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Perspective

Valuing the value: An affordances perspective on new models in the electricity market

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ABSTRACT

Prosumers can actively participate in electricity markets through new market models. Peer-to-peer, community self-consumption, and transactive energy are the three market models which are said to complement traditional electricity markets, enabling prosumers to create and capture value. To date, however, the characteristics of these models and incentivisation opportunities for prosumers cannot be easily distilled. Here, we propose a framework to distinguish between these market models based on involved parties (peers, communities, and grid operators) and traded commodities (electricity and flexibility). Furthermore, we compare the capacity of the different models in value generation for and by prosumers, which extend beyond financial benefits, by differentiation. In doing so, we systematically draw out the value generation potential in the dynamic between market models' capacities and prosumers business models. In doing so, a larger number of prosumers can be engaged and empowered in becoming active market actors, stimulating the ongoing energy transition towards achieving sustainability goals.

1. Introduction

Adverse results of climate change which increasingly manifest around the globe [1] have made fighting against climate change an international mission [2], illustrated by the European Green Deal [3] and Paris Agreement [4]. Energy transition as a path from 'status quo to the envisioned future' [5] is said to be one of the most effective preventive acts in support of this mission [6]. New market models based on decentralized energy production, which mostly entail citizen engagement, are said to be an effective means to foster energy transition, in the electricity market [7]. In particular, peer-to-peer (P2P), community self-consumption (CSC), and transactive energy (TE) models are three promising models that have attracted a lot of political and scientific attention [8]. Technical challenges of these models (e.g., impacts on the electricity grid, technical requirements), security and privacy aspects [9], data protection issues, legal requirements [10], business models [11], and energy justice issues [12] have been extensively studied in recent years [13]. Aligned with this momentum, new market models have been the center of attention in several recent publications in this journal (see [14–17]) and others. Taken as a whole, these works have generated important insights into understanding the technical, legal, and market design aspects of the new market models, mostly explored in pilot studies [18,19].

While, in their own right, valuable insights have been produced, systematic attention concerning the explicit role, or status and organization of stakeholder dynamics underlying the integration of prosumption into the mainstream business of electricity markets, is still in the developing stage (see e.g., [20–24]). In fact, the prevailing market model approach does not sufficiently incentivise prosumers to participate in P2P, CSC, and TE models which, arguably, generates a wider range of values than just financial benefits [25,26]. Nevertheless, the value generation capacity of these models has not yet been explored much. This is, arguably, a limitation to be addressed as the value generation potential is said to be the key element that can draw a larger

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number of prosumers and empower them in becoming active 'market actors' [27]. Furthermore, in conjunction with the existing literature, a clear comparative distinction of these models' potential values also needs to be identified to make them applicable on a large scale [7]. Essentially, new business ecosystems (i.e., the new market modes) will not emerge unless sufficient attention has been paid to the antecedents (e.g., citizen engagement) and consequences (e.g., value generation) alongside technical and other requirements, yet, affordances of new market models, in a comparative approach, have not been systematically investigated. Two key elements can be distilled as essential factors which make these new market models successful. First, the prosumer side and the value they gain - which depends on their involvement. Second, the capacities of the market models - what types of values these markets can offer to prosumers. In this view of a lack of options and capabilities for active participation in the market, the traditional electricity markets treated people as mere passive. However, participation in new market models can potentially transform them into active market participants, or 'prosumer' hereafter. An increasing interest can be detected in the literature, for example, a review of previous studies [11] identifying a diverse range of business models [83] in the (future) electricity markets. While taking an affordances perspective [28] is not new per se, to the best of our knowledge, it has not been applied to emerging market models for electricity trading, and which were taken up by the study at hand.

New market models, particularly, P2P, CSC, and TE models[1] are ailed as promising new market models benefitting prosumers - be it financial, independence from retailers, climate protection, etc. [29], P2P, CSC, and TE models[2] are not only seen as complementary alternatives for traditional retail markets, but they may also alternate and compete with each other in some situations. Hence, it becomes important to highlight the alignments and contradictions between them. Furthermore, it is necessary to delineate their respective positions in the dimensions of the traditional electricity markets and, if necessary, expand the dimensions of the electricity market to incorporate these models and, at minimum, accept the contradictions between the traditional and new market models as well as among the three new market models as such.

Despite the merits of previous categorizations, at present, a framework to distinguish the new market models for the purpose of comparing their value generation capacities is lacking. Through an inductive approach we propose a theoretical framework that seeks to explain new market models for electricity or flexibility trading [30]. Subsequently, we utilize the proposed categorization of market models to empirically identify new market models' affordances in generating different types of values. In doing so, this study can contribute to the energy transition literature by proposing a theoretical framework [31] to delineate new market models for electricity trading. Subsequently, building on the framework, we identify different values that market models can generate, and compare different market models' affordances in generating a diverse range of values, indicative of the impact of applying this framework in the 'real world'.

