Green-Currency : A use case for efficient solar power distribution in devices using Blockchain 2.0

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Abstract

The paper aims to design and implement an ecosystem which is based on distributed architecture of solar IoT smart devices. This ecosystem involves decentralization of data on the trusted links based on blockchain 2.0. The model features blockchain-IoT integration to provide authenticated and immutable decentralization of data. The model provides support for multiple type of IoT devices which can generate power, mine the hash equations or can do both. Each IoT device is responsible for entering the data of the corresponding solar panel into the ledger which will finally get added to the blockchain after verification, with the help of proof-of-stake principle. All the updations and other transactions are administered and managed by smart contracts. The paper introduces a green currency, a virtual crypto-currency, which the IoT device can obtain via successful verification of transaction. Along with this, the project will also introduce a concept of monetizing the power, whereby the IoT devices can sell solar power generated for digital currency. To support this, model features a currency wallet to maintain the integrity of the green currency. This model also involves diverse currency-based transactions including mechanism to lend and borrow green-currency amongst the participants of the ecosystem.

Introduction

Solar Energy is the most extensively used renewable form of energy obtained from the Sun. The solar energy produced is stored in rechargeable batteries for future use. Till date, all the solar devices are expensive, bulky along with an inefficient storage capacity. Improvising the storage can be a solution. Likewise, we can also adopt a more potent energy management system which can evolve into a bigger ecosystem and foster other vital requirements too.

The proposed system aims to provide an interface to all smart solar devices to trade power using the green-currency which is local to the system. The green-currency is responsible for transactions within the ecosystem.

The system proposes to implement an IoT architecture for transaction management among solar energy generating and consuming entities. Incorporation of IoT devices enables dissemination and administration of solar energy efficiently. However, IoT devices are vulnerable to security attacks due to their relatively small memory size. Thus IoT devices are incapable to administer security of data transmitted by an IoT device.

The implementation of blockchain technology ensures legitimacy of system operations and provides transaction authorization to capacitate/legitimize contracts of IoT devices. The concept of blockchain is similar to that of a database, only the difference being the way of interaction with the data. Blockchain works on the concept of decentralization. In a blockchain, every node signs the data it is uploading with a digital signature, so that it can verified that the data was placed in the blockchain by that node. The data stored in blockchain will be signed using the private key of the node, so that only it can read the contents within. Apart from this, the blockchain can also be used to bind the nodes to follow a common rules. This can be done using smart contracts. Smart contracts are a set of rules which will be followed or a set of commands which will be executed when a certain condition is satisfied.

Problem Statement

- To create a model for green-currency
- To design a wallet structure which can be used to perform green-currency based transactions among the participating devices.
- To design smart contracts to control transfer of green-currency and power.

Solution

The paper aims to design and implement a distributed network of smart solar IoT devices. This decentralized network of hybrid smart IoT devices offers an authenticated, immutable environment. The ecosystem makes use of Blockchain 2.0 based smart contracts to carry out transactions and to validate them.

The proposed project showcases a consensus-based power management system which will enable a very efficient way to create a competitive environment wherein all devices can generate power, earn currency by forging/validating and use the currency for transactions involved. The pre-defined smart contracts will ensure an unbiased platform for all the participating devices.

All the Blockchain transactions can be classified into two types :

- Entry of generation and consumption values into the chain.
- All wallet based currency related transactions (currency lending).

The secured mesh of IoT devices along with blockchain technology, enables a low power network that can remotely manage physical operations without the need of a centralized server.

