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meterBlock

Decentralized Energy Exchange for Open-Grid Applications

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University of the Witwatersrand
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Overview



- Problem Statement
- meterBlock Solution
 - Tokenization of kWh
 - Decentralization
- Implementation Overview
 - Smart Meters
 - Distributed Ledger Technology
 - User Frontend
- Testing Environment
- System Limitations
- Holistic System Architecture Summary

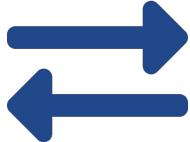




Problem Statement



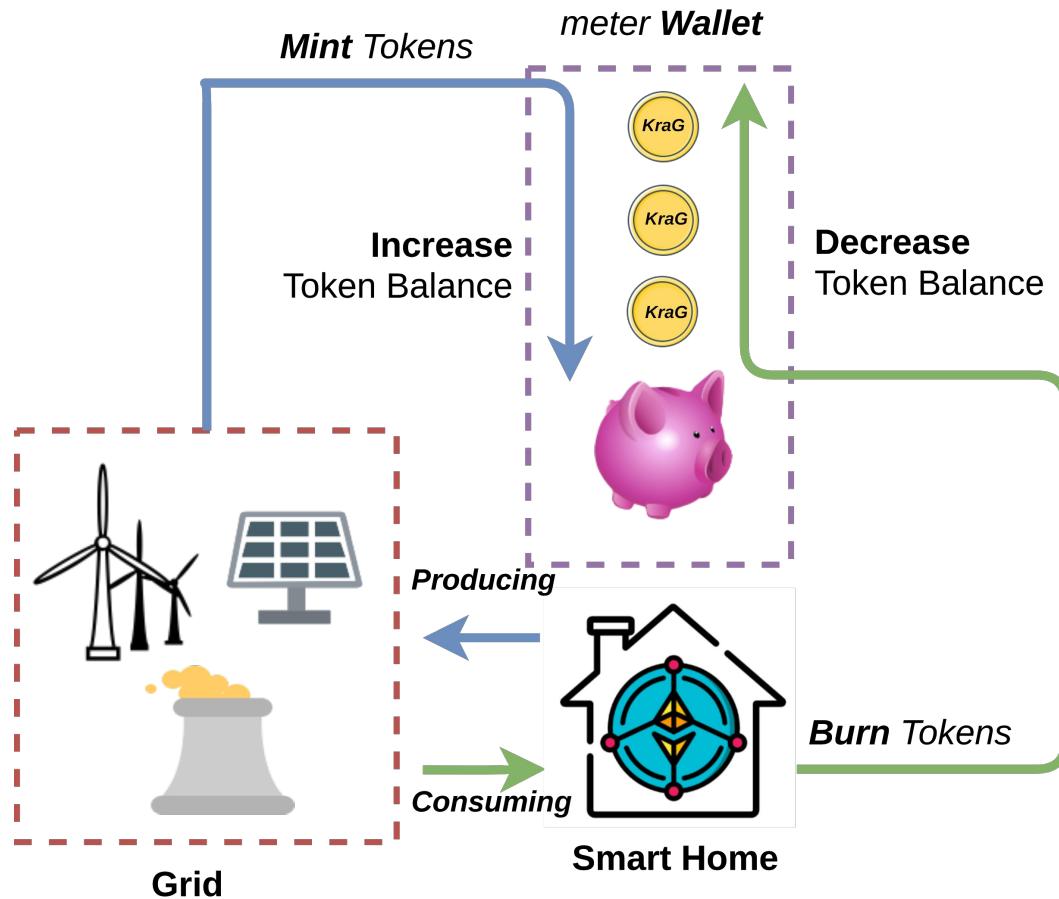
- **No mechanism for producers and consumers to trade energy peer-to-peer without a middleman**
 - Can't sell energy back to grid
 - Centralized billing authority requires trust
 - Costs due to middlemen



meterBlock's Solution



- Facilitate peer-to-peer energy exchange
 - Tokenization of the kWh through *KraG* token