The remaining part of this perspective is structured as follows. In Section 2, we contextualize the study and provide the background. This is followed in Section 3 by discussing the P2P, CSC, and TE market models. They are introduced as complementary market models which, arguably, widen prosumers' options in electricity trading highlighting their business model potential. Section 4 presents a framework, to, on the one hand, distinguish between the models based on involved parties and traded commodities and, on the other hand, to investigate different models' capacity in generating various types of values for prosumers. Section 5 discusses how the capacities of the various identified market models assist prosumers to develop, employ and adjust their involvement, and corresponding to business models. Section 6 provides an in-depth discussion where main propositions are synthesized and summarized. Finally, Section 7 concludes the perspective.

2. Opportunity structures in the electricity market

In recent years, the prosumption concept in the electricity market has gained renewed attention associated with the, increasingly, so-called 'participation society.' This and other terms, concepts, and models have been coined in diverse lines of research ranging from business, to legal, to economics, to media and communications, to capture this 'participatory turn' more widely, such as 'user-driven innovation' [32], 'commons-based peer production' [33], and 'wikinomics' [34], offering a new, or, alternative logic of firm-user dynamics that favor new over old production-consumption configurations. More specifically, these assume a remodeling of the 'opportunity structures' by which people can take part in a progressively mediatized society with particular attention to open and distributed (often, firm-hosted) platforms that are said to be empowering, and are the way of the future (cf. [35,36]).

In the electricity domain, some consumers, and particularly, prosumers can be seen to increase their capacity for self-organization. This, in turn, increases their capacity to solve shared problems on their own, from the bottom up. At the same time, those who are participating are reshaping the relationships between private (commercial) and public (communal) entities, with important implications for market structures and governance [37]. Previously, there were no such 'opportunity structures' in the electricity market context. In fact, people were considered passive actors, and even if they were electricity producers, they could only inject their excess electricity into the distribution grid for zero or fixed low rewards and were price-takers without considerable individual negotiation power on the price nor on whom to sell their surplus electricity [7]. With only limited decision power, having a business model for active market participation was not considered necessary.

However, technological breakthroughs in production of high capacity batteries and solar panels at low prices (which makes them more affordable) and prevalence of smart devices (such as smart meters, home energy management systems) have facilitated the emergence of new market models and are providing more options allowing people to actively participate in electricity markets. More specifically, with this combination of possibilities provided by the current electricity landscape, they not only have more flexibility, but can also play a more substantial and active role in electricity markets [25]. In this view, new market models are by-products of technological advancements. Regardless of whether the new market models are the source, or the result of technological advancements, participation of so-called prosumers - associated with agents' practices of both consumption and production - in new markets provides options for them, which formerly did not (much) exist [38].

As demand and supply for electricity must match at all times to keep the electricity grid running, traditionally the grid operators have been using the services of large producers and consumers to adjust the available supply/demand to keep the grid in balance (i.e., balancing market) [39]. Moreover, most of these big players have been also used by the grid operators as `reserves` (capacity market) - being available to rump up supply/demand if needed [40]. As these services are critical for keeping the grid in balance, the rewards for the big players have been also significant. However, none of the small players (consumers/prosumers) could tap into these markets due to the limited service volume each could provide as well as the lack of means to measure their service provision. With the introduction of smart meters the latter limitation has

[1] Electricity markets are categorized type-wise here. Another way of looking at electricity markets is the time-wise division; future, day-ahead, and intraday markets. Any trading on the consumption day is considered intraday, the day before consumption, day-ahead, and before that is considered a futures market.

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been addressed, while the former one has also been addressed by aggregating the services provided by each consumer/prosumer, opening a door of opportunities for the consumers and prosumers not only to tap into the balancing and capacity markets, but also to participate in new markets.

Consumers and prosumers first started providing demand response [41] services to grid operators via aggregators, essentially participating in the balancing market, and then slowly eliminating the aggregators by providing services directly to the grid operators, thus forming the TE market models [42] (i.e., consumers and prosumers competing to provide balancing services to the grid). Inspired by this transition, consumers and prosumers aspired to provide services (i.e., trading electricity) to each other too, creating the P2P market models [43] (where consumers/prosumers compete to provide services to each other). Providing services to each other has also unlocked the idea of cooperating with each other to increase their autonomy as well as to provide services to the grid operators as a group, thus creating the CSC market model [44].

3. Emerging prosumer-centric electricity market models

In the literature increasing attention can be detected that focuses on various (emerging) market models that define themselves as being P2P, CSC, TE, or a combination of them.[3] In particular, attention has been given from the electricity grid structure [45], to legal [46], to hardware, software and data [47], to security and privacy [48], and to market structures [19]. A common element between the models is encouraging and incentivising prosumers to have a more active role in electricity markets. Typically, this is achieved by allowing prosumers to trade commodities (electricity and/or flexibility) with other market participants such as other prosumers, communities, and grid operators in return for some (financial) incentives. However, among the key differentiators are the overarching objectives behind these market models, which are described next.

Peer-to-Peer (P2P) models enable mutual transactions among different entities to trade electricity [49,50]. Energy traders in the P2P market models may be of different sizes, i.e., residential houses, neighborhoods, microgrids, and local distribution network operators [49,51]. It is said to let the grid take advantage of demand-side flexible resources operationally and economically [52]. In P2P models, the objective of the market mechanism is to incentivise transactions that prioritize maximizing the benefits of individual prosumers [53]. Such models could involve intermediate parties that facilitate trades among prosumers or support fully decentralized trades among them. The market mechanisms used in P2P models usually are set to optimize the trading based on algorithms with objectives of matching the excess supply of prosumers with the demand of consumers.

