UNIVERSITY OF PLYMOUTH

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MA Smart Urban Futures

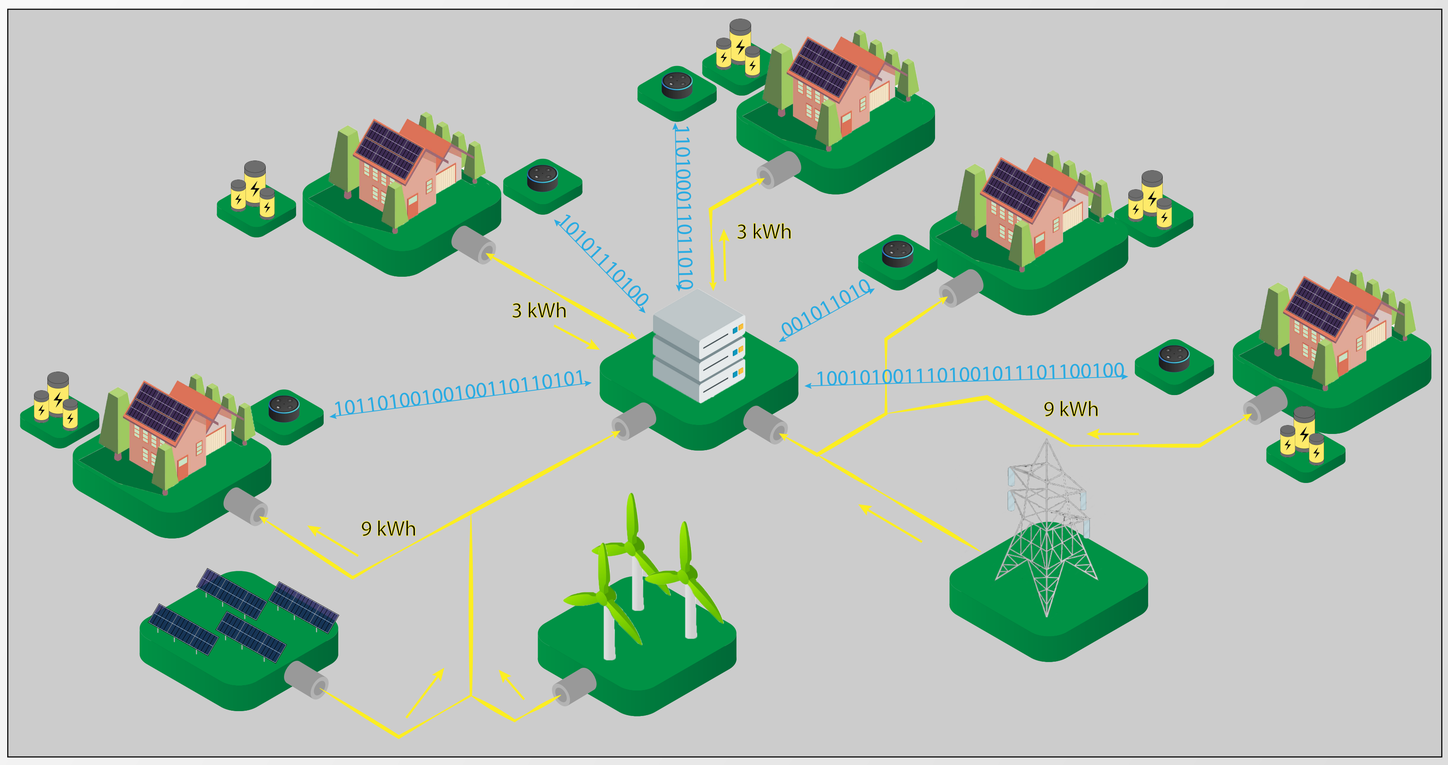
TARANIS ENERGY

"A smart meter you can talk to"

This project is a Vocie User Interface to enable a user to talk to an energy network. This energy network is also a peer-to-peer trading system that lets users tarde energy between themselves. It also features an Augmented Reality component which acts as a digital twin and simulation of the system. This gives a visual representation of what is happening as well as showcasing the options found in the VUI.

A Digital Twin is a bridge between the physical and virtual worlds. A virtual version of a system or process is informed by data collected from the physical counterpart. This data collection is done through sensors collecting useful information in the case of a physical object. For example, it can collect temperature information or volume of stored liquid in something like a fuel tank. In a system, like a traffic monitoring system, information about the contents of the system is usually collected. For example, the traffic in a particular area over time. In both cases, the data collected is used to improve performance or gain strategic insights. This is usually done with machine learning or artificial intelligence.

