



Conceptual Design of a Consensus Mechanism for Renewable Energy Markets on Blockchain

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Forces Driving the Grid of the Future

3D's



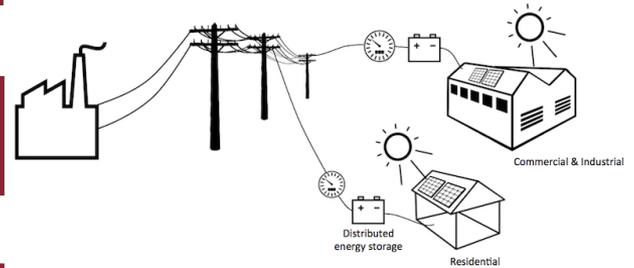
Decarbonization



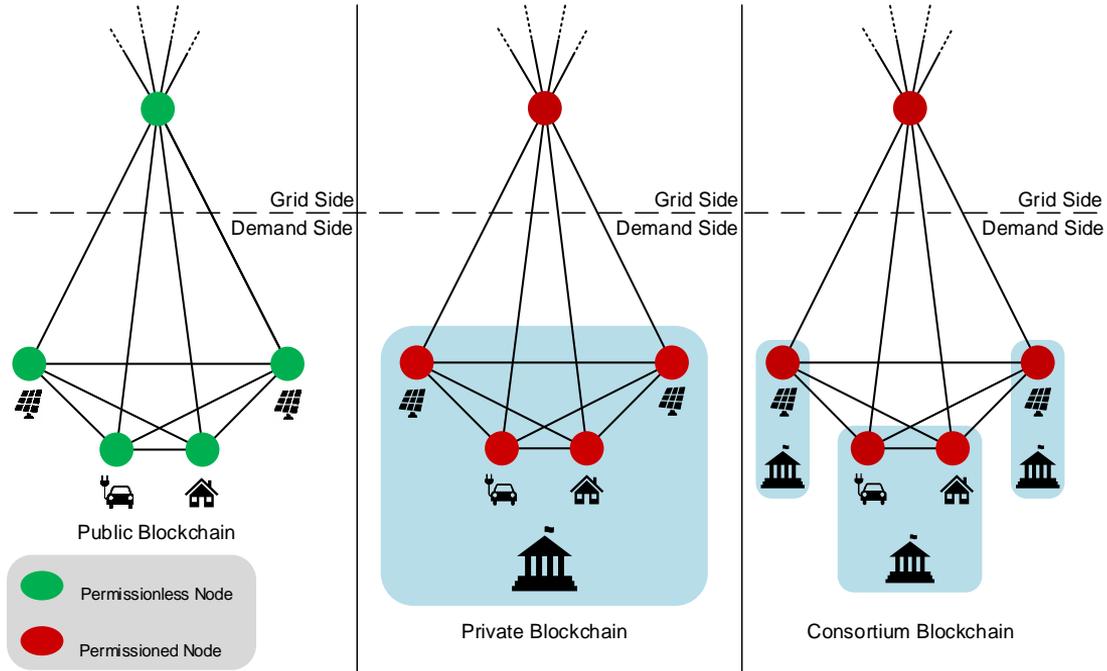
Decentralization



Digitalization



Blockchain Architecture for Power Systems



Consensus Mechanisms in Blockchain

Consensus is the process in which enables all the nodes in the chain to agree on the correctness of the latest block added to the chain.