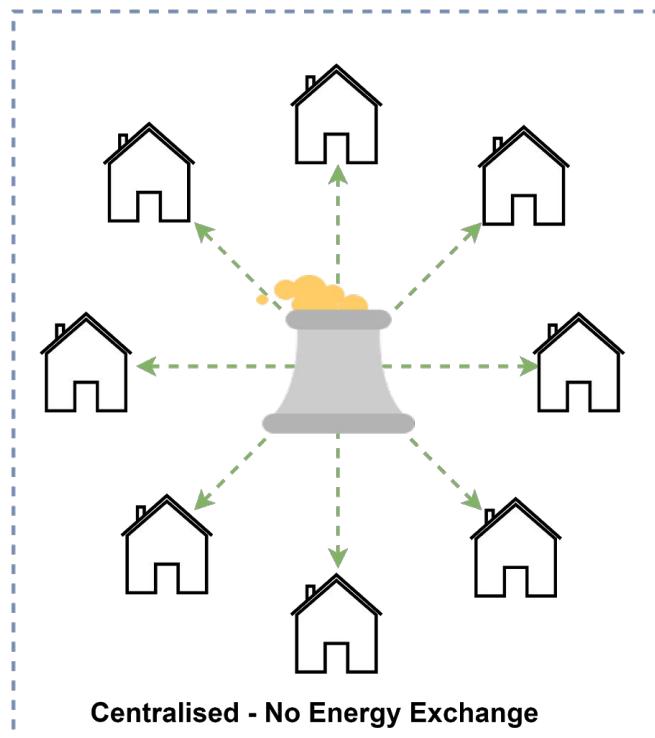




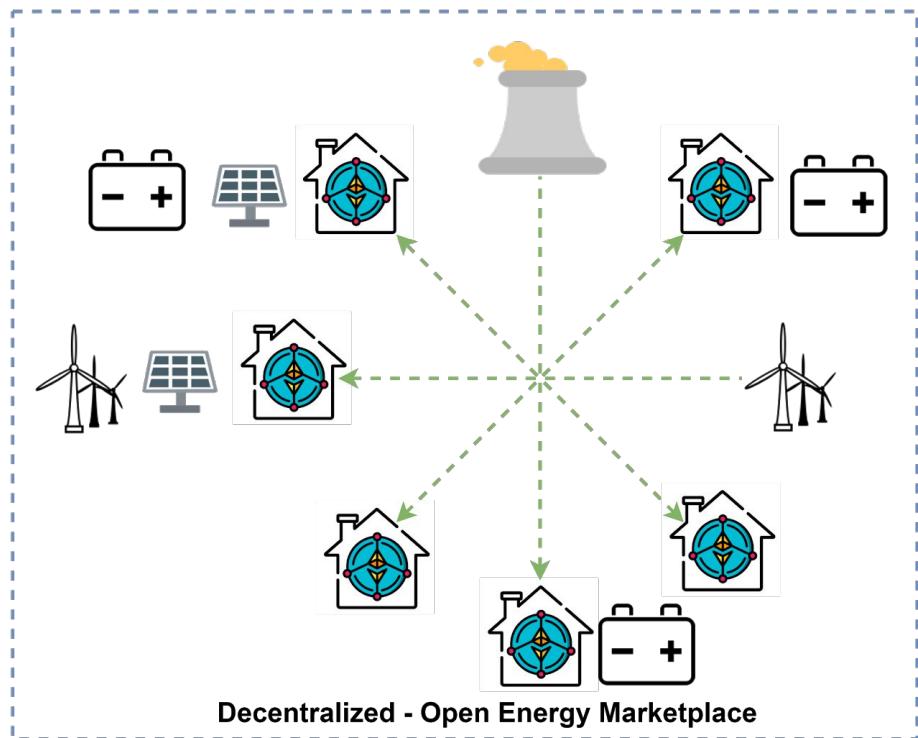
meterBlock Solution - Overview



- Design of completely trustless, decentralized system

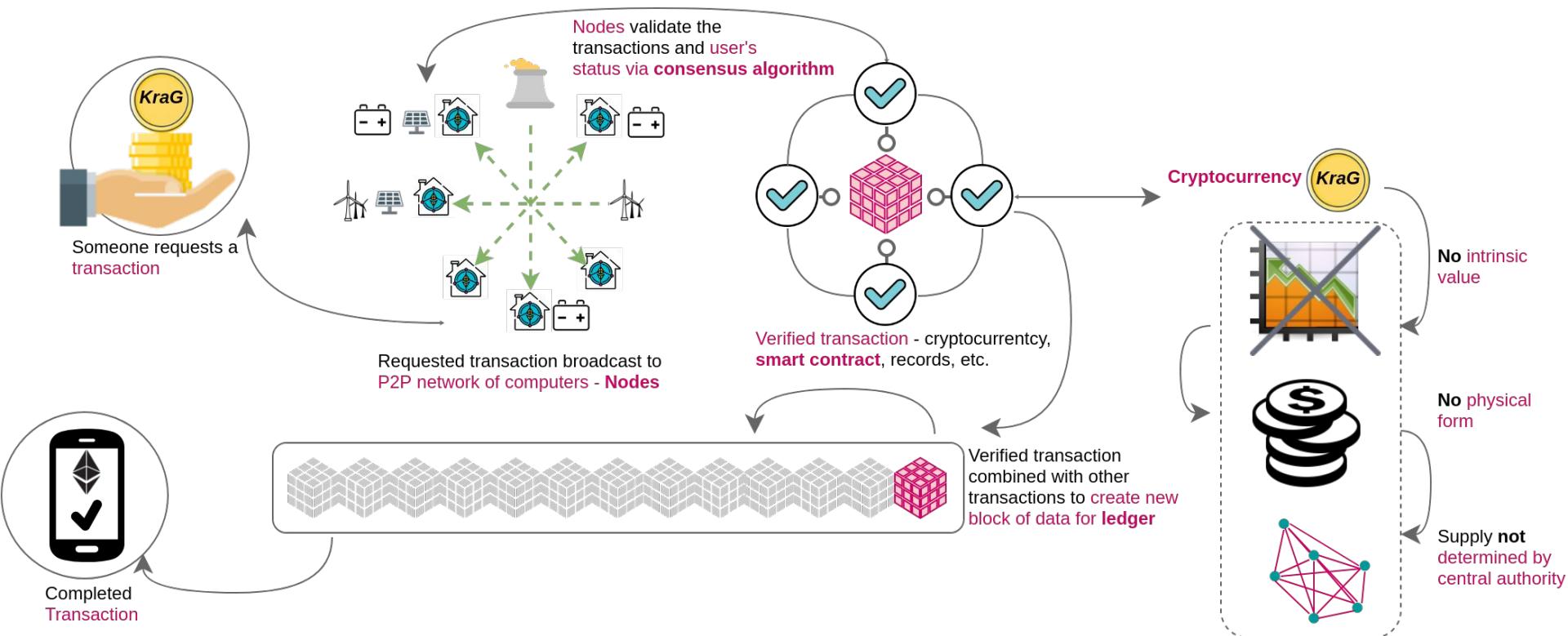


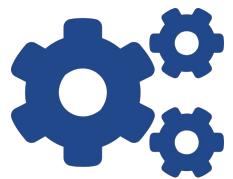
vs.