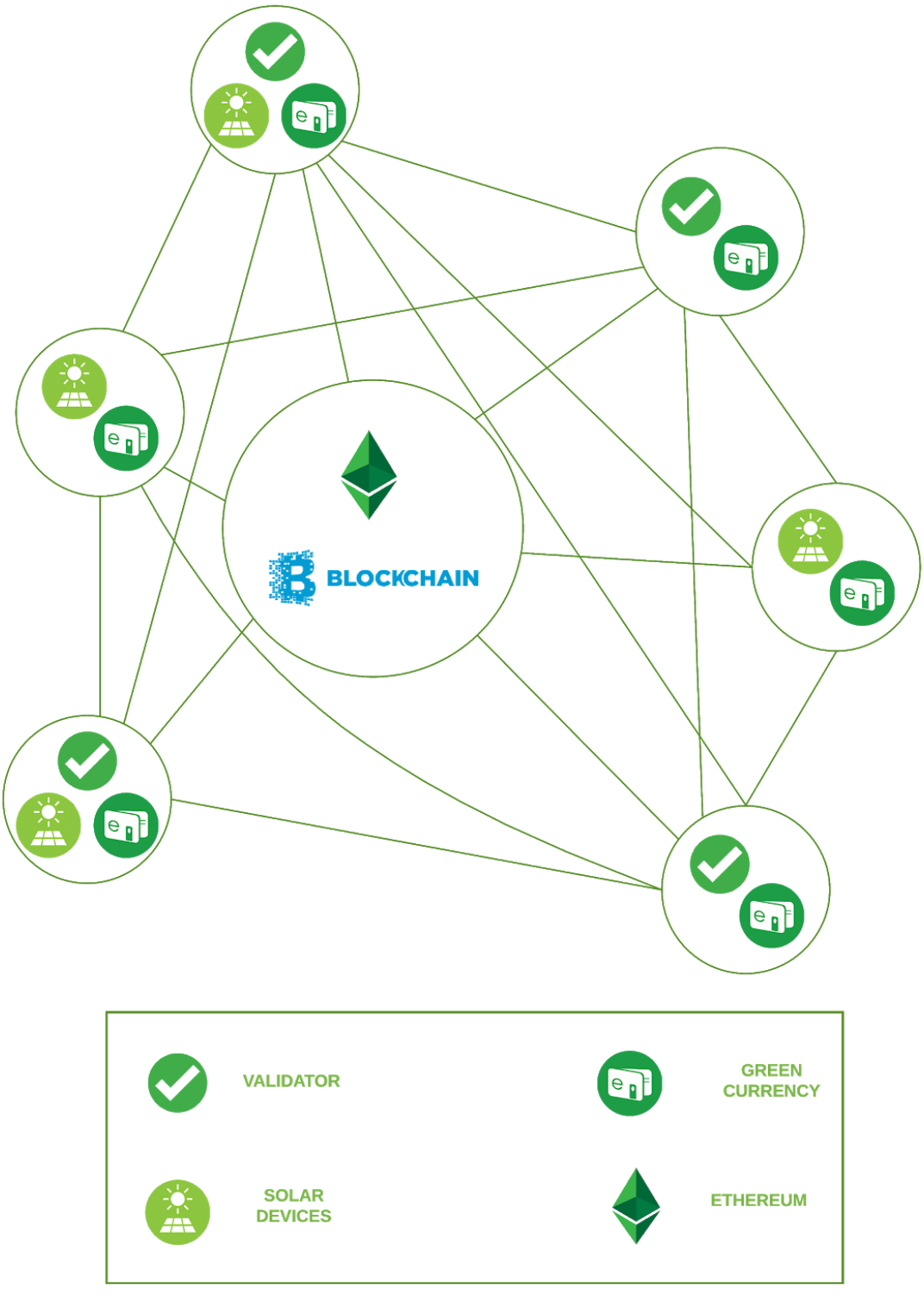


Fig : An overview of the ecosystem

The major components of the system are:

Solar IoT devices :
The solar energy generating device will be responsible for generation of energy. The produced energy is stocked in batteries. The IoT device associated with the solar generator extends internet connectivity among the solar components in the network. The embedded technology enables communication and interaction over the internet. It also facilitates to remotely monitor and control the solar devices.

All the participating devices are categorised into three categories :

- Validators : These devices only participate in solving the hash function of the block of transactions taking place to earn green-currency.

- Generators : These devices can only generate solar energy and update the generation and consumption values into the blockchain.

- Generators and validators : These devices can do both : generation and validation.

Green-currency :
The ecosystem makes use of green currency, a virtual crypto currency which can be used for all the local trades within the ecosystem. Green currency is earned as a reward by forging and is used to trade power. Green currency can be stored by devices in their respective wallets. Currency can also be lent to other devices as a loan if any devices makes such a request.

Currency Wallet :
Each participating device owns a wallet. All the currency owned by a device is stored in its respective wallet. All the currency transactions are carried via wallets. Wallets act as a small personal piggy bank for every device.

Smart Contracts :
All the updations and lending transactions are performed by smart contracts. Smart contracts ensure that the transactions which are carried in the environment are not fraudulent and the smart contracts are used to trigger a specific action when a certain predefined condition is satisfied.

Using the above components, the system is able to work out a number of activities. The activities involved in the ecosystem are:

Updation :
The IoT device associated with the power generators will fetch data about power generation and consumption and will upload the data into the blockchain after regular intervals.