For **Community Self-Consumption (CSC) models** the overarching goal is to gain independence from centralized electricity generation through pooling and governing of dispersed resources in communities [54]. Community members operate in a collaborative manner [55] to optimize usage of resources [56]. CSC models incentivise transactions that prioritize maximizing the benefits of the community. A community manager is typically involved [56] who coordinates transactions within the community as well as the transactions with other communities or the main grid. The market mechanisms used in CSC models are set to optimize the trading based on algorithms with objectives, such as minimization of the electricity the community imports from the main grid, maximization of the revenue for the community. They usually involve sharing the individual prosumers' assets [84] among each other or aggregating all the assets within the community in order to maximize the benefits for the entire community.

Transactive Energy (TE) models are based on demand response,[4] where prosumer loads/supplies are automated and engaged through market-based interactions [57,58]. They provide market access to flexibility providers, and a support tool for the grid operators to manage technical complications [59]. It is a distributed control strategy that uses market mechanisms to engage self-interested responsive loads/supplies to provide services to the grid [60]. The objective of the market mechanism is to incentivise transactions that prioritize and support the stability and reliability of the grid [61]. As the grid operators are the main actors who are responsible for maintaining the stability of the grid, they are usually the primary participant in the market buying flexibility from prosumers directly, or via aggregators [62]. The market mechanisms used in TE models are set to optimize the trading based on algorithms with different objectives, such as keeping the grid in balance, reducing grid congestion, maintaining the voltage and frequency stability, and so forth.

Apart from the different objectives of market models, the main two differentiators which can be distilled are the parties involved in each model and what is being exchanged between them. These are discussed next.

4. Framing the P2P, CSC, and TE market models

For the purpose to classify possible transactions between different market actors, and to categorize the transactions in different market models, a conceptual treatise of the P2P, CSC, and TE market models has been developed, thereby highlighting the differences between the models as well as in what situations they are likely to align or contrast. This framework is guided by two parameters: the types of involved trading parties and what is being traded. These two parameters help us to cover all the scenarios for transactions between different market actors.

Typically, there are four main parties affecting/being affected in the trading practice: *peers*,[5] *communities*, *grid operators*, and *retailers* [63]. The first two actors are the main two emerging actors due to the decentralized nature of the emerging market models. The other two actors are the currently dominant actors in both electricity and flexibility trading markets whose roles are expected to be challenged by active participation of the other two mentioned actors. '*Electricity*' and '*flexibility*' are possible commodities to be traded between the participants [63]. The first three mentioned actors are the main participants in the new market models. Retailers are the main actor in the traditional (retail) markets. When market participants have electricity surplus (or, need electricity to satisfy their demand), they can participate in markets to trade electricity. When market participants have flexibility to offer, in other words, are able to decrease or increase their supply/demand based on external signals (e.g., price), then they can trade flexibility. In other words, the participants respond to the needs of the grid (or other market participants) and get rewarded for that.

Trading 'electricity' and 'flexibility' are quite similar as in both cases participants feed to or withdraw electricity from the grid. The key difference can be found in the reason why they do this. In electricity trading, the main motivation tends to be related to the needs of prosumers [64]. Prosumers may have extra electricity or need electricity to meet their demand. Therefore, they trade (buy or sell) electricity. In flexibility trading, the main reason tends to be related to the needs of the grid [64]. In other words, prosumers may be absolutely fine with not trading, as it is up to the external price signals to convince them to trade

[3] Some models combine more than one market model. In particular, P2P and TE are most often tied in a combined model. In other words, the market mechanisms are set to optimize multiple objectives – minimize grid impact (e.g., avoid congestion) and maximize prosumer benefits (e.g., maximize revenue/minimize cost).

[4] Demand Response (DR), prosumers' response to the needs of the grid, is a means, or service that allows flexibility to be traded.

[5] A peer can be a prosumer or a community.

their flexibility (to increase or decrease their demand). It becomes only compelling when (and 'if can') these two are combined - thus, trading electricity and flexibility at the same time. To illustrate, the following two scenarios are imaginable.

1) Prosumers predict that they will consume *x* amount of electricity at time period *t*, which they would need to obtain from somewhere. However, they also predict/anticipate that in time *t*, there will be more supply for electricity than demand, so the grid operators will be looking to buy positive flexibility (i.e., operators would pay prosumers to consume electricity) in *t*. If that happens, instead of being buyers of electricity (hence, paying for electricity), the prosumers become flexibility providers (hence, being paid for consuming electricity).
2) Prosumers anticipate that they will have *x* amount of extra electricity in time *t*, which they would need to dispatch. However, instead of participating in electricity markets, they anticipate that the grid operators will be looking to buy negative flexibility (reduce demand or increase supply), hence they participate in the flexibility market, where they provide flexibility (by supplying surplus electricity). In this case, the prosumers feed electricity to the grid, but instead of being sellers of electricity, they are flexibility providers, potentially increasing their revenues.

Below we provide an overview of the possible transaction types under Traditional (Retail and Balancing), P2P, CSC, and TE market models.