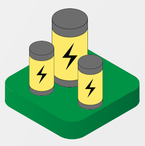
The next aspect of this project addresses a challenge in the world. This challenge is one of environmental concern. Our current types of fuels produced for and by energy sources also produce toxic gases that humans and animals alike breathe in. Sometimes, particles of heavy metals such as mercury become airborne as well and these have an impact on plantlife as well as human life. The solution is to use 'clean' energy technologies or renewable energy sources. The challenge here is to integrate these into our power infrastructure where possible and reasonable to do so. Progress in this area has been made and is continuing to do so. In 2016, Portugal managed to power itself for 107hrs on solar power alone. That's just over 4 days[1]. Also in 2016, a firm in California called SolarReserve built a massive solar plant which managed to power homes for 3hrs a day. The project became outdated as solar panels became cheaper but it was a good option until it became an expnsive project[2]. Wind turbines have proven effective in areas that can make use of them, such as offshore. As of 2019, the UK has invested £700m in connecting offshore wind turbines to the grid[3]. The number of solar installations between 2017/2018 and 2018/2019 in the UK has gone up from ~20,000 to ~ 32,000 and the mean price/kW of solar panel have gone down. 0-4kW went from 1840 to 1816[4].



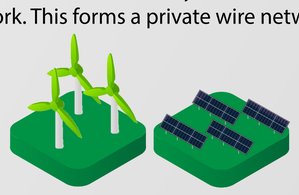
Smart Grids

For this project to work, a smart microgrid infrastructure must be in place. See the above diagram for an overview. The most important aspect of this is the ability to have a bidirectional energy flow between the consumers/prosumers of the network. This forms a private wire network while also being a smart microgrid.

VUI. This device is used to interface with the network and conduct trades or make queries. It is like a smart meter you can talk to.

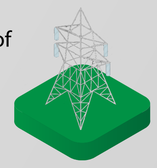


Each consumer/prosumer needs to have an energy storage attached to act as a place to send & receive energy. Think of it like a current banking account that you use for spending and topping up.



Local renewable integration: nearby industrial/commercial-grade energy production can be integrated. This is most likely to come in the form of renewable sources such wind, solar or tidal.

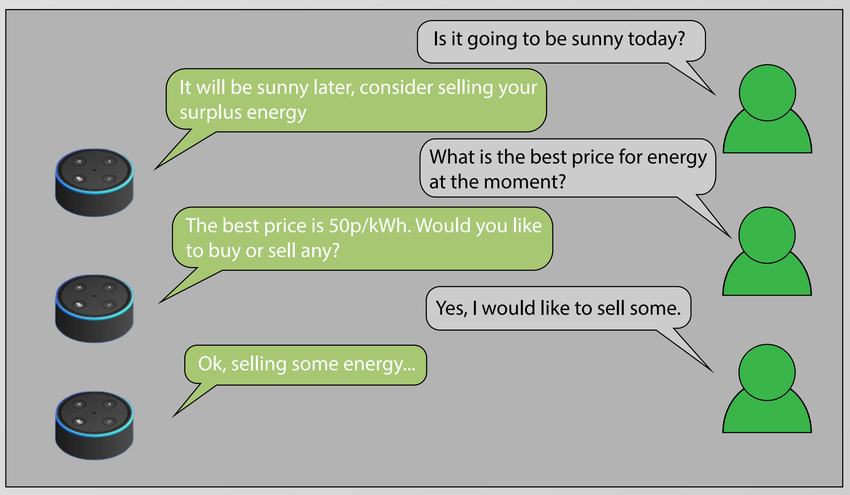
A microgrid needs to have a controller to facilitate energy transfers and load balancing. It also acts as a data node in this case. This controller/data node acts as a district node/gateway in the overall larger system.



Early phases of the project will still need to have a backup grid connection. This is because the microgrid will not be able to be 100% self-sustaining from the start and because legislation requires providing users with an option to switch provider (to another on the main grid).

Chatbot/VUI

Dialogflow



Main way to interact with the network. Each user will have an in-home device they can use which is like a smart meter you can talk to.

- Can ask price information
- Can ask about weather information
- Ask about broken cables/faults
- Ask about emergencies
- Able to conduct trades

You will be able to download the skill to your existing VUI device if you have one.

