Business model and market designs for solar prosumer on peer to peer energy trading in Thailand

P. Kokchang\(^1\)*, S Junlakarn\(^1\) and K. Audomvongseree\(^1\)

\(^1\) Energy Research Institute, Chulalongkorn University, 12\(^{th}\) Floor Institute Building III Phayathai Road Pathumwan Bangkok 10330, Thailand.

*E-mail: Phimsupha.k@chula.ac.th

Abstract. In recent years the power system is undergoing a rapid change from the traditional power system with large-scale power plants to small-scale distributed generations such as wind energy and solar photovoltaic system. In addition, the technology related to the electric business has been developed rapidly, such as solar power development technology, energy storage, and various communication and measurement devices, etc. The development of these technologies together with the reduced cost of technologies is the main factor in the transformation of the electric business model in many countries around the world, including Thailand to the way that electricity users turn from being consumers only to be both consumers and producers of electricity or called as prosumers. Also, it drives to the new paradigm: peer-to-peer electricity trading, where consumers and prosumers can buy or sell electricity locally. However, the concept of peer to peer energy trading is at early stage in Thailand. This study points out the benefits and barriers of peer to peer energy market based on reviewed existing peer to peer energy projects worldwide. The results of study show that the major regulatory barriers that restrictive to peer market in most countries are the licensed energy supplier issue, network charging and no excess generation is fed back into the national grid.

Keywords: Peer to peer energy trading, Solar prosumer, Business models and market designs, excess energy

1. Introduction

With the growing integration of distributed generation sources into the distribution system, the role of traditional electricity consumers has changed from to simply consumer to both electricity consumer producer, and so-called alternatively, prosumers. Distributed generations (DGs) or distributed energy sources include a variety of renewable energy sources (e.g. solar photovoltaic [PV] or wind turbines) and are located near power end-users rather than in a distributed manner [1]. Among DGs, solar PV has been confirmed to be a feasible technology for consumers and prosumers, mainly due to continuous policy support and the falling costs of solar panels [2].

Additionally, digital technologies such as blockchain technology is being developed to manage energy trading transactions, leading to a new form of energy trading in which consumers and prosumers can trade electricity with each other locally without intermediation by conventional energy utilities. This is called peer-to-peer (P2P) energy trading [3].
The Thai government plans to implement a P2P energy trading concept in the prosumer group in line with the national energy reform guidelines. The appropriate rules and regulations for P2P energy trading platforms will be considered and aim to open more markets to encourage electricity trading among consumers and prosumers. Since the launch of the latest national power development plan (PDP) in 2018, the new solar power generation target is set to include a 10,000 MW household solar scheme by the year 2037 [4]. Under the program, those generating excess electricity via a rooftop solar PV system will be able to sell their surplus output to the national grid. However, uptake is currently low due to an unattractive export rate. The P2P energy trading model may work to incentivize the adoption of rooftop solar PV systems in Thailand, and The P2P energy trading model can be a solution to enhance the uptake of solar PV installation in the household sector.

Nonetheless, the concept of P2P energy trading is rather new and there are still countless studies on the details of business model and market designs on P2P energy trading in Thailand. It is important to understand the business model and market designs of P2P energy trading model to fully understand the potential impacts that may arise for prosumers. The present paper reviews business model and market designs based on literature together, in addition to reviewing P2P trading projects and trials that are being conducted around the world. Since each country has different regulations, the regulatory barriers in each P2P trading projects will be discussed and identified.

2. Literature review

2.1. Concept of P2P energy trading
Peer to peer energy (P2P) trading can be defined as local energy trading that allows prosumer to directly trade excess energy with individuals, neighbours, or a groups of local energy customers and organizations. This concept is developed based on the concept of the sharing economy. The fundamental value of P2P energy trading is that peers can locally trade excess energy without the need for a third-party licensed supplier (TPLS) [3,5]. A peer in P2P can refer to an individual or a group of energy customers, including generators, consumers, and prosumers. A group of energy customers can be at a number of different scales, for instance a single household, a neighbourhood, a microgrid and a local distribution network [6]. Furthermore, the energy transaction may range quantity, timescale, and acceptable variability, while also being network location specific [7].