The retail market is the market for sales and purchases of electricity between distributed consumers and producers of electricity (i.e., prosumers and communities) and retailers of electricity (i.e., suppliers). Under the Retail trading models, the traded commodity is always electricity. Depending on who the seller and buyer of electricity is, Retail trading models accommodate the following types of transactions: i) between prosumers and retailers, and (ii) between communities (which most times are represented by community managers) and retailers. These scenarios that also incorporate the current retail markets happen when either a prosumer or community cannot participate in any of the P2P, CSC or TE market models or when their demand cannot be met in any of the P2P, CSC, TE market models; then the prosumer is left to the default option - buying from retailers, i.e., trading at the existing retail market.

Under the **P2P** market models, the traded commodity is always the surplus electricity.[6] Depending on who the peers are, P2P market model can accommodate the following three types of transactions: i) transactions *between two prosumers*, ii) transactions *between two communities*, and iii) transactions *between a prosumer and a community*. If both peers are prosumers, then a transaction between two prosumers (one with surplus electricity and another with a demand) takes place (most probably through a trading platform). If both peers are communities, then it is a situation where two communities (one with surplus electricity and the other with a demand) trade surplus electricity with each other. If one of the peers is a prosumer and the other is a community, then a transaction occurs between a prosumer and a community. This is a situation where a prosumer sells to or buys electricity from a community. In theory, the community can be the one that the prosumer belongs to or any other community. A market model that supports all of these types of transactions is also known as a hybrid P2P market [65]. In contrast to the CSC market models where the community (manager) decides (see below), it is the prosumer who decides what to do with the electricity and the community does not exert any influence over prosumer resources. Hence, while a prosumer can be a member of a community, prosumer behavior may differ depending on the type of the model their trade falls into.

Under the **CSC** market models, the trading commodity can be the electricity surplus or flexibility. There is only one type of transaction that can be accommodated by these models: a transaction between a prosumer and a community. This is a situation where prosumers share their *surplus electricity or flexibility* with the community. It is necessary that community members pass their control over their surplus electricity or flexibility to the community (manager). It is the community (manager) who decides what to do with the provided electricity and/or flexibility. In this case, the community has considerable control over prosumers' resources.

Under the **TE** market models, flexibility is the traded commodity. This type of model can accommodate the following types of transactions: i) transactions between a prosumer and grid operators, and; ii) transactions between a community and grid operators. When a prosumer provides flexibility directly to the grid operators, then a transaction between a prosumer and grid operator occurs. In this case, prosumers prioritize the grid stability to decide when and how much to use what

Table 1
Trading opportunities and domain of each model.

Sellers Buyers	Prosumer[1] (+)	Community[2] (+)	Grid operators[3] (+)	Retailers[4] (+)
Prosumer (−)	P2P (*e*)	P2P (*e*)/CSC (*e*,*f*)*	–	Retail (*e*)
Community[5] (−)	P2P (*e*)/CSC (*e*,*f*)*	P2P (*e*)	–	Retail (*e*)
Grid operators[6] (−)	TE (*f*)	TE (*f*)	–	Balancing[7] (*f*)
Retailers[8] (−)	Retail (*e*)	Retail (*e*)	–	–

Note: (+) stands for supply of electricity or flexibility and (−) stands for demand for electricity or flexibility. The letter in the parentheses indicates the commodity traded. *e* indicates electricity and *f* indicates flexibility.

* Prosumers pass their control over their surplus electricity or flexibility to the community (manager).

[1] Prosumers can supply electricity and/or flexibility to other prosumers P2P (e), to Community CSC(e,f), to grid operators TE (f), and retailers (Traditional_e).

[2] Communities can sell electricity to prosumers and retailers. They can also provide flexibility services to other communities or grid operators.

[3] Grid operators do not offer flexibility to anyone; they buy flexibility in order to keep the grid in balance.

[4] Retailers can sell electricity to prosumers and communities. They can also provide flexibility to grid operators. They can also sell electricity to other retailers at the wholesale market, which we leave aside in this framework.

[5] Communities can buy electricity from prosumers, other communities and retailers. They can use the flexibility services offered by prosumers or other communities.

[6] Grid operators can buy flexibility from prosumers, communities and retailers. Retailers, Generators and large consumers are the main flexibility providers in the current market setting.

[7] The balancing market is a real-time trading market for electricity controlled by Grid operators. It is used for matching the supply with the demand and/or alleviating any transportation/delivery issues on the transmission network during a settlement period.

[8] Retailers can buy electricity from prosumers and communities. In fact, they can also buy electricity from other retailers at the wholesale market. They are also forced to buy electricity from grid operators at the balancing market if they are short of supply. We kept the wholesale and balancing markets out of the picture in this perspective.

[6] If the demand is high (hence the offered price is high), one might even sacrifice their comfort (i.e., reduce their own demand in order to generate surplus electricity.)

