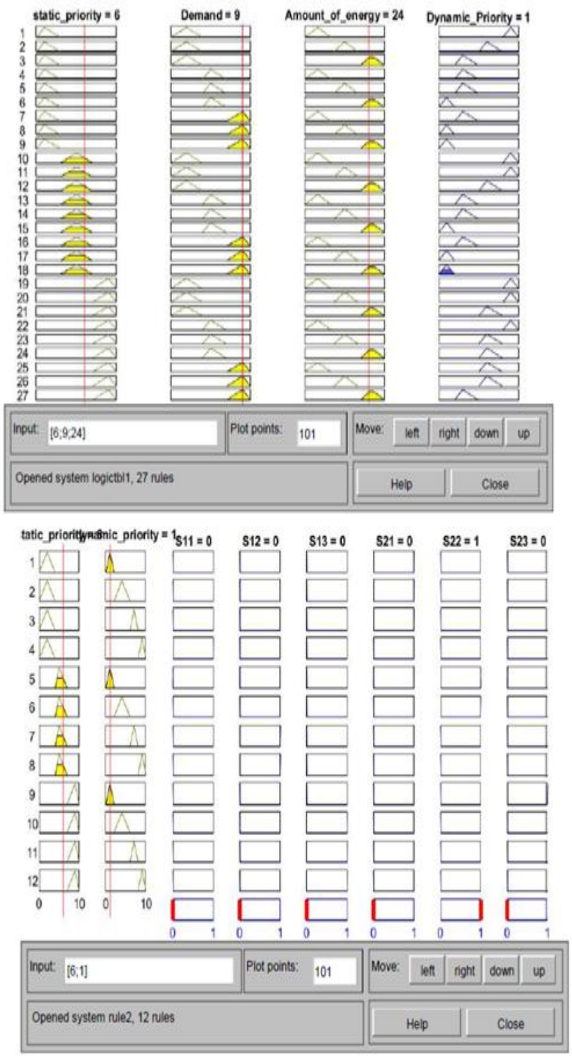

Fig. 9. Dynamic Priority and Switch position for case-III

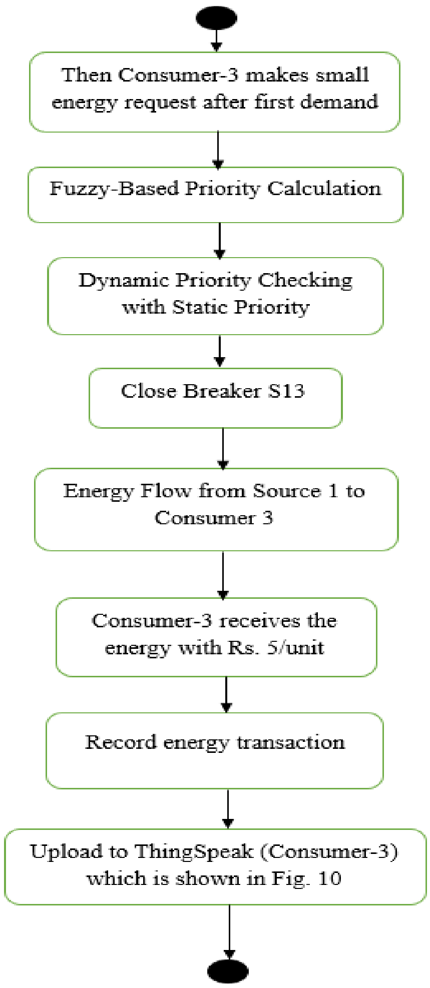

Fig. 10. Flowchart for case-III

Local Memory-1, Local Memory-2, and Local Memory-3 are the distinct channels on the ThingSpeak cloud platform that correspond to the local memory of each of the three consumers (Consumer 1, Consumer 2, and Consumer 3). After modeling the three previously indicated scenarios, the ThingSpeak channel views are shown in Fig. 11 to 13.

