Energy Trading Platform: An Internet of Energy implementation

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ABSTRACT

This project aims to create a marketplace where anyone generating energy by using renewable sources can sell it to anyone in the grid. This will in most cases will be cheaper and aims to have no carbon emissions. This entire platform has two versions, a centralized and a decentralized version. The centralized version uses the client-server architecture while decentralized version uses the concept of a transactional battery along with relay modules which is used to forward and receive power from other batteries. We were able to transfer energy from one power bank to the other using relays.

KEYWORDS

internet of energy, decentralized, micro grids, transactional battery

1 AIM

The project aims to create an energy sharing platform that will be integrated into communities and will consequently result in effective usage of energy which can be sold at a reasonable price depending on demand. The aim is to decentralize buying/selling of energy.[1] Every house will have a battery and once the energy exceeds the battery limit or whenever they want, they can sell it to anyone in the grid.

2 BACKGROUND

There have been recent news reports that excess solar could cause blackouts.[2] Due to advancement in renewable energy they are getting cheaper and are generating more energy than before. A good example would be tesla renting solar panels. The better news is that in many countries people are able to sell excess energy generated from their solar panels back into the grid which are completely controlled by your utility provider.[3] Micro grids come to picture when we want to establish remote grids or for energy trading. Energy trading could be one of the solutions to storing excess energy generated from various energy providers (neighbouring households, solar farms etc.).[4]

3 SYSTEM ANALYSIS AND DESIGN

Our inspiration comes from the design of a rechargeable battery (i.e. power banks). We introduce a concept called transactional battery. Current travelling through households will reduce battery duration and also cause more power loss. This can be fixed by just forwarding and receiving power all from just one transactional battery per locality. The number of nodes a transactional battery can host depends based on the battery type used. To eliminate power loss a transactional battery can be hooked up with solar panels or most prominent renewable power source available in that area. To ensure that we can transfer energy from one micro grid to another we can scale it up the same way, i.e., transactional battery connected to another transactional battery of a higher level. Every micro grid will have a unique ID like a domain name that links to the server IPV6 address and server which controls getting or giving power from the battery. The communication will be standard TCP/IP to improve software development speed and adding more features.[4] An open source software can be run by a non-profit organization like ICANN that could allow buying and selling of electricity.

4 IMPLEMENTATION

The centralized version uses MySQL and the Express framework on Node.js as the backend and the HTTP protocol. A Raspberry Pi communicates with a bunch of relay modules that can communicate with smart meters to control the flow of the electricity from one battery to another. The client-server architecture has a lot of support and tools available for development. Six power banks, two Raspberry Pi's, a 10-channel relay per power bank and two micro USB to USB cables are used to build the physical prototype. In this prototype we have two transactional batteries and the rest of the batteries can either get or give power. This would be possible by an 8-channel relay. The first transactional battery (i.e. power bank) would have a USB hub that provides charge to 3 other power banks by using three relays. All the three power banks cables merge to give power to the power bank. The second transactional battery would connect to its battery

in a similar manner. The prototype will only have 5v wires for safety reasons. Raspberry Pi 1 controls the relays for both the transactional batteries and power bank 1, while Raspberry Pi 2 control all relays for power banks 2, 3 and 4. The code base will be divided into 2 major micro services. One which is a flask server which provides an API where we can specify the battery ID and whether it would give or take power. Based on the ID the Python script would open the appropriate relays. This API would give an approx. time for completion. The second micro service would be a node server that runs a web app where a customer can buy electricity from listed sellers or vice versa. This JS code would call the appropriate API to enable the transaction to take place and even let a consumer know how long the transfer will take place. If the consumer gives access to the platform it would display how much power is left in the battery (In our prototype, we would calculate battery charge by how much is going in and out).