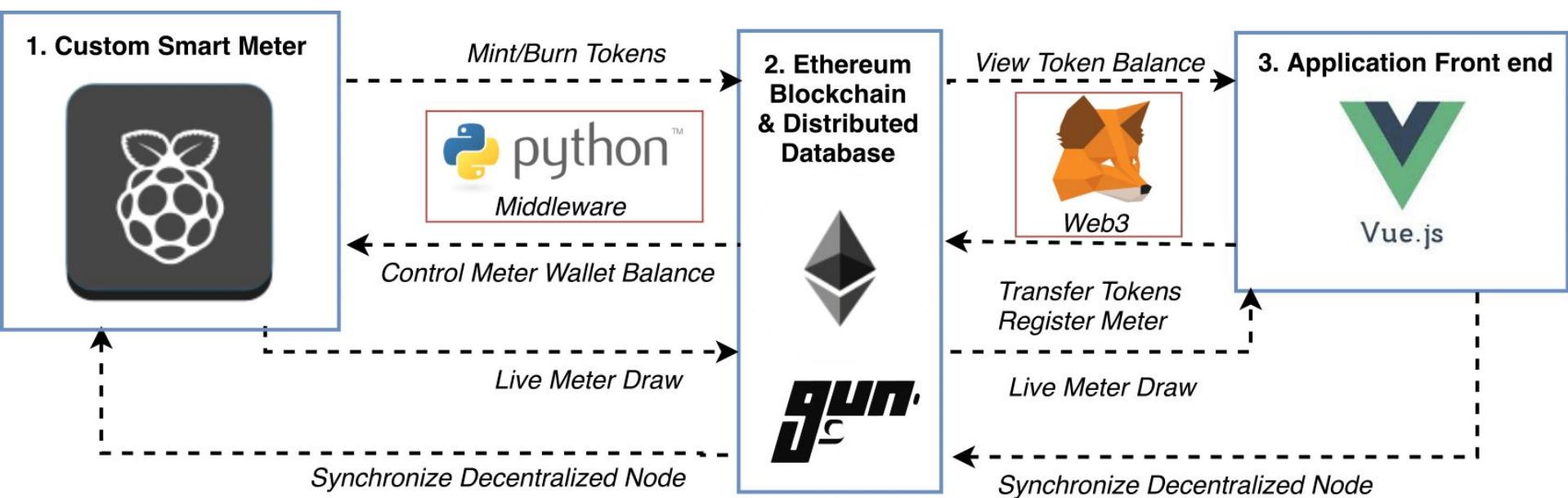


meterBlock Solution - Blockchain





Implementation Overview

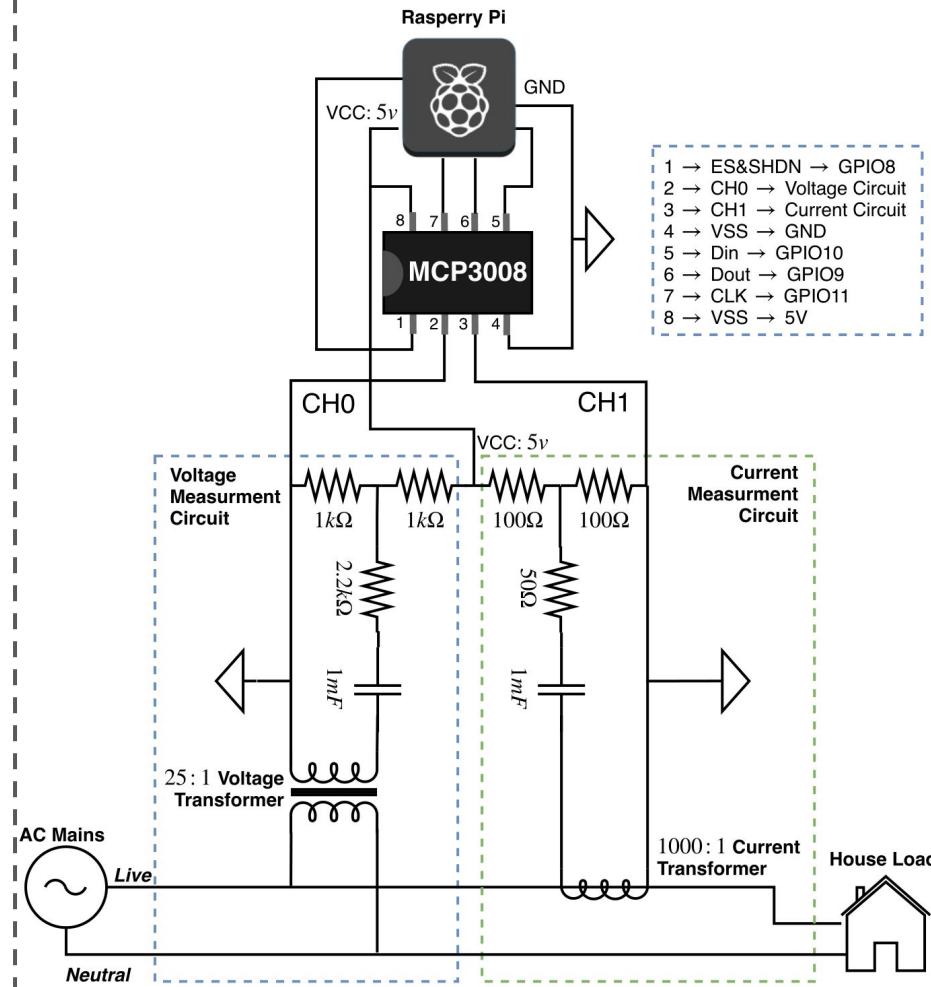




Custom Smart Meter - measurement



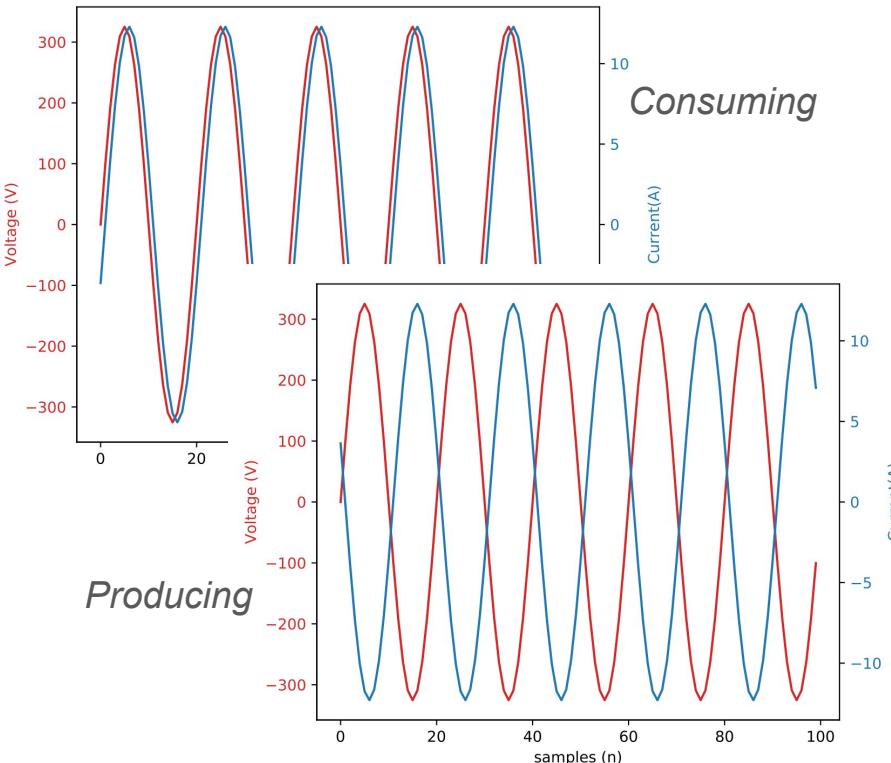
Accurate power measurement



Identify direction of power flow

$\text{if } \sum_{n=0}^k v_n i_n > 0 \rightarrow \text{consuming}$

