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POLICY BRIEF

Peer-2-Peer in the Electricity Sector: an Academic Compass in the Making

By Jean-Michel Glachant, Florence School of Regulation

Highlights

What is "Peer-2-Peer"?

- It is a new form of trading between small players: buyers and sellers. It became possible about a decade ago with a new wave of digitalization (internet, smart phones, cloud computing…) where small buyers and small sellers are easily able to meet, match, and trade.

What are the three pillars of P2P trade?

- P2P trade is demanding and builds on three pillars. 1° A "Pricing mechanism" able to give enough incentives to both small buyers and small sellers to trade in small-size units of goods. 2° A "Digital Transaction Loop" which permits these buyers and sellers to easily search for each other; match expectations; settle on quantities, characteristics, etc.; plus a dispute-resolution mechanism. 3° A "Delivery Loop" is as important as the transaction loop, because any trade will only satisfy the buyer if the delivery meets all his or her expectations.

How do the three pillars of P2P trade work in the electricity sector?

- P2P trade is specially demanding in the electricity sector. 1° The "Pricing mechanism" has to deal with very small units (kWh); with fluctuating values, which change according to time and location. 2° The "Digital Transaction Loop" has to find ways of lowering the costs of trading so small units can pass between small non-professional players. 3° The "Delivery Loop" is a perfect twin for the transaction loop only for private grids. On 'public access' grids, all the rules of connection, operation, charging, metering and billing are regulated and conceived for B-to-X trade: B2B or B2C; not for P2P.

How modular is P2P in the electricity sector?

- P2P requires three pillars to work in the electricity sector, but none of these pillars can be built by small buyers and sellers. P2P calls for something else to happen. It can be individuals grouping to together to act as one (Cooperatives, Energy Communities). It can be start-ups acting as 'Third Parties'; or creating new businesses for bigger players: either incumbents or new entrants. It can be grids becoming monopsonyic buyers. This explains why P2P does not yet have a regular design in the electricity sector. Furthermore, regulation always plays a key role in electricity, as markets, contracts, grids, etc. are all framed by public or private rules for B2B or B2C, ignoring or discouraging P2P. Then the immediate future of P2P does not seem to be primarily created by peers meeting peers for trading. Rather, it depends on getting the three pillars of trade up and running with P2P compatible rules.

Introduction: What is "Peer-2-Peer"?

"Peer-2-Peer" is a relatively new business and academic research area. Airbnb came on the market only in 2008; while BlaBlaCar became a mobile app and Uber was founded in 2009. What is "Peer-2-Peer" about? Obviously, it touches on trade from a peer to another peer: a trade among equals; or, if not true equals, at least similar-level agents within a particular area of the gigantic world of trade. Trading between similar agents means, logically, a particular type of trade. And we all know that "B-2-B" (*Business to Business*) is a category. The buyer (being a "B") has the size, the skills and information-access, plus the interests to invest in a special framing of his or her relations with other sellers or "Bs". Oliver Williamson, a Nobel Laureate in economics, made all this very clear in his seminal "new institutional economics" in *Firms, Markets, Relational Contracting*, 35 years ago.

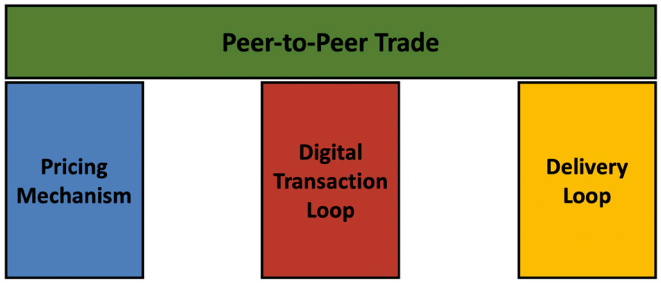
But "B2B" is not "P2P". This is intuitive. The "peers" Americans refer to, are not the respectable Peers of this or that "House of the Lords". They are much smaller. They are "guys": *P2P* meaning primarily "Guy2Guy". *P2P* /Guy2Guy trade is about trading between agents of similar types and of a similarly small size. We have long known this in my generation of European Baby-Boomers: the baker, the butcher, the plumber, the hairdresser, the doctor, the taxi-owner, the café-owner, the Bed & Breakfast owner, etc. Questioning us about the "size of an individual" is precise enough to characterize "P2P".

