Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 105 (2017) 2563 – 2568

Energy Procedia

The 8th International Conference on Applied Energy – ICAE2016

Review of Existing Peer-to-Peer Energy Trading Projects

Chenghua Zhang[a,*], Jianzhong Wu[a], Chao Long[a], Meng Cheng[a]

[a]*Cardiff University, Cardiff, CF24 3AA, UK*

Abstract

Peer-to-Peer (P2P) energy trading is a novel paradigm of power system operation, where people can generate their own energy from Renewable Energy Sources (RESs) in dwellings, offices and factories, and share it with each other locally. The number of projects and trails in this area has significantly increased recently all around the world. This paper elaborates main focuses and outcomes of those projects, and compares their similarities and differences. The results show that although many of the trails focus on the business models acting similarly to a supplier's role in the electricity sector, it is also necessary to design the necessary communication and control networks that could enable P2P energy trading in or among local Microgrids.

Peer-review under responsibility of the scientific committee of the 8th International Conference on Applied Energy.

Keywords: Peer-to-Peer Energy Trading, Microgrids, Business Models, Energy Markets

1. Introduction

Existing power systems were designed to accommodate large-scale generating plants, with demand traditionally considered as uncontrollable and inflexible. However, with the increasing integration of distributed energy resources (DERs), traditional energy consumers will become prosumers, who can both generate and consume energy. [1] Generation of DERs is unpredictable and intermittent, and prosumers who have surplus energy can either store it with energy storage devices, or supply others who are in energy deficit. This energy trading among prosumers is called Peer-to-Peer (P2P) energy trading. [2]

There are already several projects and trails on P2P energy trading carried out worldwide. This paper will summarize the details of those trails in Part 2. Comparison is made between them in Part 3. In Part 4, a future scenario of P2P energy trading is proposed. And finally conclusions are drawn in Part 5 based on the previous contents.

* Corresponding author. Tel.:+44-29208-70422.
E-mail address: zhangc29@cardiff.ac.uk.

Peer-review under responsibility of the scientific committee of the 8th International Conference on Applied Energy.
doi:10.1016/j.egypro.2017.03.737

2. Existing P2P Energy Trading Projects

A number of trails and projects on P2P energy trading have been carried out in recent years. Some of them focus on business models and platform for energy markets acting similarly to supplier's role in electricity sector, while some are targeted at the local control and ICT systems for Microgrids. Here a number of trails in this area are presented in detail.

2.1. Piclo

Piclo was established in the UK. It was a collaboration between an innovative technology company called "Open Utility" and a renewable energy supplier "Good Energy", where business consumers could buy electricity directly from the local renewables. The meter data, generator pricing and consumer preference information were used to match electricity demand and supply every half hour. Generators have control and visibility over who buys electricity from them. Consumers can select and prioritize from which generators to buy electricity. Piclo matches generation and consumption according to preferences and locality, providing customers with data visualizations and analytics. Good Energy provides contracts, meter data, billing, award-winning customer service, and balances the market place. [3]

Fig. 1. Example of Matching Generation and Consumption in Piclo

2.2. Vandebron

Vandebron is an online platform in Netherland where energy consumers can buy electricity directly from independent producers, such as farmers with wind turbines in their fields. [4] Very similarly to Piclo, it acts as an energy supplier who links consumers and generators, and balances the whole market.

2.3. PeerEnergyCloud

PeerEnergyCloud was a project in Germany. It developed cloud-based technologies for a local electronic trading platform for dealing with local excessive production. It was established in order to investigate innovative recording and forecasting procedures for device specific electricity consumption, to establish a virtual marketplace for power trading and to develop value added services within a Microgrid. [5]

2.4. Smart Watts

Smart Watts was also a German project. It proposed new approaches for optimizing energy supply through the use of modern information and communication technologies (ICT), and these ICTs were developed and tested. It has exploited the optimization potential of ICT in order to achieve greater cost-effectiveness and security of supply. [6]

2.5. Yeloha and Mosaic

Both Yeloha and Masaic were trails in the US. They allow interested consumers, such as apartment owners and others who do not own solar systems, to pay for a portion of the solar energy generated by the host's solar system. The subscribers get a reduction on their utility bills, so that in total, they save money, even if they move. [7] [8] They are similar to Piclo and Vandebron, but more interested in solar power than other renewables.

