How blockchains can empower communities to control their own energy supply

July 12 2018, by Valentin Robu, David Flynn And Merlinda Andoni

Credit: AI-generated image (disclaimer)

As the cost of solar panels, wind generation and battery storage falls, individual households and consumers are increasingly generating their own electricity, becoming less reliant on the power grid. This has led to energy systems becoming increasingly decentralised, which helps shift market power from large utility companies to individual "prosumers" –

consumers who produce their own electricity.

These developments have encouraged a rapid rise in the number of community energy projects around the world, where households generate, store, and trade energy with each other. In Scotland alone, the main community energy advice group lists over 300 projects that it supports.

Academics studying the UK's energy future are increasingly interested in the potential of these community energy models, such as the Findhorn ecovillage in northeast Scotland, with its energy efficient homes, solar panel arrays and community-owned wind turbines.

Such projects usually work by enabling exchanges of energy between producers and consumers inside a microgrid which serves the community, providing local energy resilience to future supply shocks. One house can buy excess renewable generation from a neighbour's solar panels, or from a community wind turbine.

Trading electrons using blockchains

Blockchains are best known as the technology behind cryptocurrencies such as Bitcoin, but are increasingly explored in community energy systems. Blockchains can act as a digital record for tracking energy and money transactions, without the need for a utility company to act as a trusted intermediary.

Simply defined, blockchain is a shared log of transactions, copies of which are shared by multiple parties, forming a distributed ledger. These ledgers take the form of an expanding chain of interconnected blocks of information (hence the name "blockchain"). Each new block added contains a pointer and a cryptographic hash of the data from the previous block, forming a linked list. This assures that blockchains are tamperproof, as no party can change the information in a previously written block without this change being detected by all parties.

Credit: Karolina Grabowska from Pexels

In an energy context, blockchains promise to enable "real electron trading", where the energy bought can be traced to the specific generator, battery or storage unit it came from at the time it is consumed. This is different from a consumer simply purchasing energy from a "carbon-free" utility company, which sources their energy from a renewable generator such as an offshore wind farm. In practice, this is not as effective, because due to power network constraints, the demand during peak times can often only be met from a nearby conventional power station that burns fossil fuels.

By contrast, a community energy scheme using blockchains enables the consumer to buy power directly from the solar panel of their neighbours or from local storage. It also provides the choice to specify what should happen if the neighbour's solar panels cannot supply power when needed – for example, it could defer some of the loads until locally generated renewable energy becomes available again. This not only cuts carbon emissions but also keeps energy revenues in the community.

Smart energy needs smart contracts

One of the main ways in which blockchains can enable this process is through so-called smart contracts – peer-to-peer agreements to supply energy which consumers can make with energy producers. Once a contract has been agreed, an algorithm will automatically enforce the terms and regulate the exchange of energy and money, without the need for a central trusted authority.

For instance, a user could specify from which neighbour's solar panels they prefer to buy energy at any given time. If the smart meter of the energy-exporting neighbour is linked to the blockchain, it can automatically detect how much energy is generated or exported and record this information, along with the transfer of the corresponding amount of money. It can also record how many other parties the neighbour has made contracts with and prevent double counting.

One key issue blockchain technology needs to overcome is its reputation for wastefulness, courtesy of its use in crypto-currency mining – a huge consumer of electricity. The Bitcoin network alone has been estimated to require as much energy as Ireland to run every year.

This is because, in the absence of a central authority, establishing which party can write a new block on the chain is done through performing an energy intensive computation, through a mechanism called "Proof-of-Work". In recent years, research attention has shifted to consensus mechanisms that are faster and more energy efficient, such as Proof of Stake or Proof of Authority.

While blockchains are a promising technology, unlocking their potential for a truly decentralised energy system will require research from a variety of areas. We can imagine a future in which software enabled by blockchains and Artificial Intelligence (AI) can negotiate smart energy contracts on our behalf, but enabling this transition is something that cannot come quickly enough for communities and the climate.

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