Decentralized Energy Trading Model with Smart Grids and Blockchain

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Outline

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- Literature Survey
- The Proposed Decentralized Energy Trading Model
- Results and Analysis
- Conclusions

Decentralized Energy Trading Model with **Smart Grids** and **Blockchain**

Introduction

What is Energy Trading?

Energy Generation and Distribution

Energy Generation Sources [1]

- Renewable - 26%
- Non-renewable - 74%

Energy Lost during Distribution [1]

- Distribution - 5%
- Generation - 59%

[1] International Energy Agency. IEA data and statistics for energy consumption [Online]. Available: https://www.iea.org/data-andstatistics/data-tables?country=WORLDenergy=Balancesyear=2018. Accessed: June 15, 2022.

How can we minimize energy loss?

Efficient and reliable energy generation and distribution

How can we provide efficient and reliable energy distribution?

Smart Grids [9]

[9] M. Nazari, S. Khorsandi and J. Babaki, “Security and Privacy Smart Contract Architecture for Energy Trading based on Blockchains”, Proceedings of ICEE: 29th Iranian Conference on Electrical Engineering, Iran, IEEE, 2021 pp. 596-600, 10.1109/ICEE52715.2021.9544155.

Energy Trading

When energy demand exceeds supply, energy trading enters scene

Who Trades Energy?

Who Trades Energy?

- Producer
- Consumer
- Prosumer

Note: Cochin Airport (CIAL) is positive-powered.

Literature Survey

State-of-the-Art Comparison between the Existing Models

Author	Anonymity	Decentralized	Eliminate trusted third-party	Micro grid	Protection from SPOF	Load balancing	Price governance
Li et al. [5], 2019	✓	✗	✗	✓	✗	✓	✗
Pee et al. [6], 2019	✗	✓	✓	✗	✓	✗	✗
Liang et al. [10], 2020	✗	✓	✓	✗	✓	✗	✗
Esmat et al. [7], 2021	✓	✓	✓	✓	✓	✓	✗

Challenges in Existing Mechanisms

- **Transparency** for users to gain trust
- **Load balancing** of multiple transaction
- **Insider threat** from a trusted third-party
- **Centralized** systems are vulnerable to SPOF

What are the solutions?

Blockchain

Can blockchain and price governance provides solutions for above challenges?

Yes,

Blockchain to eliminate TTP and SPOF, and provide transparency

The Proposed Decentralized Energy Trading Model

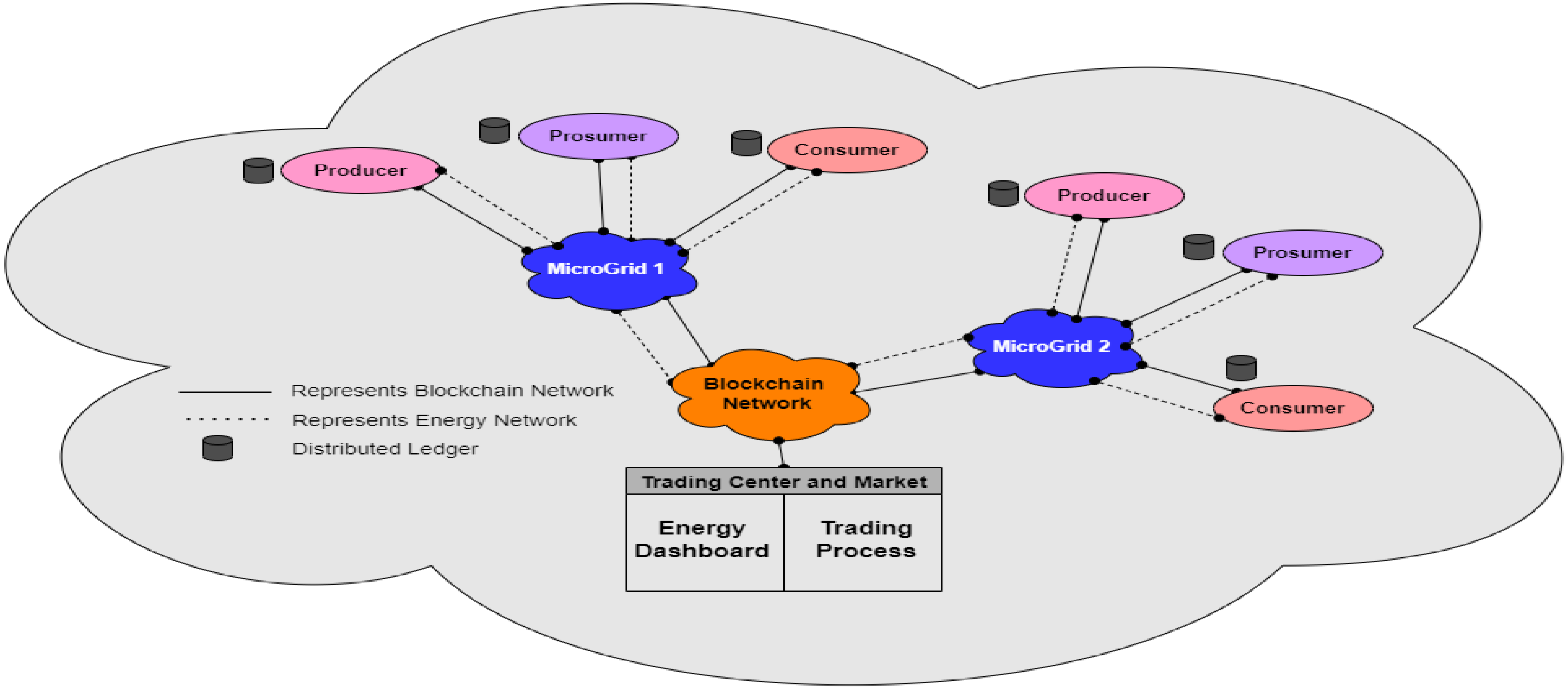
Proposed Decentralized Energy Trading Model