$\text{if } \sum_{n=0}^k v_n i_n < 0 \rightarrow \text{producing}$

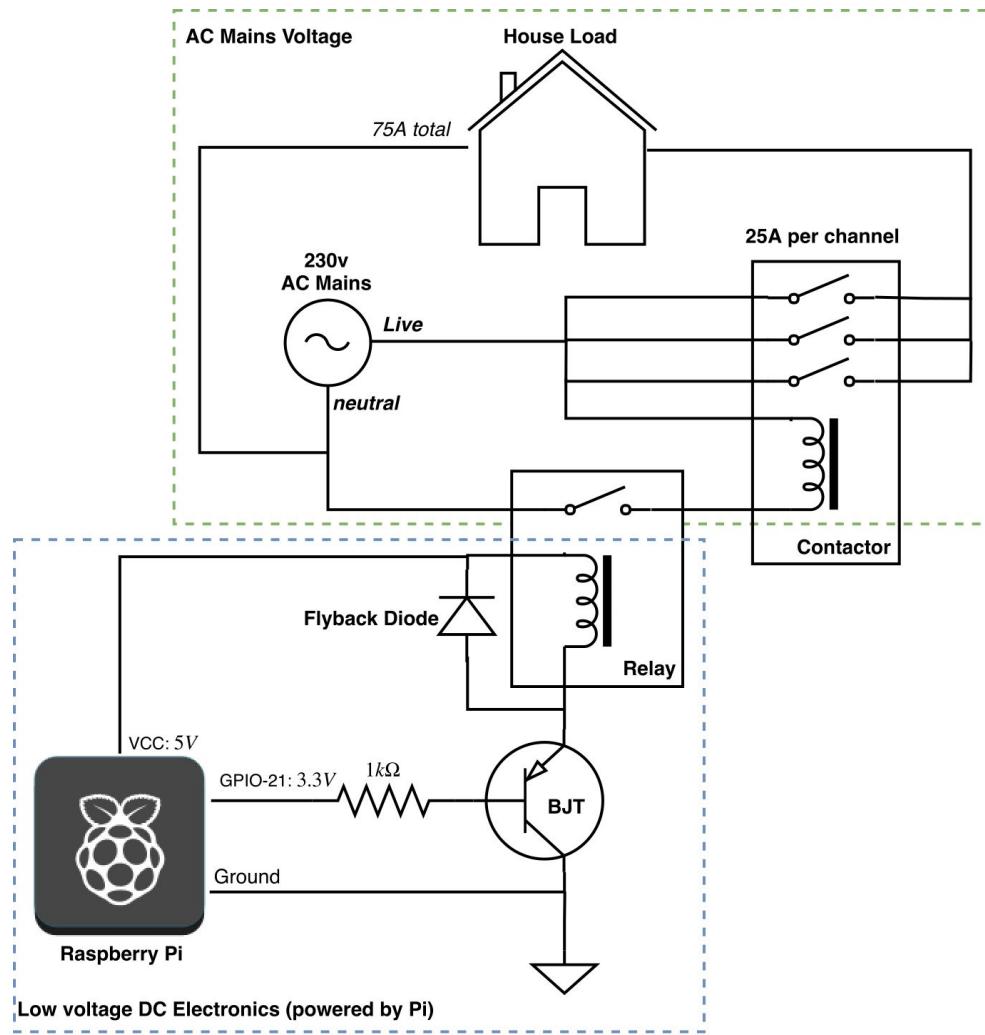




Custom Smart Meter - load controller



- Control supply to house based on *KraG* token balance

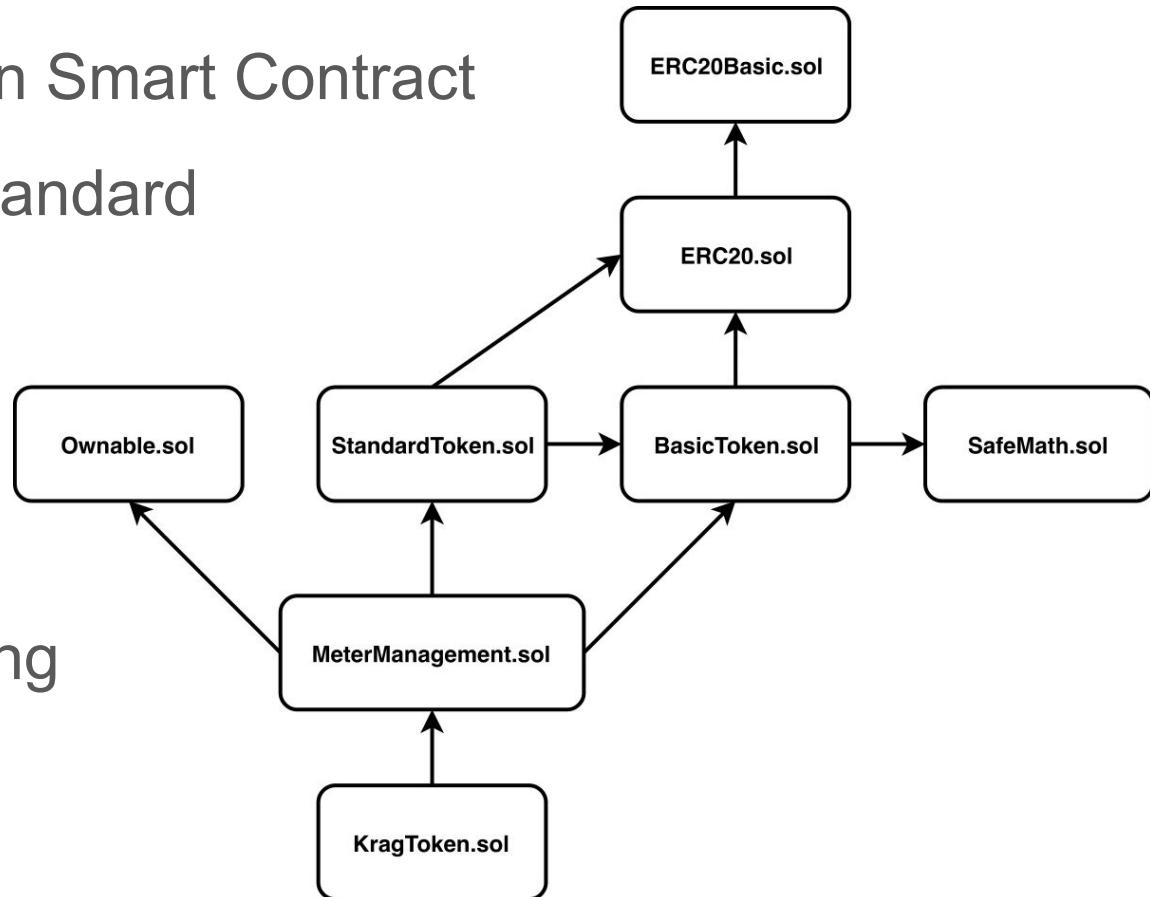




Blockchain Technology - Ethereum



- Blockchain is used as a ***Store of value***