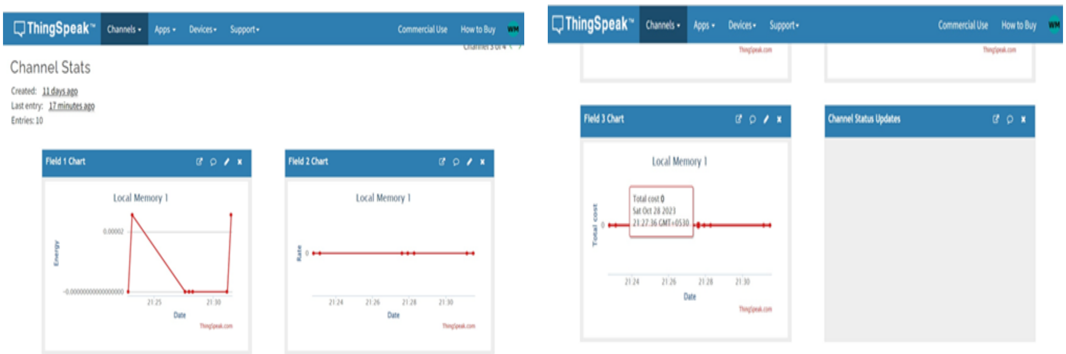

Fig. 11. Local memory of consumer-1

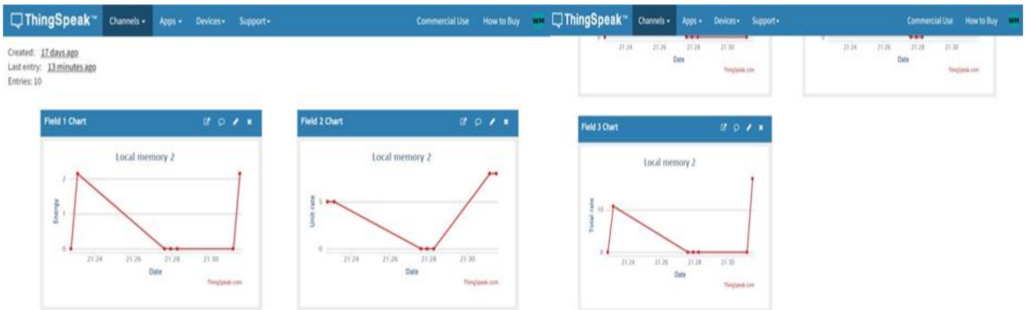

Fig. 12. Local memory of consumer-2

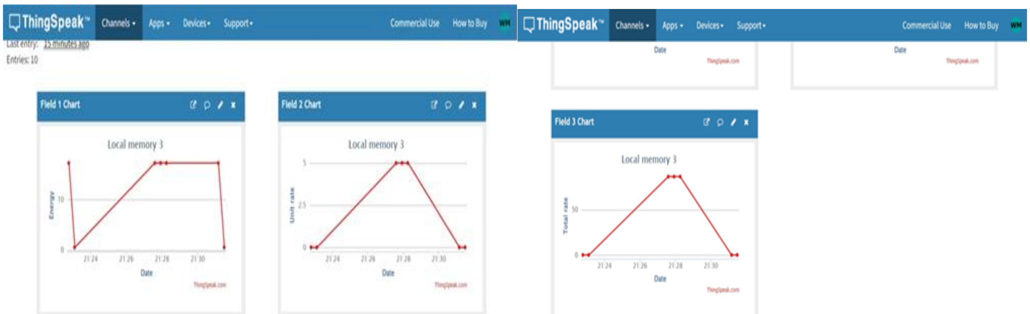

Fig. 13. Local memory of consumer-3

4. Conclusions

This work introduces a fuzzy-based priority system for local energy markets, assigning weighted priorities to consumers and classifying generators by reliability and tariff. The method ensures low-cost, secure, and transparent energy transactions using a simplified block generation process. The proposed credit-based system supports efficient, secure energy distribution aligned with modern smart grid goals.

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