Indeed, what Americans, and the entire world after them, started to call *P2P* does not cover all trade by individual buyers with self-employed producers or within their small enterprises; but, rather, it covers only a new type of Small-2-Small trade. Typically, in the 20th Century, small buyers and small sellers were limited to local Small2Small trade; in local areas in small size markets. Here the new wave of digitalisation, with broadband Internet, laptops, tablets, smartphones, thousands of apps… plus Cloud computing, have revolutionized matters. By lowering the costs of searching, matching, delivering, settling, and dispute-resolution… for many categories of "Small2Small" trade, be they already old (e.g taxis, or Bed & Breakfast) or brand new (like electricity). Another Nobel Laureate, Jean Tirole, in his 2017 *Economics for the Common Good*, already noted that digital platforms were turning, in retail markets, the impossible into the possible. Our 21st digital world is visibly able to challenge an old type of retail market impossibility: an over strong asymmetry of knowledge and information between buyers and sellers, which prevents buyers from buying. What a third Nobel Laureate, Akerlof, addressed fifty-years-ago in his acclaimed *Markets for Lemons* – the market for second-hand cars – in 1970.

1. The Three Basic Pillars of P2P Trade

The new retail world, made possible by the recent wave of deeper digitalization, goes beyond "B2C" (Business-to-Consumers): in a kind of "C2C" (Consumer-size seller-to-Consumer-size buyer). However, to make this new type of market work, three basic pillars are needed (see Fig. 1).

Figure 1: Three basic pillars of P2P trade.



1. First, an adequate "*pricing mechanism*" is required for attracting demanders and suppliers in a converging frame of product valuation. Both buyers and sellers have to have enough economic incentives to be willing to trade. But this has been known since Adam Smith, who was not expecting his butcher, brewer, or baker to work outside their own zones of self-interest. The fact

that a pricing mechanism is needed, is a characteristic of any market. This does not strongly define what *P2P* has to do to be able to trade.

2. A second pillar is of the highest importance, and the core of the digitalisation renewal of "Small-2-Small" trade between peers. It is the "*digital transaction loop*". The set of tools used to lower the costs of transacting, by facilitating: the search (for products and their suppliers); °the match (between the buyer and a seller); °the settling (of any transactions); °plus the establishment of a frame to deal with possible *ex-post* disputes (which, in turn, adds to the *ex-ante* credibility of any trade). Given the small size of both buyers and the sellers, reducing these costs and increasing the credibility of their deals are necessary pre-conditions for the take-off of *P2P* trade. It is why, the "digital transaction loop" acts as a magic tool in *P2P* trade.

3. However, a third pillar is of similar importance. It is the "*delivery loop*". That is the set of assets and operations by which the product is actually delivered to the buyer, after having being contracted with from a seller. Again, given the small size of both sellers and buyers, if the buyer does not come to the seller's premises to take away the products (or the services), then the "delivery loop" becomes as important as all the other tools put together in the "digital transaction loop". Intuitively we know that, as long as the product is not delivered to the buyer, with all the characteristics expected at the matching stage, the trade proves unsatisfactory: it might end up being contested, interrupted, disputed, and, of course, it would not be repeated again.

2. P2P Trade in the Electricity Sector

In the new 21st century world of peers, where small electricity buyers can look for small electricity sellers, each of the three pillars of *P2P* trade has particular features. Let's take the case of PV generated electricity to illustrate why.

1. The *pricing mechanism* has to be adapted to very small quantities of the goods in question, and to its intermittent delivery by the seller. A typical size unit on the seller side, is 0.5kWh to 1kWh, with a notional reference price of Euro 0.025 to 0.05. The supply is intermittent by nature (like renewable energy), and also submitted to another type of variability, namely the seller's own intermittent self-consumption. The pricing mechanism has to adapt to the specifics of supply, while taking into account the varying value of supply at different times of the day, or of the week etc., from the buyer's point of view. The few experiments being run also showed that the prosumer-sellers do not have a uniform elasticity in the prices being offered. Some prosumer-sellers have very low-price elasticity. Others have more price elasticity, but with significant elasticity thresholds, governed by the "preference for self-generation and self-consumption" that storage can mitigate, though only partially. On the buyers' side, some have a pure "price reaction" like a classical rational consumer; but others react to the local nature of the supply, and even to the identity of the individual supplier. Defining the best "Pricing Mechanisms" for *P2P* is still an open field for experiment and research. Some may think that the wholesale power market already sends all the fine granular price signals needed; but here there is the danger that we forget that PV electricity is very local, meeting very local peaks in generation, or in consumption – in a very local system, balancing conditions or grid congestion issues.