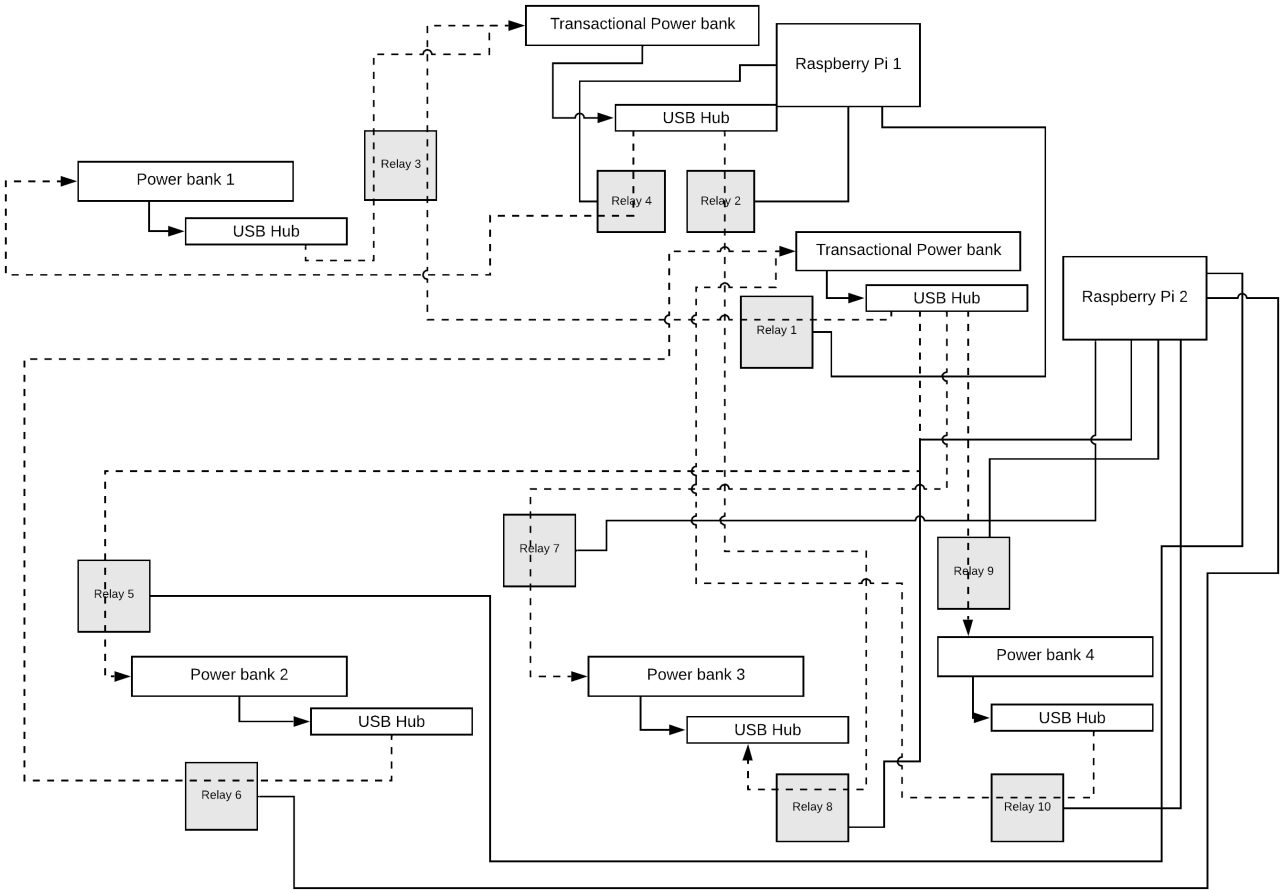

Fig 1: Diagram representing the prototype of the implementation of a micro grid

5 EVALUATION AND TESTING

The relays and sending energy from one battery to another does take place, the only challenge is when sending energy it is very hard to accurately track the energy sent and based on battery duration (i.e., every battery has different lifespan, ex: Lithium batteries last for approx. 2 years)[5], it would make it even difficult to detect power loss. This power loss can be reduced or not even happen if we have the grid companies to compensate for them (like hooking up small solar panels on top of transaction batteries just to compensate for power loss). In the more practical scenario, we would use smart meters to track accurate power transferred on both sides the sender and receiver. This prototype is just a proof of concept hence we are just assuming electricity reaches the necessary batteries based on time. Because the prototype uses 5v cables there would slight variations when dealing with more capacity because 5v is completely safe and does not cause any harm.

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