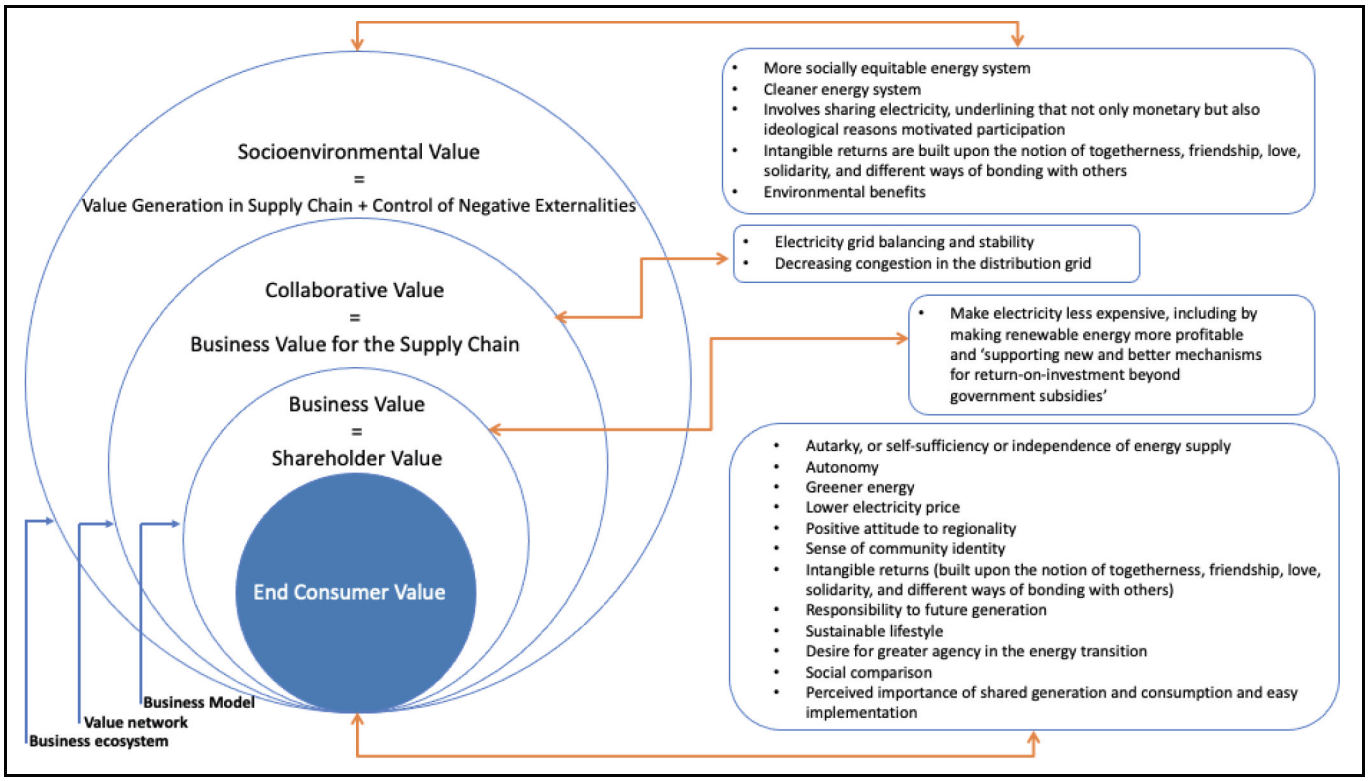

Fig. 1. Value proposition of P2P, CSC, and TE models for electricity and flexibility trading [7].
Note: Each circle represents the limits of different tools (see the left bottom of the picture).

appliances. If a prosumer provides flexibility to the operators via a community, then a transaction between a community and grid operators occurs. This is possible due to the community's resource pool, which is the result of unifying community members' resources.

Table 1 presents an overview of the proposed scenarios for the Traditional (i.e., Retail and Balancing), P2P, CSC, and TE market models. From a prosumers' perspective, it draws out different choices based on which they can decide to participate in electricity or flexibility trading as it maps the options described, under P2P, CSC, and TE models, which are likely to widen citizens' inclusion in value co-creation in electricity markets. In addition, it shows three scenarios associated with traditional electricity trading which entails prosumers or communities' purchase of electricity from retailers, or prosumers or communities selling their surplus electricity to the retailers[7] as well as grid operators purchase flexibility from retailers.

5. Capacities for value generation

As differences between involved parties in 'trading' as well as 'traded' commodities delineated different market models, market models have also been found to differ in type and degree of values (e.g., social, economic, environmental) which they can generate. More specifically, they hold different potentials for value generation, and may, therefore, be taken up differently according to prosumers' preferences [18]. In this view, participation in a market model is a means for value generation and capturing by and for the participants. Prosumers, who may have different preferences at different times, utilize different market models, which have relatively limited, and to some extent, clear affordances in value generation and capturing. Accepting this view, a business model could be a tremendously valuable tool to reflect prosumers' preferences in their market models' selection. More specifically, here, "a business model describes the design or architecture of the value creation, delivery, and capture mechanisms [a market participant] employs" [66] (p. 172). Thereby, participation in a market model is a match between prosumers' business models [11] and market models' capacities. Consequently, an investigation on values both from the human side (i.e., prosumers' side) as well as market models' capacity is helpful to establish a complete picture of prosumers' participation in new market models.