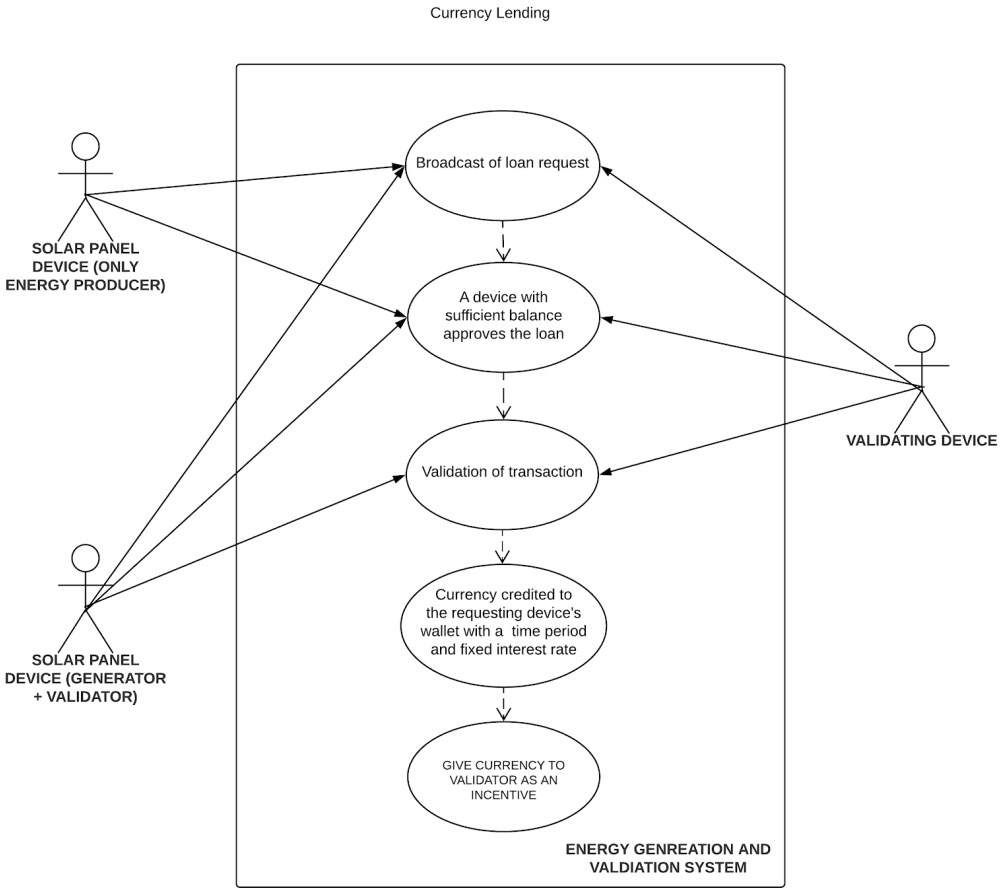
Buying :
Whenever a device's power requirements exceeds its generation, then the device can borrow power from other devices within the ecosystem by paying the respective node a specific amount of green-currency. A smart contract will be generated to perform this transaction. Once the transaction has been validated by the validator, the exchange of power and green-currency takes place.

Lending :
When a device is running low on both power and green-currency, then it can borrow green-currency on loan from other device and using part of that green-currency, it can buy power for its use and the other part of the green-currency can be used as stake to participate in forging to earn more green-currency. Similar to buying, a smart contract will be generated to perform the transaction. At the time of lending, a rate of interest is calculated and the loanee is expected to repay the loan amount along with the interest within a time interval. Failing to do so will result in ascendency of loaner over loanee.

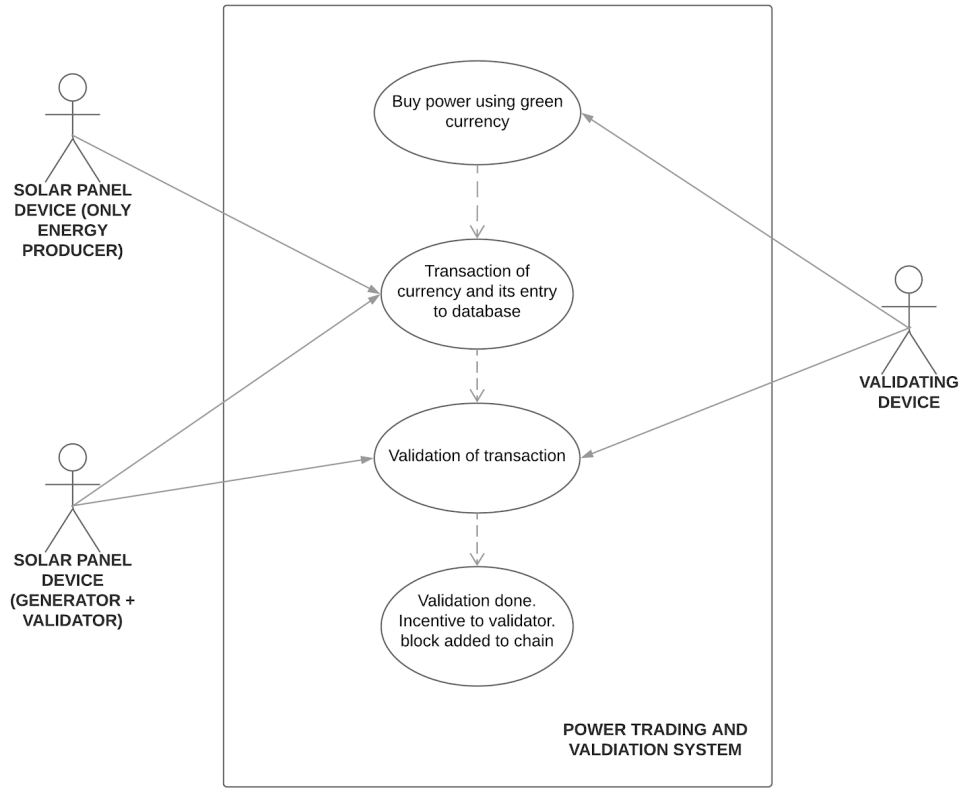
Forging :
Using proof-of-stake principle, all the records provided by each device will be added to a block and based on the stake, a validator is selected and that validator is responsible for verifying the contents of that block. Once