2.2. Business model and market design for P2P energy trading
There is an increasing interest in the literature about the business model and market design for P2P energy trading. Sousa, Soares, Pinson, Moret, Baroche and Sorin [6] proposed the business model can be classified as Business-to-Business (B2B), Customer-to-Customer (C2C), or Business-to-Customer (B2C), dependent upon how the different types of market players trade goods or services. Moreover, they suggested that the P2P market can provide a new form to B2C business models in the electricity market with regard to consumer preferences and interests. Parag and Sovacool [8] identified potential prosumer markets in which prosumers may play an important role, comprising the P2P model, Prosumer-to-Grid-model, and the prosumer community group. A few studies have proposed three distinct P2P market designs: Full P2P; community-based; and the hybrid P2P model. The full P2P market is based the trading among peers without a centralized structure (as the wholesale market) or intermediary entities (as the retail market). The community-based market is more organized, in which trading involves an aggregator or a community manager. This type of market design can be applied to microgrid systems or to a group of local prosumers and consumers. The hybrid market then combines the features of the full P2P and community-based markets [6,8,9].

2.3. Review of existing global P2P energy trading projects
There has been a growing number of P2P energy trading projects worldwide. Most projects aim to promote the use of small-scale energy sources and open new electricity markets between prosumers and consumers [10]. This is essentially to allow households and organizations to become small energy suppliers. However, the barriers of existing regulatory structures remain restrictive for the implementation of P2P trading in most countries. A few projects are presented in detail, as follows.
The best-known P2P energy trading project example is the Piclo project, a British online-based P2P energy trading platform that performs P2P energy trading for generators and business consumers. The project began in October 2015 as a trial project after receiving funding from the Energy and Climate Change Department (DECC). The project last for six months in a joint effort between an innovative technology company called “Open Utility” and a renewable energy supplier called “Good Energy”. Piclo utilized meter information, generator pricing, and consumer preference information to match electricity demand and supply in thirty-minute settlement. Generators were about to control and visibility over who buys electricity from them. Meanwhile, a buyer could choose and prioritize which generators to buy electricity from. Piclo matches generation and consumption according to preferences and locality and provided customers with data visualizations and analytics [11]. The benefit of local generation matching included reducing annual Distribution Use of System (DuoS) charges by up to 39% or £ 20,000 based on trial data from the Eden project. Piclo is not however currently able to achieve reduced DUoS charges for consumers based on consumers purchasing locally generated electricity. Another regulatory barrier is the need for a third-party licensed supplier (TPLS) which impedes the implementation of a true P2P market [5].

Vandebron was established in the Netherlands in 2014 as a for-profit organization. It is a direct renewable energy marketplace between consumers and independent green energy producers, such as local farmers who own wind turbines or solar farms. Vandebron offers an online platform with a variety of renewable energy sources including wind, solar, biofuel, and gas. Customers can select the desired package, including energy producers, the type of electricity generation, the contract duration and the amount of energy required through the company’s website [3,10]. A strong driver for this model is that the Netherlands has a deregulated energy market which allows the P2P energy trading model to work directly between independent energy providers and consumers [12].

Sonnen, a German battery storage manufacturer, known as Sonnenbatterie, launched a community energy trading platform called sonnenCommunity in December 2015. It aimed to allow solar PV installers with energy storage to share the excess energy generated with other members in the sonnenCommunity [13]. Sonnenbatterie enables the owner of solar PV systems to generate, store and trade solar PV generated in their batteries. The service combines distributed generation, battery technology, and digital networking to create a new electricity business model between prosumers and consumers in the community. SonnenCommunity subscribers pay a monthly membership fee of €19.99 with a 10-year guarantee for using Sonnenbatterie and receive a low-price electricity rate called Sonnenflat [13,14]. A key driver behind this trading platform is that German regulation does not permit customers to occasionally feed electricity back into the grid once the grid is oversupplied [12].

Another well-known P2P project is the Brooklyn Microgrid (BMG) Project developed by LO3, Consensys, and Siemens in 2016 in New York, United States. The BMG pilot project is an energy marketplace for locally generated renewable energy. The objective of this project is to increase renewable energy generated within the community and improve grid efficiency by reducing the amount of energy lost through transmission under the microgrid concept. Participants who install installed solar PV in this project can trade their excess energy to community members. The kWh can be essentially transacted very efficiently on the P2P network via blockchain technology, which acts as an automated accounting system. However, the system is not linked to settlement and is currently more expensive than buying electricity from utility companies [5]. In addition, New York state’s current regulations do not permit local P2P energy trading, with only utilities and retail service providers being permitted to trade energy. BMG pilot project is actively working on this issue to get approval to implement true P2P energy trading [15].