Trading system

IOTA
ethereum

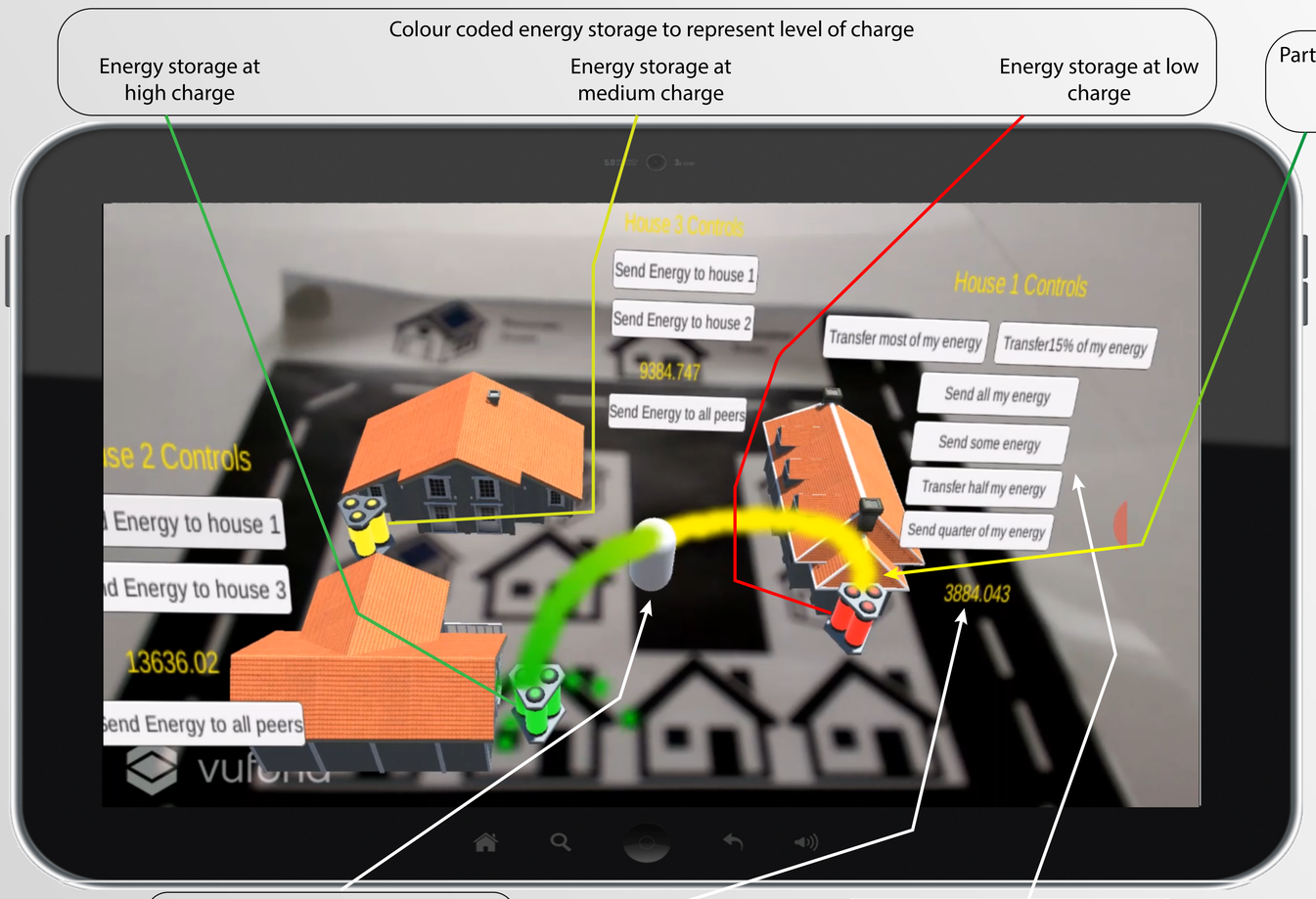
- Trading system is another key feature. It utilises a distributed ledger technology/blockchain to facilitate trades.
- Escrow contract is made in computer code and placed on this ledger for participants to use to make trades between themselves.
- Energy becomes tokenized, meaning it has a unit of value attached to it.
- Creates an energy marketplace for people to buy and sell in their neighbourhood/community.

Community/Social

- Network of friends/peers in a social network-type setting
- Customisable profiles.
- Increase energy awareness/mindfulness by knowing their energy usage aand from prices of energy if they trade regularly.
- Some may wish to use this as a means to make money by trading on the market.
- Increased/maintained quality of life through renewable integration, resulting in cleaner air. It is also more pleasant to breathe.

P2P Network

- Blockchain/Distributed Ledger Technology. Helps achieve decentralised system, or semi-decentralised in this case due to a grid controller being present in each neighbourhood/microgrid.
- Network structure prevents malicious actors changing data because of a consensus mechanism involved.



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User Scenarios

Homeowner

- Can use this while in their home or away to gain an overview of the state of energy in the neighbourhood. This is only allowed if their friends/peers allow them to see energy data.
- The user will need to have a copy of the AR marker.
- Viewable through mobile device with app

Energy supplier or DSO

- Behind-the-meter data. Can be used to analyse performance of assets, particularly any larger energy-producing assets attached to the local grid such as wind farms.
- Future versions to allow reporting of faults by showing them on the AR twin.

Town/City Council

- Behind-the-meter data. Can be used to analyse performance of assets.
- Inform planning and developments.
- Help councils meet their green mandates (if applicable) by measuring renewable/clean energy production in their energy mix and measuring energy efficicency in terms of consumption/production.

Both the DSO and councils can use this in meeting room(s) by having the marker permanently there or taken in as need be. They can use devices to view this during the meeting.

1: https://www.theguardian.com/environment/2016/may/18/portugal-runs-for-four-days-straight-on-renewable-energy-alone - Article explaining Portuaal powering itself for 4 days
2: https://www.bloomberg.com/news/articles/2020-01-06/a-1-billion-solar-plant-was-obsolete-before-it-ever-went-online - Article explaining about the costs of Crescent Dunes, causing it to fail
3: https://www.ofgem.gov.uk/publications-and-updates/infographic-promoting-sustainable-energy-future - Ofgem energy infographic for the UK 2019
4: https://www.gov.uk/government/statistics/solar-pv-cost-data - Cost of solar panels in the UK