- Ethereum Blockchain Smart Contract
 - **ERC20** Token Standard
 - OpenZeppelin
- Meter Registration
- Meter Management
- Extensive Unit Testing

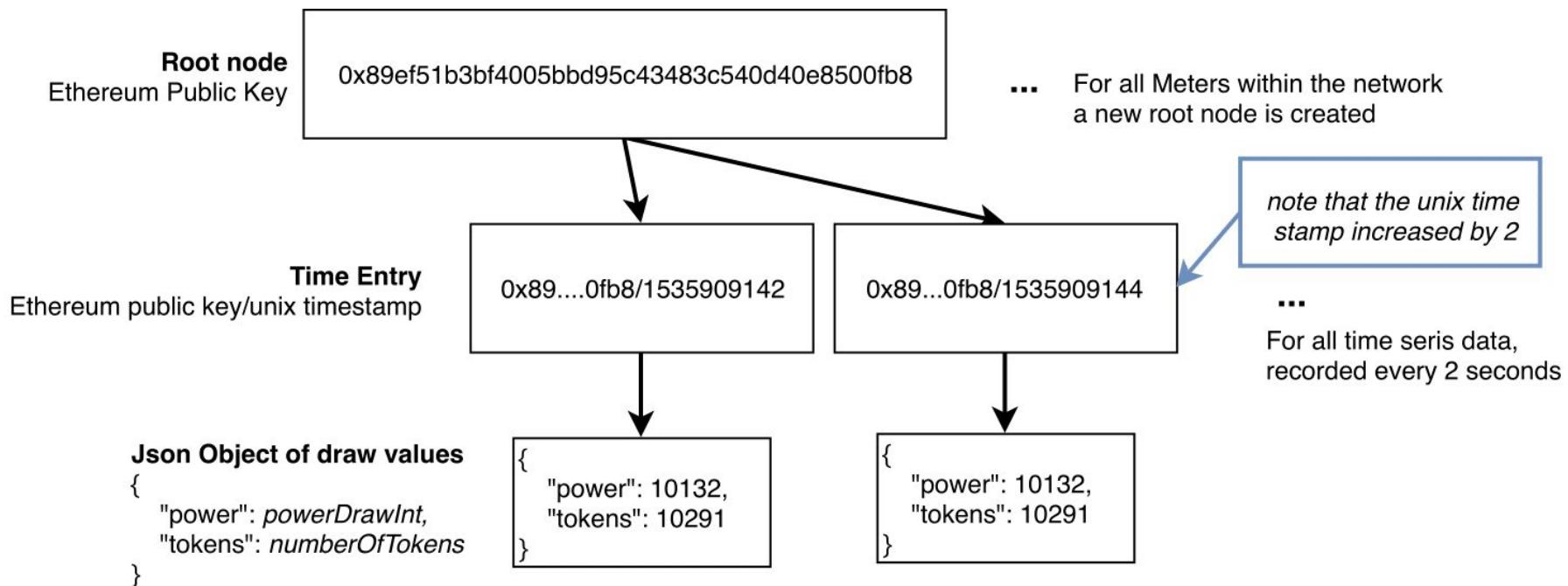




Distributed Database - GunDB



- Distributed Database is used for *real time data*
- GunDB synchronized between nodes storing live values





