Smart Electrical Utility

Problem

There are economies where electrical utilities are not run efficiently and incur debt from municipalities and other customers who do not pay their bills. Such inefficiencies drive the consumer prices up which in turn increase the number of non paying customers and increase debt further. There are real world examples of utilities crippled by debt like PREPA in Puerto Rico.

Institutional consumers of electricity act irresponsibly and local communities usually have no control over the actual electricity spent in lighting streets, stadiums or other public places. Local groups like a home owners association may want to pay directly to light their street, a group of merchants would like pay to light a town square for a night market, or a baseball team would like to light a stadium for a game.

Smaller producers of electricity like roof solar owners find it impossible to sell their excess power to other consumers on the grid. Implementation of a net metering system is blocked by the lack of funds, mistrust and bureaucracy. Island or isolated communities would to organize into microgrids and sell electricity to each other.

Charities would like to crowd fund purchase of additional electricity for the households of the poor or the elderly during heat waves, and would like be sure the money is spent for that purpose only.

Solution

Electricity can be bought directly from the utility and paid for in advance. This will allow a debt ridden utility to avoid borrowing for month to month operation and offer lower rates. Prepaid electricity will promote responsible use.

Electricity can be bought by any resident or a group which in turn can fund any consumer of electricity: a household, a stadium, a lighting pole. Each device consuming electricity carries a QR encoded id placed visibly like on a household meter or a lighting pole. A resident can read that id with an app and instantly fund it with the electricity units from his account.

Smart meters will keep track of the electricity produced and consumed and automatically turn on power to a household or a device when funded. Such meters are relatively inexpensive and constitute the bulk of the investment into the system.

All the accounting is done on the blockchain with the utility and the residents interacting with the blockchain's smart contracts (chaincodes) to sell and buy electricity in bulk and retail. Producers create units of electricity on the blockchain while consumers destroy them just like real electrical power is generated and burned.

Actor: Fiat Payment System

As electricity is not traded for cryptocurrencies yet we need to introduce transactions in fiat occurring outside of the blockchain. A payment system such as a credit card processor acts as a trusted oracle with the knowledge about transfers of fiat money between the actors. Upon a successful payment in fiat the payment system notifies affected chaincodes.

Interface

On the payment system simulator page choose payer A, payee B, chaincode C from a dropdown of accounts; enter amount in dollars and click. This will invoke chaincode C with the notification of a transfer of fiat between A and B.

Real World

A webhook is called by a bank, PayPal or Stripe upon a successful payment. The payload carries blockchain ids of the payer, payee and the chaincode to invoke. The webhook invokes the chaincode with these data.

Actor: Producer

Power plant, solar panel array, battery bank.

Use case: Producer generates electricity

Coin k is created per every kWh produced. Producer acts as a miner.

Interface

On the producer simulator page when an image of a solar panel is clicked an image of sun appears and the count of produced kWh starts ticking. For every kWh produced a chaincode is invoked with the producer's account.

Chaincode *generator*

One coin k is created and added to the producer's account.

Real World

A smart meter with an induction coil over on the output line of the generator. Code embedded in the meter will call the generator chaincode to add k for every kWh flown out.

Use case: Producer sells wholesale electricity to the Utility

An employee of an energy utility buys electricity on the power plant's web site at the preset price. The transfer of fiat money for payment is initiated by the utility and processed by the payment system.

Interface

On the payment system simulator page: initiate a transfer of fiat between the utility and the producer, invoke chaincode *wholesale-seller* with the ids of the utility and the producer and the amount in fiat.

Chaincode *wholesale-seller*

Divides the fiat amount by the preset *wholesale* price of kWh and transfers resulting k coins from the producer's to the utility's accounts.

Actor: Utility

Maintains the grid, buys electricity wholesale from producers and sells retail to consumers.

Use case: Utility sells retail electricity to Residents

A resident buys electricity units at the utility's website. The purchase is funded by the resident's fiat money from his bank or credit card account. The funds are transferred by the payment system which notifies a webhook which in turn invokes chaincode *retail-seller* with the ids of the utility and the resident and the amount in fiat.

Interface

On the payment system simulator page: initiate a transfer of fiat between the consumer and the utility, notify retail-seller.

Chaincode *retail-seller*

Divides the fiat amount by the preset *retail* price of kWh and transfers resulting k from the utility's to the resident's accounts.

Actor: Resident

Buys electricity and funds consumers: devices that burn electricity.

Funds actual consumers of electricity from his account or jointly with other residents.

Use case: Resident spends prepaid electricity

Scans the QR code placed on his household's smart meter with an app. Selects the amount of units k to add. The app invokes chaincode *resident*. The meter is funded and turns on the household's circuit.

On a local website's map selects a device like a street light, adds the amount of electricity k and the time period. The street light is funded, its smart meter is notified and turns on the light.

Interface

On the resident's account page choose an account B of a consumer from a table or a map, enter amount in k no less than the amount currently in the resident' s account A, invoke chaincode resident with the ids of the meter, the resident and the amount k.

Chaincode *resident*

Transfers amount k from the resident's account A into the consumer's account B.

Actor: Consumer

An actual consumer of electricity: a household, a street light, an illumination system of a stadium.

Use case: consumer burns electricity

An electricity consumer is funded with prepaid electricity. It is connected through a smart meter which turns on the circuit when funds are available and turns it off otherwise. Each consumer is available for anyone to fund, with an optional time period.

Interface

A simulator page with an image of a household meter and a bulb. Clicking on a bulb lights it up, the meter starts turning increasing the count of consumed kWh and chaincode *consumer* is invoked for every k consumed from the consumer's account.

Real world

A smart meter wraps a coil around the wire supplying the current to the consumer, without disrupting existing circuitry. For every kWh flown through the wire and burned the embedded code in the meter invokes the chaincode which destroys the coin k in the consumer's account.

Chaincode *consumer*

Destroys amount k in the consumer's account.