2.6. SonnenCommunity

The sonnenCommunity is developed by sonnenBatterie, which is a storage manufacturer in Germany. It is a community of sonnenBatterie owners who can share self-produced energy with others. As a result, there is no need for a conventional energy supplier anymore.

With a sonnenBatterie and a photovoltaic system, members can completely cover their own energy needs on sunny days – often even generating a surplus. This surplus is not fed into the conventional power grid, but into a virtual energy pool that serves other members in times when they cannot produce enough energy due to bad weather. A central software links up and monitors all sonnenCommunity members - while balancing energy supply and demand. [9] This idea is very similar to Piclo's and Vandebron's, but sonnenCommunity obviously highlights the importance of storage system.

2.7. Lichtblick Swarm Energy

Swarm Energy is a set of services provided by energy supplier Lichtblick. Swarm Conductor, which is one part of Swarm Energy services, is a unique IT platform in the energy market. On the platform, the processes of an increasingly complex world of energy to customer-friendly products and services for residential and business customers are combined. Customers' local power plants and storage are optimized. Swarm Energy allows a meaningful interaction of distributed and renewable energy sources. [10]

2.8. Community First! Village

Community First! Village is a 27-acre master-planned community that provides affordable, permanent housing and a supportive community for the disabled, chronically homeless in Central Texas. The project organizers are trying to supply the village with power from donations. [11]

2.9. TransActive Grid

TransActive Grid is a community energy market, and a combination of software and hardware [12] that enables members to buy and sell energy from each other securely and automatically, using smart contracts and the blockchain. The current prototype uses the Ethereum blockchain. Located in Brooklyn,

Table 1. Comparison of different projects

Project Name	Country	Start Year	Objectives	Network Size	P2P? Layers	Outcomes	Shortcoming
Piclo	UK	2014	P2P energy trading platform from suppliers perspective	National	Business	A P2P energy trading platform	No discussion on local markets
Vandebron	Netherland	2014	P2P energy trading platform from suppliers perspective	National	Business	A P2P energy trading platform	No discussion on local markets
PeerEnergyCloud	Germany	2012	Cloud-based P2P Energy Trading Platform, Smart Home	Microgrids	Energy Network, ICT	Cloud-based platform for smart homes	No discussion on control system
Smart Watts	Germany	2011	Optimizing energy supply via ICT	Regional	Energy Network, ICT	A smart meter gateway as interface to Internet of energy	No discussion on control system
Yeloha, Mosaic	US	2015	Solar sharing network for lower energy bills.	Regional	Business	Terminated due to funding issues	No discussion on local markets
SonnenCommunity	Germany	2015	P2P energy trading with storage system	National	Energy Network, Business	A P2P energy trading platform (online)	No discussion on local markets
Lichtblick Swarm Energy	Germany	2010	IT platform for energy markets and customers	National	Energy Network, ICT	Plenty of services provided by the energy supplier	No discussion on local markets
Community First! Village	US	2015	Energy sharing from donations	Community	Business	Saving energy bills for poor people	No discussion on ICT and control system
TransActive Grid	US	2015	P2P energy trading within Microgrids using Blockchain	Grid-connected Microgrids	Energy Network, Control, ICT, Business	Automatic energy trading platform within Microgrids	Communication before exchange was ignored
Electron	UK	2016	Energy metering and billing platform using Blockchain	Unknown	Energy Network, ICT, Business	Not started yet	Not started yet

New York City, consumers can choose where to buy renewables from. Home energy producers can sell their surplus to their neighbors, and communities can keep energy resources local, reducing dissipation and increasing micro and macro grid efficiency. [12]

2.10. Electron

Electron is a revolutionary new platform for gas and electricity metering and billing systems, which is still under development. It will open the way for exciting and innovative consumer energy services. It is a completely secure, transparent, decentralized platform that runs on a blockchain and provides a provably honest metering, billing and switching service using Smart Contracts and the power of Distributed Consensus. The platform will be open source and operate for the benefit of all users. It will not be owned or controlled by suppliers or brokers. [13]

3. Comparisons of Projects

A comparison of the above projects has been summarized in Table 1.