User Frontend - Administrator



- Administrator view to enroll new meters

Admin Controls

Register Meter > To Owner

Mint new Tokens > Tokens(kWh)

Token Balance

Balance: "750553" Owner: 0x89ef51b3bf4005bbd95c43483c540d40e8500fb8

KraG Token Properties

Value	Property
owner	0xbd599d0ed9ec45b6c70d902d36aae06841c8dd5e
tokenContractAddress	0xc2d4a7b3024479a6b2b50864c04ccb5f52cb8700
tokenName	KraG Token: 1 token = 1kWh
tokenSymbol	KraG
tokenTotalSupply	1301408105
tokenDecimals	6



User Frontend - Meter Management



- Household owner view to manage their meter

Meter Management

You have 5 meters registered to your address

```
[ "0x20e8652108d73044bb765bbb7355a10d10c8ec64", "0x69046dcc316e2401556726ad6d845a8618cd1786", "0xc84cf1395a1e3deee5db877c86459772b32a501", "0xac687e1ca5fae313fc92f6aa01f7baeac95a9e53", "0xe65a7c9dcde4091cc182750e5cd4f44b60ead85" ]
```

Select Meter to manage

Meter Account Management

Your web3 account has 0 KraG Tokens.

Transfer tokens to Meter from account

Tokens(1 KraG = 1 kWh)

Load

The selected Meter has 0 KraG Tokens.

