DISEMINATION POTENTIAL IN GERMANY OF PEER-TO-PEER ENERGY TRADING AND LOCAL ELECTRICITY MARKETS AS AN OPTION OF DECENTRALIZED ENERGY SYSTEM

[César De Jesús, Offenburg University of Applied Sciences, +49 (0)781 205-4932, cesar.dejesus@hs-offenburg.de]
[Niklas Hartmann, Offenburg University of Applied Sciences, +49 (0)781 205-4645, niklas.hartmann@hs-offenburg.de]

Overview

Peer-to-peer (P2P) energy trading (ET) and local electricity markets (LEMs) have been widely discussed a as new option for the transformation of the energy system from the traditional centralized scheme to the novel decentralized one. Moreover, it has also been proposed as a more favourable alternative for already expiring feed-in and feed-out tariff policies (e.g. EEG surcharge in Germany) that promote the investment in renewable energy sources. P2P-ET is usually defined as the integration of several innovative technologies, namely, information and communication technologies (ICT), distributed energy resources (DER) and distributed ledger technologies (DLT), e.g. Blockchain. Furthermore, the techno-economic aspects go hand in hand with the socio-economic aspects, which represent at the end significative barriers that need be tackled in order to reach a higher impact on current power systems. As an assessment for evaluating a higher market penetration of P2P concepts, even on supralocal areas such as regions, states or including country-wide extent, a methodology that determines the following aspects is proposed with this study:

- The most promising types of scalable P2P concepts
- The probabilities of prosumer participation rate into entering mentioned P2P concepts
- Proposed descriptors for defining consistent scenarios for modelling high penetration of P2P-ET in Germany

Methods

Literature review of the most significative P2P-ET concepts, pilot projects and demonstrators in the European region (table 1), followed by a content analysis to characterise and select the most suitable P2P market types to be scalable into a region-wide zone in Germany. Based on the eligible P2P concepts, a thematic analysis of literature focusing on socio-economical aspects evaluating the prosumers and consumers willingness to participate into P2P-ET is performed, assessing qualitative data summarized in the literature.

Table 1: P2P-ET summary of pilot projects and demonstrators in Europe.

P2P Demonstrator	Country	Potential Scalability	Participant Entry Barrier	Market type/Information flow			Accessibility	
		Local-Regional-National	Low-Medium-High	Centralised	Decentralised	Distributed	Open	Restricted
enyway	Germany	National	Low		X		X	
Lition	Germany	National	Low			X	X	
Tal.Markt	Germany	National	Low			X	X	
stromodul	Germany	Regional	Medium			X		X
sonnen	Germany	National	High	X			X	
LAMP	Germany	Local	High	X				X
NEMoGrid	Germany, Switzerland, Sweeden	Local	High			X		X
e.on - Simris	Sweeden	Local	High	X				X
Quartierstrom	Switzerland	Local	High		X			X
Powerpeers	Netherlands	National	Low			X	X	
SunContract	Slovenia	National	Low		X		X	

Results

Results can be summarized in three aspects. First, a concise list of European P2P pilot projects and demonstrators with its main characteristics is proposed, selecting two most promising scalable concepts. Second, a clustering of prosumers and its willingness to participate into P2P-ET parting from the different end-use energy sectors considering techno-economical aspects and social preferences with focus on the demographics of Germany is suggested. Third,

the proposition of four main techno-economical scenario descriptors with the objective of defining consistent P2P energy modelling scenarios. The performed analysis shows two of the most promising P2P options for scaling them in a regional/nation-wide area with a positive participation rate of prosumers into LEMs (table 2). An average of 5 – 40% of participation probability into P2P can be derived for prosumers and consumers which prefers lower energy price, autarky and green energy.

Table 2. Prosumer clustering and their willingness to participate in P2P-ET.

					Regional/Supraregional	
End-use energy sector	Motive	Preference	Role	Technology	Variant 1: Direct trading	Variant 2: Distributed market
Private Households	I don't care about environment & Co.	Lower Energy Price	Consumer	none	<1%	<1%
		Gray Energy	Consumer	none	<1%	<1%
	Save money/Price consciousness	Self-sufficiency	Prosumer	PV-rooftop	<1%	<1%
			Prosumer	PV-rooftop + BSS	<1%	<1%
			Prosumer	PEMFC	<1%	<1%
		Lower Energy Price	Consumer	Flex. Load	10 - 30%	10 - 30%
			Prosumer	PV-rooftop	5 - 30%	5 - 30%
			Prosumer	PV-rooftop + BSS	5 - 40%	5 - 40%
	I care more or less about environment & Co.	Self-sufficiency	Prosumer	PV-rooftop	<1%	<1%
			Prosumer	PV-rooftop + BSS	<1%	<1%
			Prosumer	CHP	<1%	<1%
	Environment & Co. are the most important thing to me	Renewable energy	Consumer	Flex. Load	5 - 20%	5 - 20%
			Prosumer	PV-rooftop	5 - 20%	5 - 20%
			Prosumer	PV-rooftop + BSS	5 - 20%	5 - 20%
			Prosumer	PEMFC	5 - 20%	5 - 20%
		Self-sufficiency	Prosumer	PV-rooftop	<5%	<5%
			Prosumer	PV-rooftop + BSS	<5%	<5%
			Prosumer	PEMFC	<5%	<5%
		Regionality	Consumer	Flex. Load	<10%	<10%
			Prosumer	PV-rooftop	<10%	<10%
			Prosumer	PV-rooftop + BSS	<10%	<10%
			Prosumer	PEMFC	<5%	<5%

Conclusions

It is proven that P2P-ET has benefits such as reduction of electricity bills, social welfare and can have even impacts on the distribution grid expansion costs as demand and generation can be balanced in a local or regional area by energy communities. With our qualitative content analysis two promising P2P market structures scalable on a region-wide area are depicted. Moreover, a classification of prosumers with a willingness to participate into these P2P structures based on the end-use energy sectors, motives and preferences is presented as well. Finally and in order to build consistent scenarios, four main descriptors related to P2P-ET are proposed within this study. Although positive impacts of P2P-ET are assessed, also the disadvantages of social, political and legal barriers are addressed, in order to provide the necessary framework to stimulate P2P dissemination on a country-wide area.