- Entities
  - Producer
  - Consumer
  - Prosumer

- Trading Market Center (TMC)

- Blockchain Netwok

Architecture of the Proposed Decentralized Energy Trading Model



Producer Algorithm

Algorithm 2: Producer pseudo code

Data: $PP_{add} \leftarrow Producer's\ publicaddress,$
$T \leftarrow get(currenttimestamp)$
Result: Verification of producer and smart contract initialization

```
if PP_add is registered then
    TmcOffers() ← P_Offer();
else
    Terminate transaction;
end
while offerSelected() is not True do
    if offerSelected() then
        smartContract();
    end
end
```

Consumer Algorithm

Algorithm 1: Consumer pseudo code

Data: $CP_{add} \leftarrow Consumer's\ publicaddress$,
$T \leftarrow get(currenttimestamp)$

Result: Verification of consumer and smart contract initialization

if CP_{add} *is registered* **then**

  $get(offersFromTMC)$;

  $energyTradeOffer \leftarrow SelectedOffer$;

  smartContract();

else

  Terminate transaction;

end

Smart Contract Algorithm

Continued on next page...

Algorithm 3: Smart contract pseudo code

```
Data: PP_add ← Producer's publicaddress,
      CP_add ← Consumer's publicaddress,
      T ← get(currenttimestamp),
      balance ← get(WalletBalance),
      energy ← get(energyOfProducer),
      finalAmount ← get(finalAmount),
      finalEnergyUnits ← get(finalEnrgyUnits)
Result: Validate the payment amount in consumer's
        wallet and the energy units in producers
        wallet. Smart contract execution and
        termination if fails.
if balance ≥finalAmount then
    if energy ≥finalEnergyUnits then
        PP_add ← finalAmount;
        CP_add ← finalEnergyUnits;
        closeContract();
    else
        closeContract(); Terminate transaction;
    end
else
    closeContract(); Terminate transaction;
end
```

Results and Analysis

Implementation Methodology

- RSA for public-private key generation
- Keccak Hash Function to generate public address on ethereum (20 byte)
- Remix IDE for smart contract development

Security and Privacy

- Producers and consumers - Instead of real identities use public keys (addresses)
- Blockchain - Provides immutability of records and transperancy
- Smart contract enables automatic energy trading

State-of-the-art comparison between proposed decentralized energy trading model and the existing models

Author	Anonymity	Decentralized	Eliminate trusted third-party	Micro grid	Protection from SPOF	Load balancing	Price governance
Li et al. [5], 2019	✓	✗	✗	✓	✗	✓	✗
Pee et al. [6], 2019	✗	✓	✓	✗	✓	✗	✗
Liang et al. [10], 2020	✗	✓	✓	✗	✓	✗	✗
Esmat et al. [7], 2021	✓	✓	✓	✓	✓	✓	✗
Proposed model	✓	✓	✓	✓	✓	✓	✓

Conclusions

Conclusions

- Proposed a model for the management of energy trading
- Used blockchain to eliminate centralized management
- Provides a transparency in the energy trading management
- Ensures security and privacy of users (producers and consumers)
- Ensures users will get correct price

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Thank You

Centralized Vs Decentralized Architecture