2. The "*digital transaction loop*" has similar particularities, but within its own dimensions of transaction. Permitting small buyers and small sellers to trade their small units, in the range of Euro 0.05 each, but with strongly local characteristics

(Williamson would have said "*with notable asset specificities*"), requires an effective and precise transaction process. This, note, is well beyond the capabilities and resources that each small agent can individually have or that, indeed, they can rationally acquire.

Of course, digitalisation helps critically in this regard. What is created there, for that local area, can be reproduced somewhere else, for other local areas; because a robust digital application with adaptable parameters can easily be reproduced and can easily spread. Of course, there are already families of apps having demonstrated, in other businesses, that they can deal with multiple individual trading parties with no heavy central administration, hence no heavy costs: the "*blockchains*". But, in the institutional economics of trade governance, this mechanism for supporting trade is called a "*Third-Party*". The electricity small players cannot individually build the "digital transaction loop" that they need to be able to trade. For example, when building a single new house, an individual would call an architect to get an implementable plan for that house and monitor its construction through various specialized tradesmen. However, this "Third-Party" is not an "*intermediary*"; in the sense that it is only the "*agent*" of the "*principal*" or consumer. But, as a "Third-Party", it also has to make its living from the trade services delivered to the individual small players. Here two sets of business plans have to work together: those of third parties, and those of trading individuals.

These small players cannot individually build a full "digital transaction loop", the loop needed to make their Small2Small trade work. However, they can join together to act jointly… It might be a traditional cooperative (like the one I am a member of in Paris, installing its own PV panels on school roofs). It can also be a proper "*Energy Community*", of the type that European Law has allowed since the adoption of the "*Clean Energy Package*". Again, because of the particular rules governing cooperatives and Energy Communities, one can welcome both of them as forms of "Third-Party", acting as the agents of their "principals" namely the individuals. Cooperatives and "Energy Communities" can regroup in alliances to reach an operational size large enough to create their own apps or blockchains. Alternatively, they can remain small, and benefit from the applications and blockchains developed by external providers.

We can now add another layer to this reasoning. The providers of ready-to-use "digital transaction loops" for cooperatives and communities, can also set up their own *P2P* businesses. They can do so either to make additional money; or to test other variants of pricing, searching, matching, settling, and dispute resolution than what their "principals" prefer. Some of these innovative providers are real "start-ups": not making much money on their billing; but building an operating unit to sell later to a bigger player, be they an energy incumbent or a new entrant.

We then end up with incumbents having pockets large enough to launch their own "digital transaction loops". This does not mean that it is a sound business model for all. New entrants, too, can have a large enough size, like the many European oil and gas companies so keen to diversify (Equinor, Total, BP, Shell…); but the same reservations apply regarding the accuracy of the *P2P* business model for players of this type.

This is why the landscape for "digital transaction loops" building, ownership, and day-to-day management still looks very open, and moves so fast.

3. The "*delivery loop*" is the other critical pillar, without which *P2P* electricity simply cannot work.

Within a private network, be it inside a multi-level building, or a multi-building property, or any other ambitious microgrid or minigrid, the "delivery loop" can be conceived as working closely with the particular "digital transaction loop" built by the property owner(s) or the manager.

This is not the case anymore when a "digital transaction loop" intends to work among individuals connected to the "public access" network. Public networks are regulated, and function with rules set for the "B" side: the established generators and suppliers. They can easily deliver "B2B" and "B2C"; they are alien to the too many particularities characterizing "C2C" transactions among peers.

The famous "Brooklyn Microgrid" (BMG, launched at the end of 2015) attempted to create a new private DC grid, to bypass the established AC network owned and operated by the Edison company; but it never managed this. After "proof of concept' between two neighbours in 2016, BMG became a registered corporation, cooperating with Edison to produce integrated bills, for about 100 participants in a larger trial. Each of these participants needed a special Siemens meter and communication device, embedded in a private blockchain. Then BMG applied for a "regulatory sandbox" in 2019, to start with 200 consumers and 40 prosumers in 2020. This world-famous case illustrates two key issues faced by P2P when entering "public access" networks.

