On the Privacy and Trust in Blockchain-Based Decentralized Renewable Energy Marketplaces

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I. Renewable Energy Marketplaces

Energy distribution systems play a vital role in modern societies. The dependency on electricity supply transcends every aspect of a society's operation, making it a necessity. However, the electricity production conducted by power plants that work on fossil fuels results in atmosphere carbonization. In order to make electricity generation cleaner, renewable energy sources (RES), *e. g.,* solar panels, were introduced as an alternative to fossil fuel ones. Consequently, the introduction of RES opened opportunities for electricity prosumers, *i. e.,* producers/consumers, to become a part of the grid as a distributed energy resource (DER) [1]. This allows prosumers to not only consume energy as a conventional node but also to produce and output it to the energy grid [2]. Further, prosumers can also trade the produced electricity through the energy marketplace, which incentivizes the installation of RES and the production of green electricity. However, today's energy markets face a number of challenges when it comes to management and operation. The first is the *inflexible pricing model* of today's marketplaces, where the prosumer is limited to selling the generated electricity to a single buyer without any other options [3]. The second is *inaccurate green consumption information*, *i. e.,* buyers receive unreliable information about the sources of the electricity they consume. Nowadays, the information about RES-produced electricity is recorded in the *guarantee of origin* (GO). GO is proof to the buyer that a given quantity of electricity was produced by the RES [4]. However, due to the inflexibility of energy distribution systems, *e. g.,* unavailability of RES in close proximity to consumers, they still end up using the electricity produced by fossil fuel energy sources while having the GO [5].

These limitations can be alleviated by introducing the *peer-to-peer* (P2P) *electricity trading*, which is an automated sale process for renewable energy between market participants using a contract with pre-determined conditions [4]. A P2P energy trade settlement allows prosumers to trade electricity directly with each other, enabling them to control when, where, and for what price the electricity is bought or sold. The ultimate goal of P2P energy trading is the widespread adoption of RESs, resulting in the decarbonization of the energy distribution systems [6].

Today's marketplaces are built as centralized systems. Thus, a *trusted third-party* (TTP) (typically a prosumer's energy provider) has to be present to guarantee that the predetermined conditions of a P2P energy trading contract are followed. *However, trust issues are raised, when it comes to scaling the marketplace to more than one energy provider*. Energy providers want to keep their operations private to maintain a competitive advantage in the electricity market. This requires the introduction of an external TTP that can be trusted by all energy providers within the marketplace [7]. To remediate these limitations, a *decentralized marketplace architecture* can be used to distribute control over the marketplace operations to multiple energy providers. However, all organizations require an efficient and robust consensus-reaching mechanism that provides guarantees that P2P trade settlement conditions are followed while maintaining actors' data privacy. Such capabilities can be provided by blockchain technology [8]. Blockchain provides marketplace participants with distributed storage, *i. e.,* the ledger, and brings such benefits as provenance, accountability, and privacy to all data processed in a system. It also acts as a consensus-reaching platform, allowing initially non-trusting energy providers and prosumers to establish a trusted relationship and conduct P2P energy trade settlements without needing a single TTP acting as a middleman [9].

Based on the challenges discussed above, the presentation talks about a decentralized blockchain-based P2P energy marketplace platform that utilizes *Hyperledger Fabric* (HB) [10] as the blockchain platform. The proposed marketplace utilizes HB's *smart contracts* (SCs) to automate P2P energy trade settlement and issue and consume GOs. To make the marketplace compliant with energy trade regulations, it incorporates the *regulator* actor, which manages the issue and consumption of GO and certifies the RES used to generate traded electricity.

References

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