The study of human values, or 'what is important to us in life' [67] (P. 3), has long been a research topic in social sciences and humanities. While, on the one hand, some human values appear to be universally held, on the other hand, they are also extremely subjective and context-sensitive. Each individual and group holds their own subjective subset of these values which vary in importance [67]. Thus, social values are inherently normative, and may be contested by different groups and at different points in space and time. Not only the value generation capacities differ across market models but also, as shown in Fig. 1, the generated values by each model cover a wide range which are categorizable in different levels [68]. Prosumers participate in market models with the highest capacity for generating their favored types of values. Prosumers' business models [11] dictate their decisions with regard to

[7] It is also possible that this happens by reverse turn of the prosumers' meters (mostly for the pre-smart meter generation).

Table 2
P2P, CSC, and TE models potential in generating value for prosumers.

Prosumers' value[a,b]	P2P			CSC	TE		Traditional	
	i	ii	iii		i	ii	Retail	Balancing
Autarky	M	M	M	H	M	L	L	L
Autonomy	M	L	M	L	H	H	L	L
Green energy	H	H	H	M	L	L	L	L
Lower electricity costs	H	M	H	M	M	L	L	L
Positive attitude to regionality	M	H	H	H	L	M	L	L
Sense of community identity	M	H	M	H	L	M	L	L
Responsibility to future generations	H	H	H	H	H	H	L	L
Sustainable lifestyle	M	L	L	H	M	M	L	L
Desire for greater agency in the energy transition	H	M	M	M	L	L	L	L
Social comparison	H	M	M	M	L	M	L	L
Perceived importance of shared generation, consumption	M	M	M	H	L	L	L	L
Easy implementation	L	L	L	M	M	M	H	H

[a] Different scenarios for each market model as explained in the previous section.

[b] Note: Autarky refers to self-sufficiency or the proportion of energy demand met by the prosumers consuming their own energy, or independence of energy supply [71]. Autonomy refers to a way for individuals and communities to take ownership of sustainability; It implies the sense of oversight and decision-making power [72]. Green energy (Kubli, Loock and Wüstenhagen, 2018) refers to more environmentally- friendly produced energy. Positive attitude to regionality [72] refers to benefits for local communities or regions [73]. Sense of community identity refers to intangible returns built upon the notion of togetherness, friendship, love, solidarity, and different ways of bonding with others [74]. Responsibility to future generations refers to environmental benefits which are often cast in ethical terms [75]. Sustainable lifestyle refers to environmental benefits in cultural terms [76]. Desire for greater agency in the energy transition refers to new roles and relationships that the participant can have in these models [73]. Social comparison refers to people comparing themselves with their peers [77]. Perceived importance of shared generation and consumption and easy implementation are mentioned in contrast to financial factors [72].

value generation and capturing [69].

As this field is still very much under development, only limited real-world trials have thus far been conducted [14]. These are complemented by studies based on surveys and interviews which have set out to explore expectations rather than experiences or practices with P2P, CSC, and TE models [70]. To provide a better understanding of the potential of the three models in generating value, Table 2 conducts a comparison of the new models as well as traditional models in terms of the capacity of each model to generate different types of values. The first column shows the prosumers' intended values. Each column ranks different scenarios under each market model, as explained above, - Low (L), Medium (M), or High (H) - based on their capacities in generating that specific type of value. The ranking of the models was based on the potential of each of the market models to provide the prosumers' values. For example, in the case of autarky (i.e., self-sufficiency), traditional models score Low as prosumers depend on these markets; P2P and TE models score Medium and Low as prosumers, although less dependent on the traditional markets, they are more self-sufficient as they have more flexibility in these markets models; while CSC models score High as by definition these market models aim for self-sufficiency.

As these market models can coexist together, they provide prosumers with choices to trade their electricity or flexibility. From a prosumer perspective, this might result in an environment that derives value from their (active) participation. Consequently, prosumers' active participation also increases the aggregate supply and demand for prosumers' electricity, or flexibility. Moreover, by framing market models in this way, prosumers can choose their preferred market model based on what they value most. Thus, for example, more 'profit-driven' prosumers may choose to participate in a specific market model which focuses on maximizing individual benefits. While, more 'environment-conscious' prosumers may choose to have a more active participation in a model which prioritizes grid stability, while more 'community-oriented' prosumers may choose a model which is ranked higher on community-related capacities. Coexistence of several market models, however, may not be necessarily beneficial from the grid, or community perspective as some of the P2P models may cause additional grid congestion [78] or may result in a concentration of value transfer to only a few prosumers while increasing the costs for less active electricity grid