First, there is a settlement issue; which originates in the previous "pillar" of "digital transaction loop". It is possible to install private meters, on top of publicly-regulated ones, as BMG did, meters which fully synchronize injections from small sellers and withdrawals from small buyers (using a proxy for the grid losses). But this won't work well because the public metering system will automatically bill any flow between these small sellers and buyers, with its own "B2C" rules, ignoring any direct trade from a non-registered trading party. It would be technically possible to trace official "public" bills, and to reconcile them with private unofficial billing. However, this might take the transaction costs among small parties up to unreasonable levels.

A second issue is, indeed, a typical physical "delivery loop" issue: local grids have their own constraints on injections and withdrawals; particularly with PV; most of the time added to a distribution network having not being conceived to host injections. Not knowing the state of the local grid, not grasping how the local grid secures the flows, balances the load, and manages congestion, would create significant uncertainty about the actual delivery of privately-contracted *P2P* goods. This kind of "Russian roulette" would deter the establishment of confident long-term relations between small buyers and small sellers. *P2P* trade is, in fact, submitted to the regulated grid's veto, when there is no private "delivery loop" working. On "public access" electricity networks, there is no Amazon company capable of building a private "delivery loop", fully mastered by its "digital transaction loop" twin.

This duality between two fundamental pillars, both being necessary for *P2P* take-off, can be significantly reduced when a public access network voluntarily opens to Peers interested in selling, with the network acting as a monopsonyic buyer. This is a third dimension: not fully *P2P* anymore, but "*Peers-to-Grid*", or "*Peers-to-X*". This new dimension is already well known in the advanced world of flexibility procurement, where grids can launch their own subsidiaries, or rely on "Third-Party" platforms implementing it as a "delegated service".

3. The Significant Modularity of P2P in the Electricity Sector

In twenty-first-century electricity, *P2P* is becoming noticed; while it had no meaning ten years ago, or was only a notional concept for thinking outside the electricity models of that time.

It is not yet possible to give a uniform description of what *P2P* is and how it works, because many options exist, even on the smallest scales, upturning the issue of their scalability. In this short paper we also have simplified reality by referring to domestic rooftop PVs (2 to 4 kW); we have ignored larger scale PV like 100kW (requiring 600 square meters: shopping malls, hospitals, factories); and wind (500 kW to 3

MW for a single wind mill). Also, when public grids go to open flexibility procurement, they look for MWs not kWs; but communities and cooperatives can aggregate to reach that threshold…

However, this paper established that all P2P systems have at least three pillars: 1° a *pricing mechanism*, without which buyers and sellers would even not consider trading; 2° a *digital transaction loop*, which very dramatically lowers the costs of transacting small units between small size parties; and 3° a *delivery loop*, which implements the trading decisions contracted between peers. The existence of these three pillars shows that *P2P* trade is modular by nature, and that it can exhibit many different working designs, and many different operational architectures. Initiatives to open *P2P* trade can come from: innovators (inventing digital transaction loops); from small parties (regrouped in cooperatives or communities); from pro-active or reactive incumbents or new entrants. It can even come from regulated public grids looking for peers eager to sell them an appropriate service (like "flexibility").

Many different players are able to take initiatives, and create new options, or new models, to test novelties or to reproduce already working *P2P* rules and tools. However, initiative is not enough to succeed in the *P2P* world. Too many parts of the electricity sector are already regulated: the "B2B" market design, the "B2C" market design, the distribution network, the transmission network, the operation of the power system, as well as the legal framework for supply business and supply contracts; the relevant charges and taxes; etc. Producers of public rules, be they governments, energy regulators, system and market operators; business associations; etc., hold enough keys to impede any *P2P* take-off. Either by prohibiting; or by keeping blocking rules; or by involuntarily, or astutely, increasing the costs and the uncertainty for trading among peers to levels that will deprive *P2P* of any significant role in the electricity sector.

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Florence School of Regulation
Robert Schuman Centre
for Advanced Studies

European University Institute
Via Boccaccio, 121
50133 Florence
Italy

Contact:
email: fsr@eui.eu website: fsr.eui.eu

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