all the transactions within that block are verified, the block is added to the existing chain of blocks and the validator receives specific amount of green-currency as a reward for validating the block. This will fulfill the“consensus” criteria and will allow for an authenticated environment.

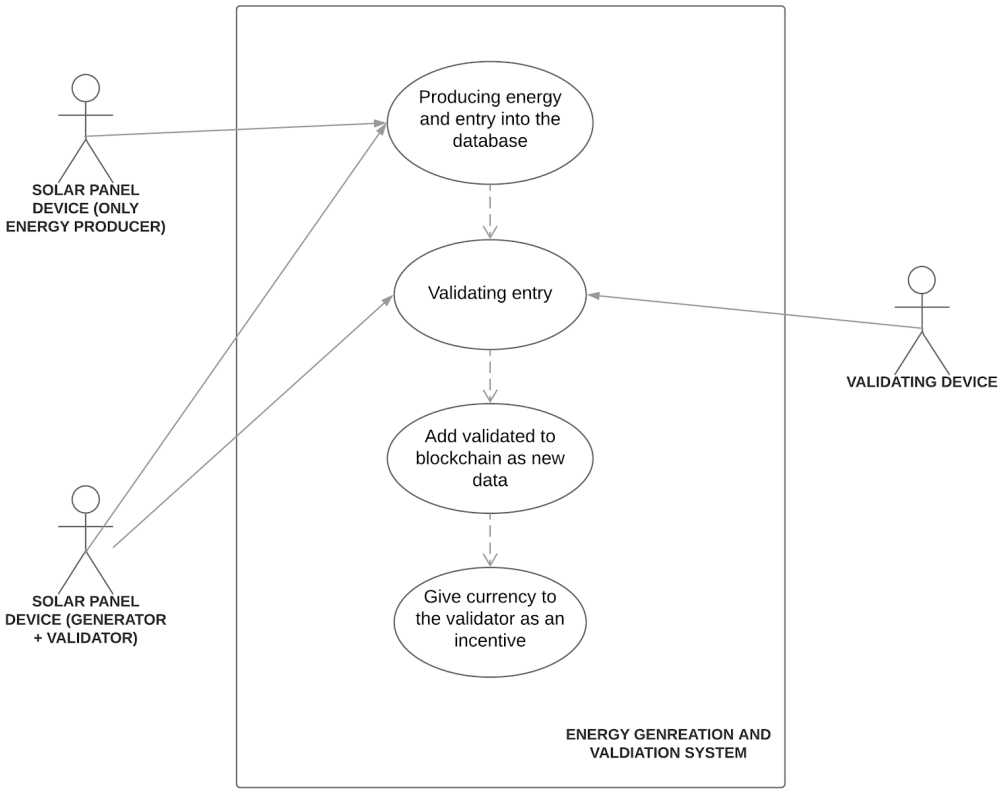
The use case models for the proposal are as follows :



Currency-Power trading



General Usecase



Conclusion

With the constant evolution of both the fresh technologies - Blockchain and IoT, their integration can make way for numerous prospects. Taking into consideration the decentralized attribute and security aspect of Blockchain along with intelligence and heterogenous characteristics of IoT architecture, Blockchain can provide a platform for IoT devices to interconnect reliably by eliminating all the threats which possibly can affect other centralized server models. The smart contract controlled environment will assure reliability and will eliminate the need of third-party verification. The self-sufficient smart contracts will provide a fair and autonomous environment to all the participants. The encryption and distribution of storage will maintain a trust among all the parties involved in the system. With the help of appropriate optimization techniques, the overhead and middlemen costs can also be significantly reduced. Thus, the Blockchain-IoT amalgamation will enable a forgery-free, resilient power management ecosystem for devices to run on.

References

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