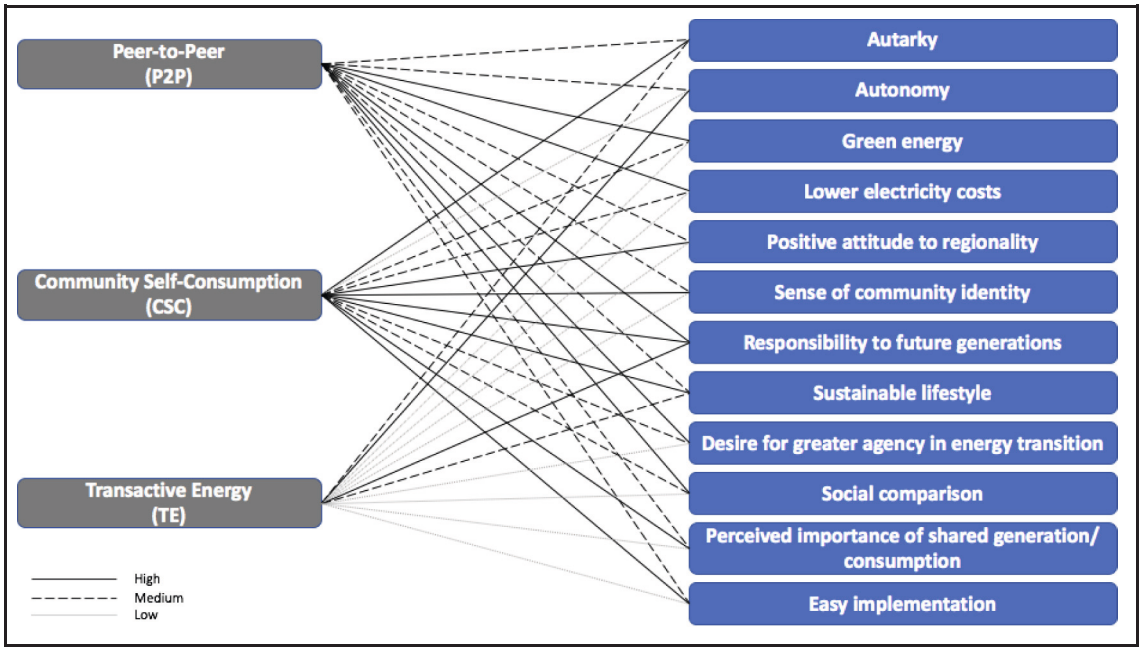

Fig. 2. Overview of P2P, CSC and TE model capacities in generating different types of values.

users, such as consumers [79]. It remains to be seen whether these market models can converge into one that can satisfy the objectives of prosumers corresponding to various kinds of priorities and values [18]. An ideal market mechanism would use an algorithm that deploys a multi-objective optimization to prioritize and select transactions that do not downplay or contradict each of the market participants' objectives. In other words, ideal market transactions would simultaneously (i) *support the grid stability*, (ii) *maximize the community benefits* and (iii) *provide the best returns for the participants*.

Accepting our framing for P2P, CSC, and TE models, we propose three models as the new dimensions for the electricity market (re) structure in the energy transition path. In other words, prosumers can be simultaneously present in these markets, in addition to their presence in the traditional electricity retail market. In this view, P2P, CSC, and TE market models complement and alternate the traditional trading models as well as each other. The main difference between prosumers' presence in traditional electricity markets and their extended options associated with new market models is that traditional models do not have the capacity to accommodate prosumers' active participation in trading. Nevertheless, prosumers can personalize their participation through the new market models by trading their surplus electricity as well as flexibility as they prefer. There is no need to emphasize prosumers' decision to participate in different markets as it depends on different models' capacities as well as prosumer preferences. Fig. 2 provides an overview of the different model capacities in generating different types of values.

6. Discussion

We contend that a prosumer participates in a market by creating and capturing value, which are the two main attributes of a business model. In this view, a business model is understood as the navigation system of a prosumer to participate in different markets. Having a clear distinction at one's disposal between P2P, CSC, and TE models' capacities in value generation, prosumers are afforded to develop, employ and adjust their business model and consequently their (active) participation in different markets. If a prosumer prioritizes a specific type of value, the provided distinction between models assists in deciding which market model has higher capacity in generating the preferred type of value. Hence, participating in the market with the highest capacity in generating prosumers' preferred value type will better satisfy their preferences. This complements the claim made in [11] - "innovative BMs are emerging that the primary focus is the prosumer preference." (p. 14) Prosumers participate in market models by submitting bids. Since bid submission happens in short time intervals, which requires applying digital technologies, prosumers' home energy management systems are most probably the means to 'signal', or 'translate' their preferences into their participation in different market models. A clear distinction between different market capacities - provided in Table 2 - can serve as a guideline for algorithmic decision-making, for example, guided by a home energy management system. If a prosumer prioritizes certain values, which can change at different times, a home energy management system systematically matches prosumers' values with market models' capacities and participates in the most potent markets on behalf of prosumers.

In sum, from a value generation framework, in P2P market models, prosumers act self-servingly and try to maximize their returns and minimize their costs; in CSC models, prosumers are community-oriented, so they give up (to some extent) personal benefits for the wellbeing of the community; and, in TE models, prosumers are either (i) sustainability-driven, so they engage in these markets as they are aware that they help the grid to run much 'greener', or (ii) profit-oriented and risk takers, so they are after the better rewards offered at the flexibility markets. Note that the closer one trades to real-time electricity dispatch, the better rewards can be gained. As transactions in the flexibility markets are typically closer to real-time trading and linked to the grid stability, the prices/rewards offered tend typically to be higher than those on offer in electricity trading. This comes with risks too, as the penalties are also higher. Therefore, participants in TE markets typically have higher risk-taking profiles who would go for TE markets for higher returns.