In Thailand, the T77 urban precinct in Bangkok launched a P2P solar rooftop trading trial using blockchain technology, developed by Power Ledger, together with a Thai renewable energy business BCPG. The trial participants include a shopping mall, apartments, a school, and a dental hospital on the Power Ledger platform. This model involves deregulation to support the generation of electricity by communities and private power purchase agreements. With an installed solar rooftop capacity of 635 kilowatts combined with battery storage, the project aims to provide 20% of the community’s entire electricity need. The Power Ledger platform will allow individuals and communities in the T77 Precinct
to choose the source of their power, while providing a cheap, dependable and low-carbon mechanism to harness energy [16,17]. However, true P2P transactions are not yet underway in this project due to licensed energy supplier and wheeling charge issues (fee for transmission line use).

Table 1: Summary of existing P2P energy projects

| Project         | P2P market structure | Benefit of the project                                                                 | Regulatory Barriers                                               |
|-----------------|-----------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| Piclo           | Full P2P              | 1. Local energy matching of renewable energy producers and consumers.                   | 1. Licensed energy supplier issue.                                |
|                 |                       | 2. Reduces costs of DuoS.                                                               | 2. Networking charging issue.                                     |
|                 |                       | 3. Promotes the use of clean energy in community.                                       | 3. Billing and settlement process.                                |
| Vandebron       | Full P2P              | 1. Matches the preferences of renewable energy suppliers and establishing local clean energy community. | 1. None (The Netherlands has a deregulated energy market.          |
| SonnenCommunity | Hybrid P2P            | 1. Enables trading of excess energy from solar PV with battery systems.                 | 1. No excess generation feed back into the grid.                  |
| Brooklyn microgrid | Full P2P             | 1. Improves the grid efficiency by reducing the energy lost through transmission        | 1. Licensed supplier issue.                                      |
|                 |                       | 2. Supports local economy and reduces greenhouse gas emissions and air pollution.       | 2. Billing and settlement process                                 |
| T77 precinct Bangkok | Full P2P             | 1. Enables trading of excess energy from solar PV within community.                    | 1. Licensed energy supplier issue                                 |
|                 |                       |                                                                                        | 2. No excess generation fed back into the grid                    |
|                 |                       |                                                                                        | 3. Wheeling charge                                                |

3. Discussion
Most of the reviewed projects implement a full P2P structure in which peers can directly trade with others without an intermediary entity, with the exception of the SonnenCommunity which is a hybrid P2P model. In terms of prosumer market, the P2P market model is being employed in almost every P2P energy trading project. This model allows prosumers and consumers to sell and buy electricity with each other on the platform and may create a new form of electricity market. However, under such a model, a wheeling charge may be present to cover its distribution function to the distribution grid. For instance, the Piclo program is an online market for renewable energy for local commercial consumers. Similarly, the Bangkok-based T77 precinct has launched a platform that allows participants to trade excess PV generation in the community.
Most of the P2P energy trading projects face regulatory barriers. A major regulatory barrier that the Piclo, BMG project, and T77 precinct project face is a licensed energy supplier issue. Since all transactions must be made through a licensed supplier and customers can only have one licensed energy supplier, it is restrictive for prosumers with solar PV generation and result in them being unable to sell excess electricity to other consumers. In other words, it is not possible for consumers to buy excess generation from PV prosumers, and that surplus power must instead be sold back to the national grid. The next major regulatory barrier that is interlinked with the previous barrier is billing and settlement. At present, all electricity that passes through a customer’s meter is purchased from one licensed supplier, which could potentially lead to double counting if this issue is not addressed. Another regulatory barrier is the network charging issue. In the UK, network charging is under review to determine fair rate for all users [17]. Even though, local generation matching may reduce annual DuoS charges, Piclo still pays the full network charge for locally electricity supply. In Thailand, an appropriate rate for the wheeling charge has not yet been determined. With many details still under investigation, the T77 precinct project has still not implemented a true P2P energy transaction market.

4. Conclusion and further research
The recent P2P energy trading is at an early stage in Thailand and the current structure of P2P energy trading trials in Thailand is focused on implementing a full P2P market, following a prosumer P2P market design. This paper provides literature of the business model and market designs for P2P energy trading. Based on the literature, the business models were reviewed in terms of the type of business models for the trading and prosumer market model, while market designs were highlighted for P2P structures. In addition, the regulatory barriers to the P2P market model have been identified. Although, existing regulations are still restrictive for the implementation of P2P market worldwide, the P2P energy trading concept can create a future electricity market that is strongly driven by the community-based model. Further research should explore the most appropriate business models and market designs of P2P energy trading model for PV prosumers in Thailand.

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