Transfer tokens from meter to account

Withdraw

Meter Usage

Find Meter Minute Hour Day Week

0x20e8652108d73044bb765bbb7355a10d10c8ec64 Power Consumption

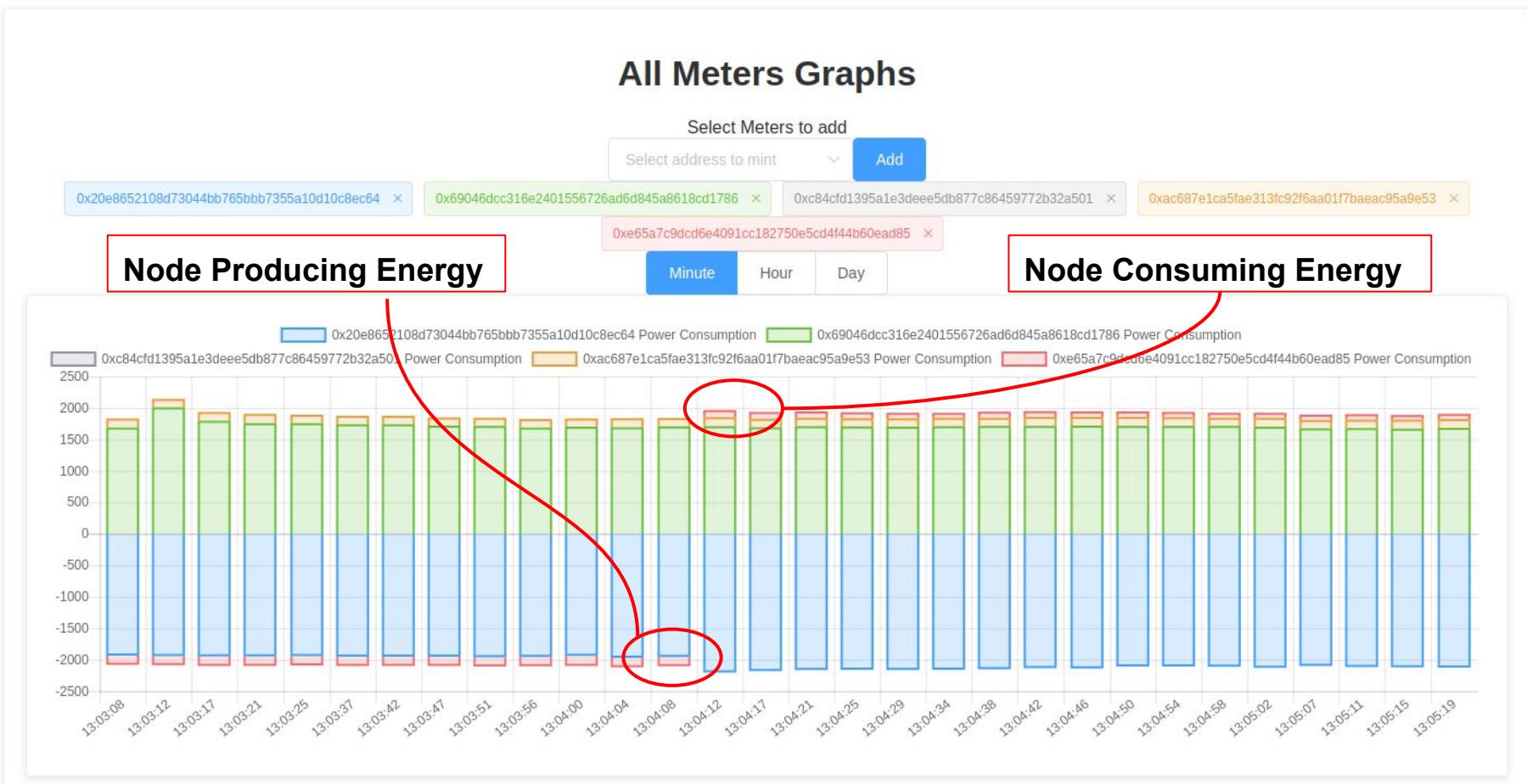
0
-500
-1000
-1500
-2000
-2500



User Frontend - Overall Grid Status

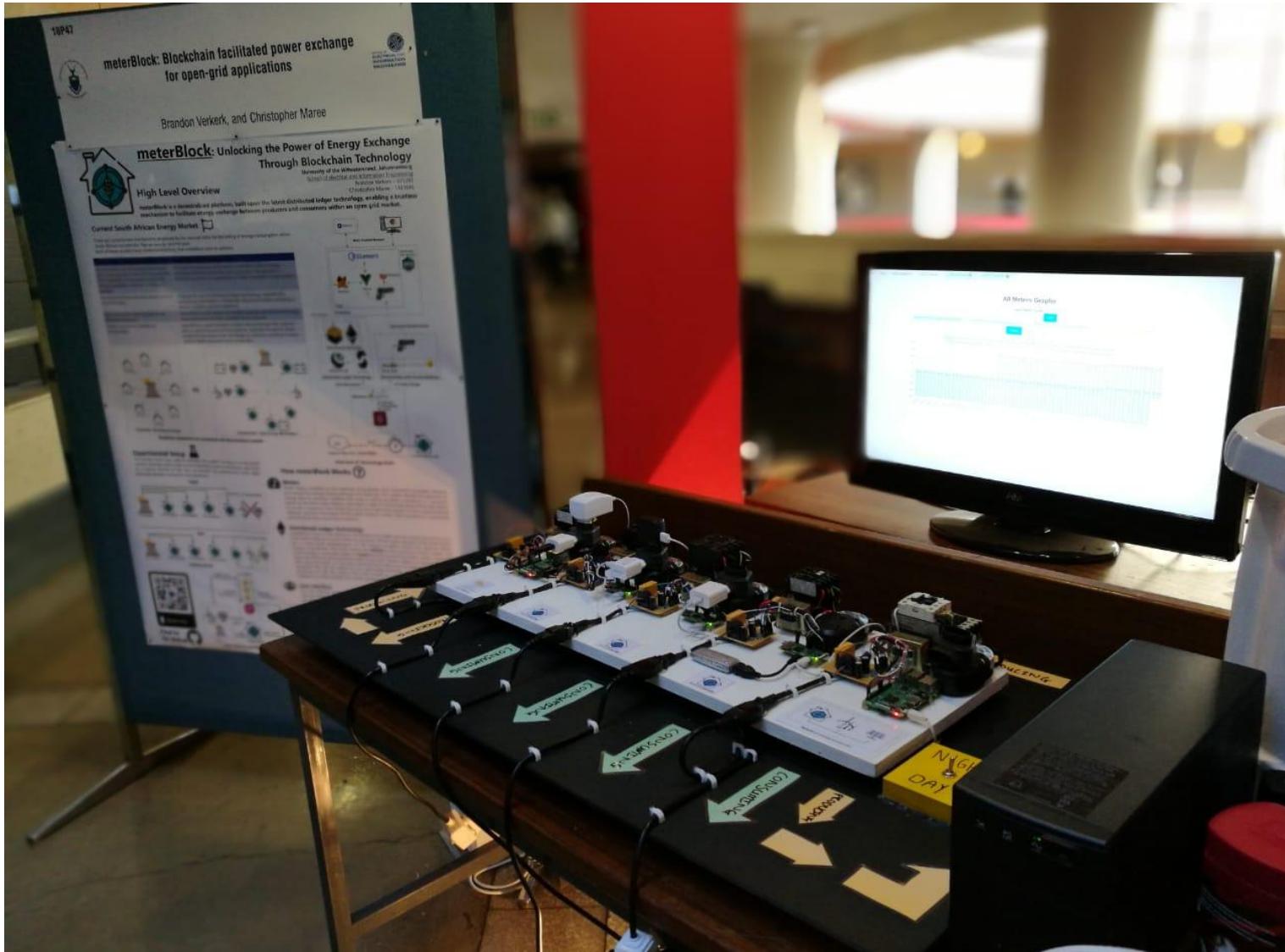


- View total grid production and consumption





Testing Setup

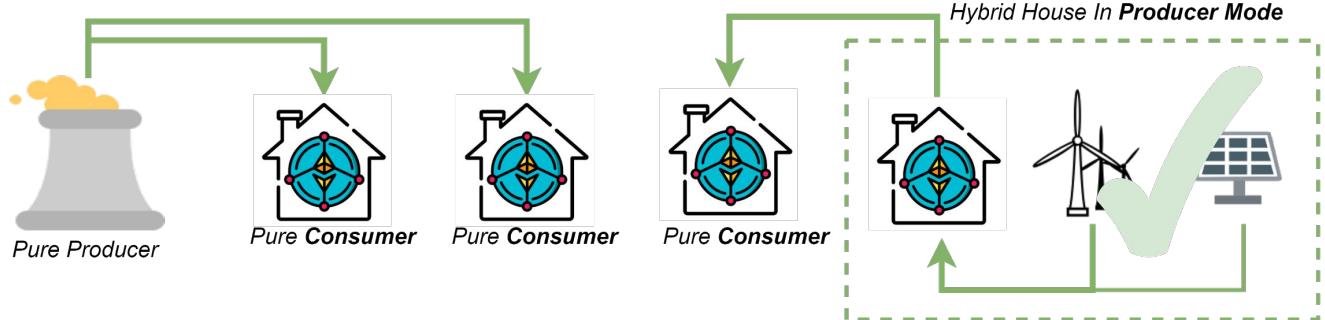
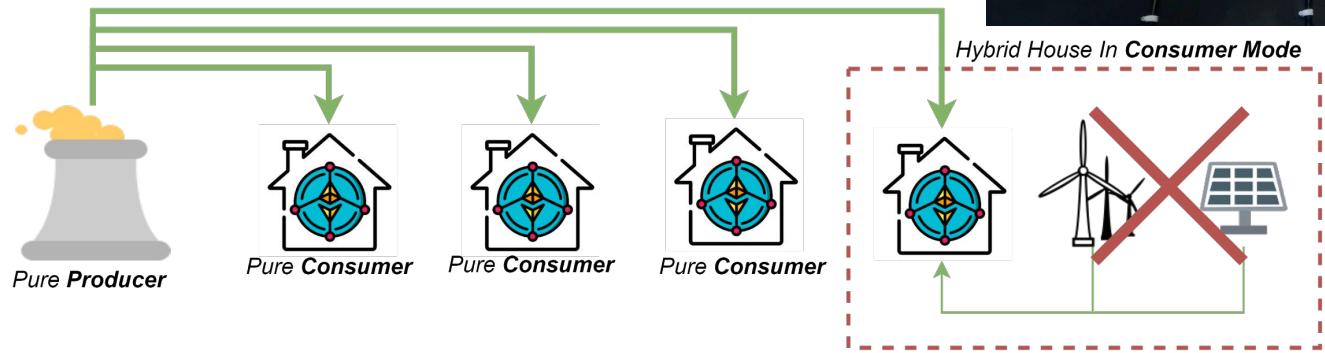