According to Table 1, many of the above trails have some similarities. For example, Piclo, Vandebron, SonnenCommunity, Yeloha and Mosaic are all national or regional online platforms that support P2P energy trading among their members and these platform owners acted similarly to a supplier's role in the electricity sector. They only focus on the development of business models, and ignore the possibility of introducing those models to smaller-scale local energy market. The design of ICT and control systems was not considered. Apart from those similarities, they, on the other hand, have different research focuses. Piclo and Vandebron aim to provide connections between energy consumers and generators, so that the unit price of electricity differs from time to time, while SonnenCommunity highlights the importance of storage system, and tends to adopt a more stable tariff.

Both PeerEnergyCloud and Smart Watts were based in Germany, and focused on the ICT technologies suitable for local P2P energy markets. They proposed different scenarios that described the business arrangements for P2P energy trading. However, the development of ICT technologies was treated as their main research direction rather than the P2P energy trading.

Finally, both TransActive Grid and Electron introduced the blockchain technology into energy sector to simplify the metering and billing system in the energy markets. However, TransActive Grid is more interested in developing a local P2P energy market in Microgrids, while Electron is targeted only at an advanced billing platform for energy suppliers.

4. A Future Scenario of P2P Energy Trading

Due to the hierarchical nature of the distribution networks, the future P2P energy trading will be carried out in three levels: Level 1: P2P within a Microgrid; Level 2: P2P within a CELL (multi-Microgrids); and Level 3: P2P among CELLs (Multi-CELLs). There will be hierarchical P2P markets across all levels, which aim to keep energy and power balancing level-by-level respectively.

The P2P energy trading relies on the availability of local energy sources, therefore the first level is the basis of the whole hierarchical system. A local energy market and a sophisticated ICT and control system is essential for managing the balancing of the system. And that is also why many existing projects started from the Microgrid level to investigate the operation of P2P energy trading.

The future P2P approach promotes regional energy trading and demand response to available resources in local areas. This will increase the efficiency, flexibility and responsiveness of local resources.

5. Conclusions

There are a number of projects on P2P energy trading worldwide. While some of them share similarities, they have different focus at the same time. Details of those trails and projects have been listed, and a comparison is also provided. Many of these trails designed business models and marketplace for P2P energy trading, but ignored the possibility of local energy markets in Microgrids, and the relevant ICT and control systems for such local markets. And some of the trails only focused on ICT technologies, and the details about control system of the proposed market was not considered. Blockchain was considered to be a very promising techniques which can simplify the metering and billing system of the P2P energy trading market.

Copyright

Acknowledgements

The work is supported by P2P-SmarTest project under the grant of EU commission.

References

[1] Luo Y, Davis P. Autonomous Cooperative Energy Trading Between Prosumers for Microgrid Systems. 3rd IEEE International Workshop on Global Trends in Smart Cities goSMART 2014.

[2] C. Zhang, J. Wu, M. Cheng, Y. Zhou, and C. Long, "A Bidding System for Peer-to-Peer Energy Trading in a Grid-connected Microgrid"

[3] Open Utility, "A Glimpes into the Future of Britain's Energy Economy", available at "https://piclo.uk".

[4] available at "https://vandebron.nl".

[5] B. Brandherm, J. Baus, and J. Frey, "Peer Energy Cloud – Civil Marketplace for Trading Renewable Energies", 2012 English International Conference on Intelligent Environments.

[6] available at "http://www.iis.fraunhofer.de/en/ff/ener/proj/smart-watts.html".

[7] Yeloha Website, available at "http://www.yeloha.com".

[8] A. Degode, "New Business Models Through a 'Sharing Economy' in the Energy Sector", E-Energy – Challenges and Opportunities for Information Systems in the Smart Grid.

[9] SonnenCommunity Website, available at "https://www.sonnenbatterie.de/en/sonnenCommunity".

[10] Swarm Energy, Lichtblick Website, available at "https://www.lichtblick.de/privatkunden/schwarm-energie".

[11] Community First! Village Website, available at "http://mlf.org/community-first".

[12] TransActive Grid Project Website, avaialble at "http://transactivegrid.net".

[13] Electron Website, avaiable at "http://www.electron.org.uk".