- ✓ Proof of Work (PoW)
- ✓ Proof of Stake (PoS)
- ✓ Practical Byzantine Fault Tolerance (PBFT)
- ✓ Proof of Authority (PoA)
- ✓ Proof of Elapsed Time (PoET)

The Need for a New Consensus Mechanism

- ✓ A mechanism where prosumers and consumers can transactions on blockchain
- ✓ A mechanism that takes advantages of the existing mechanisms
- ✓ A mechanism that eliminates the disadvantages of the existing mechanisms
- ✓ A mechanism that can be scaled up as the nodes in the network increase
- ✓ A mechanism that incentivizes renewable energy generation and conservation

The Proof-of-Reserve (PoR) Mechanism

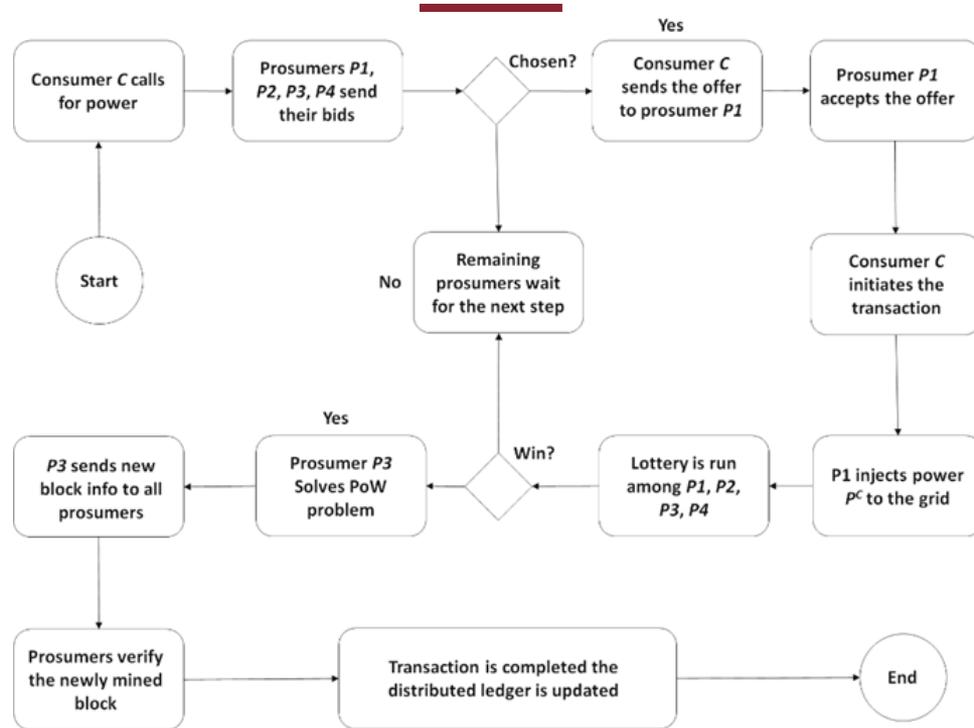
Step 1: All candidate miners will announce the available power that they are willing to sell.

Step 2: For each specific reserve level, a solar stake is allocated to each prosumer.

Step 3: All candidates will enter a lottery. The lottery is designed so that candidates with higher solar stakes have a higher chance of winning.

Step 4: This round of lottery will be closed, and new solar stakes will be calculated for the next round. This procedure will be repeated from Step 1 for each round.

P2P Energy Trading Using PoR Mechanism



Numerical Analysis

The consensus problem computation performance for different CPU configurations and difficulty levels using PoR consensus mechanism

CPU Configuration	Nonce / Computation Time (s)	
	Difficulty level=27	Difficulty level=29
Core i7/ 3.00 GHz/ 8 GB RAM	85,139,183 / 275	1,418,926,383 / 4720
Core i5/ 3.00 GHz/ 4 GB RAM	85,139,183 / 281	1,418,926,383 / 4757
Core i3/ 3.00 GHz/ 2 GB RAM	85,139,183 / 293	1,418,926,383 / 4788

Conclusions and Future Work

- ✓ The PoR mechanism can significantly reduce energy consumption, as only a fraction of prosumers can participate in the block mining process.
- ✓ The proposed PoR design is capable to prevent monopolization of the blockchain platform and reduce the energy consumption for mining process.
- ✓ In our future work, a mathematical formulation of a game-theoretical framework will be presented to quantitatively test the effectiveness of the model.

Thank You!

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