Testing Environment - configuration



- Simulated microgrid
 - Hybrid producer/consumer

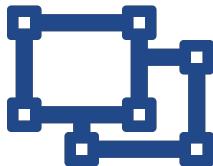




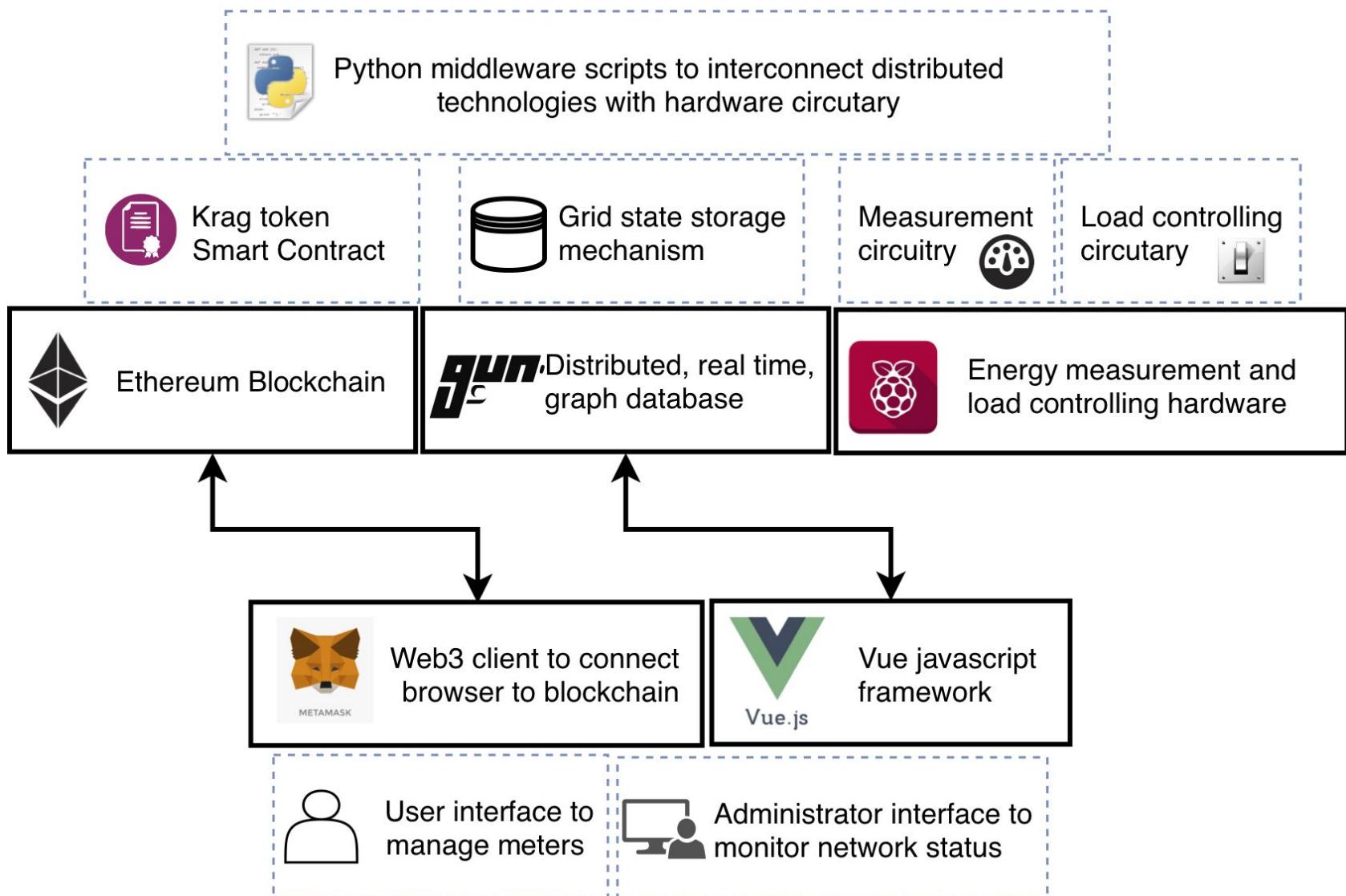
System limitations



- Fundamental economic limitations
 - Network black start problem
 - KraG - kWh conversion
 - Possible losses in the network
- Distributed Ledger Technology limitations
 - Blockchain scalability
 - Need to trust meter
 - Blockchain adoption



Holistic System Architecture

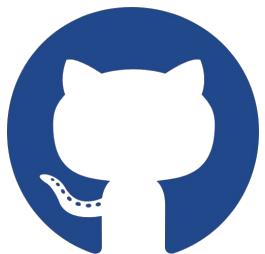




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