http://dx.doi.org/10.21622/RESD.2019.05.1.001

Small Scale Renewable Generation Unlocking an Era of Peer-to-Peer Energy Trading and Internet of Energy

Dr. I A Gowaid and Dr. Ahmed Aboushady
Glasgow Caledonian University, 70 Cowcaddens Road,
Glasgow, G4 0BA, United Kingdom
azmy.gowaid@gcu.ac.uk; ahmed.aboushady@gcu.ac.uk

Millions of people worldwide suffer from lack of reliable electric energy supply. Energy justice scholarship has noted that small scale decentralized renewable energy offers a unique opportunity to democratize local energy provision, increasing the access to and affordability of electricity for those who are currently on the margins of centralized energy provision systems. This, in turn, is believed to result in critical human development benefits at the local level.

There is a strong drive in the industrial and academic community toward the deregulation and decentralization of power systems to enable wider deployment of medium and small-scale renewable energy resources such as wind and solar systems. In a centralized power system, the flow of electric power is unidirectional from generators to consumers. In a decentralized system of distributed generators and consumers that are also able to produce energy (prosumers), power flow is no more unidirectional, and so are payments. To this end, peer-to-peer (P2P) energy trade concept aims to provide the business model and technical infrastructure enabling prosumers to trade their produced energy with one another in addition to (or instead of) trade with the utility. This eventually will realize a power grid structure based on the concept of Internet of Energy (IoE) where electric power becomes a commodity tradable in an open market. Implementation of this concept is made possible by the ongoing migration of traditional power grids from centralized systems to more decentralized networks so as to accommodate renewable and distributed energy resources (DERs) as well as Smart Grid infrastructure.

The generic P2P energy trading system can be represented as a four-layer architecture. The basic (physical) layer is the power grid layer followed by communications layer, a control layer, and business layer at the highest level. These interoperable layers control the whole P2P trading process whereas peers can be prosumers, electric vehicle (battery) owners, microgrids, or regions of the power system.

Much of the attention in the literature has been dedicated to developing appropriate structures of the communications and business layers in a bid to realize P2P trading without expensive alterations to the existing AC grid physical infrastructure. Therefore, researchers and innovators focus on developing platforms that run different forms of trading processes among peers taking in account grid security, economic incentives, and system operator requirements. Various criteria for peers to select who to trade with are possible, including 'least power loss', 'highest reliability' or 'most environmental'.

As it is very hard to trace actual power flows in a power grid and reward prosumers for their energy production, energy market regulators normally issue Renewable Energy Certificates (RECs) as an incentive for system operators to purchase renewable energy from DER owners. For instance, in the US each DER owner is issued 1 REC, which is tradable with utilities, for each 1MWh of energy produced (REC is named differently in different countries). Likewise, it is the common theme between the various P2P energy trade platforms whether in operation or under development to manage energy trade between peers and third parties by means of trading RECs, or equivalent tokens, efficiently and securely.

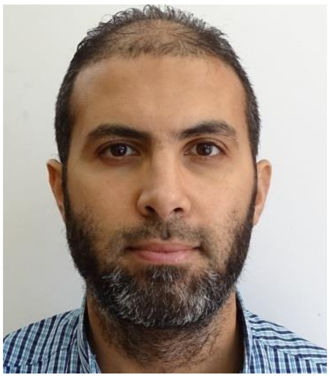
Some of such platforms utilize third party for transactions auditing, while the more advanced platforms are built on Blockchain technology to realize near-instant decentralized payment and auditing of transactions without the need for a third party.

RESD © 2019
http://apc.aast.edu

http://dx.doi.org/10.21622/RESD.2019.05.1.001

About the authors:

Dr. I. A. Gowaid received the B.Sc. (First Class Hons.) and M.Sc. degrees in electrical engineering from Alexandria University, Egypt, in 2007 and 2011, respectively. From 2013 to 2017 he was with the Power Electronics, Drives, and Energy Conversion (PEDEC) Research Group, University of Strathclyde as a PhD candidate then as a postdoctoral research associate. He was a teaching assistant (currently on leave) at the Department of Electrical Engineering, Alexandria University as of 2008. He is currently with the Department of Electrical and Electronic Engineering, Glasgow Caledonian University as a lecturer of electrical power engineering. His current research interests include power electronics, solar and wind energy integration, high voltage DC transmission (HVDC), smart grids, and power system dynamics. Over 8 years of active research, Dr Gowaid has co-authored a number of highly-cited publications in top-ranked journals and conferences in the field of electrical power engineering.



Dr. Ahmed Aboushady received his B.Sc. (Hons) and MSc degrees in Electrical and Control Engineering from the Arab Academy for Science and Technology, Egypt in 2005 and 2008 respectively. Following this, he obtained his PhD degree in power electronics form the University of Strathclyde, Glasgow in 2013. He is currently a Lecturer in power electronics at Glasgow Caledonian University, UK and the MSc programme lead in Electrical Power Engineering. Dr. Aboushady has over 10 years of lecturing and research experience in power electronics and its applications. As principal investigator, he has been awarded a number of projects totalling over £0.5m from Scottish Power Energy Networks, Energy Technology Partnership and Oil and Gas Technology Center on new wireless charging technology applications and technology assessment of subsea DC power electronic systems for the offshore oil and gas sector. Dr. Aboushady had successful industrial collaborations in the past with Aker Solutions, Technip Umbilicals and Alstom Grid, and has published over 20 technical papers in refereed journals and conferences, a single-authored book, a book chapter contribution and a PCT patent. To date, he supervised 4 PhD students, a postdoctoral researcher and a number of master students. Dr. Aboushady is a senior member of IEEE, and his main research interests are in medium and high voltage DC transmission systems, integration of renewable energy systems and wireless power transfer applications.

RESD © 2019
http://apc.aast.edu