7. Conclusions and future research

Assuming that the range of values that new market models can generate is one of the key elements that can engage a larger number of prosumers as well as incentivise them in becoming active 'market actors' in the electricity market, this Perspective has explored the value generation capacities of P2P, CSC, and TE models. In doing so, a distinction has been made between prosumers' business models as potentially active participants in different markets and the new market models' value generation capacities. The concepts and the overarching objective of the P2P, CSC, and TE market models have been introduced, followed by a framework to distinguish the new market models based on involved actors and traded commodities. Accordingly, the new models have been positioned as complements for the traditional trading in retail markets. Furthermore, the theoretical framework has been applied to investigate and compare the new market models' value generation capacities. Building on this distinction, we speculate that prosumers adjust their involvement level in each market, based on their preferences and the capacity of each model to generate different types of values. In this view, the outcome of this study assists prosumers to develop, employ and adjust their business models accordingly, such as in a home energy management system.

As a result, important opportunities for further research can be identified. In particular, as the focus has now been on the market models' value generation capacities and, to some extent, their links with prosumers' business models, it would be fruitful to pursue further research to yield insights into other elements of prosumers' business models, such as revenue models for prosumers. Another opportunity is to use the values in Table 1 for a quantitative study by utilizing a questionnaire to, on the one hand, gather data from prosumers to explore their preferences and, on the other hand, from experts to validate models' value generation capacities from experts' view which can provide systematic insights into the heterogeneous capacities of the market models. Consequently, it can assist policy makers in allocating public resources more efficiently in support of models which generate (public) goods and services in the public interest.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix 1. Methodology

In the following we explain the applied methods to back up the four tables and figures in our perspective. This section is divided into three subsections.

Theoretical framework (Table 1)

To build this framework a theory building process was followed, namely 'typology' style [31]. The idea was to come up with a framework with predictive power. The dependent variables in the framework are: (1) Involved actors in trading, and (2) traded commodities. The dependent variable is the type of market model.

Table 1
Trading opportunities and domain of each model.

	Prosumer[1] (+)	Community[2] (+)	Grid operators[3] (+)	Retailers[4] (+)
Prosumer (−)	P2P (*e*)	P2P (*e*)/CSC (*e,f*)*	–	Retail (*e*)
Community[5] (−)	P2P (*e*)/CSC (*e,f*)*	P2P (*e*)	–	Retail (*e*)
Grid operators[6] (−)	TE (*f*)	TE (*f*)	–	Balancing[7] (*f*)
Retailers[8] (−)	Retail (*e*)	Retail (*e*)	–	–

[1] Prosumers can supply electricity and/or flexibility to other prosumers P2P(e), to Community CSC(e,f), to grid operators TE (f), and retailers (Traditional_e).
[2] Communities can sell electricity to prosumers and retailers. They can also provide flexibility services to other communities or grid operators.
[3] Grid operators do not offer flexibility to anyone; they buy flexibility in order to keep the grid in balance.
[4] Retailers can sell electricity to prosumers and communities. They can also provide flexibility to grid operators. They can also sell electricity to other retailers at the wholesale market, which we leave aside in this framework.
[5] Communities can buy electricity from prosumers, other communities and retailers. They can use the flexibility services offered by prosumers or other communities.
[6] Grid operators can buy flexibility from prosumers, communities and retailers. Retailers, Generators and large consumers are the main flexibility providers in the current market setting.
[7] The balancing market is a real-time trading market for electricity controlled by Grid operators. It is used for matching the supply with the demand and/or alleviating any transportation/delivery issues on the transmission network during a settlement period.
[8] Retailers can buy electricity from prosumers and communities. In fact, they can also buy electricity from other retailers at the wholesale market. They are also forced to buy electricity from grid operators at the balancing market if they are short of supply. We kept the wholesale and balancing markets out of the picture in this perspective.

Identification of market models' values (Fig. 1)

The study uses [80]'s meta-model to identify the value proposition of the P2P electricity trading (see section A in Findings for further information). The data was systematically collected through a literature review which took into account state-of-the-art publications, namely books, journal articles, and conference papers about P2P, CSC, and TE models. The gathered data from the literature review process has been enriched, triangulated, and validated by expert interviews. Research strategy includes comparison and assessment of data from different mentioned sources, and finally formation and reasoning of the research team's interpretation.

Twenty-three semi-structured interviews with experts were conducted between October 2019 and March 2020. Interviews were planned to cover several aspects of the current and future structure of the electricity market, actors in the market, their responsibilities, resources, objectives, etc. Interviews were conducted face to face and via Skype. Each interview lasted 45 min (on average). The interviewees are academics and practitioners in the electricity market. They were selected from several stakeholder groups (transmission system operators, distribution system operators, retailers, aggregators, suppliers, consumers, prosumers, and potential emerging actors coming from other fields like platform operators to name a few) in Belgium to provide a comprehensive view of the electricity market. Semi-structured interviews were guided by the questions about the value proposition and the structure of the current electricity trading as well as P2P trading. Interviews were recorded and transcribed afterwards. If the interviews were not recorded, due to the interviewees' preferences or technical problems, notes were taken. Data is coded based on the elements of the selected frameworks. Reported findings are the interpretations of the research team of the coded data. To support the findings, direct quotes are inserted in the findings section. The results have been validated by two expert members of Global Observatory on Peer-to-Peer (P2P), Community Self-Consumption (CSC), and Transactive Energy (TE) Models, who are researchers on peer-to-peer electricity trading.

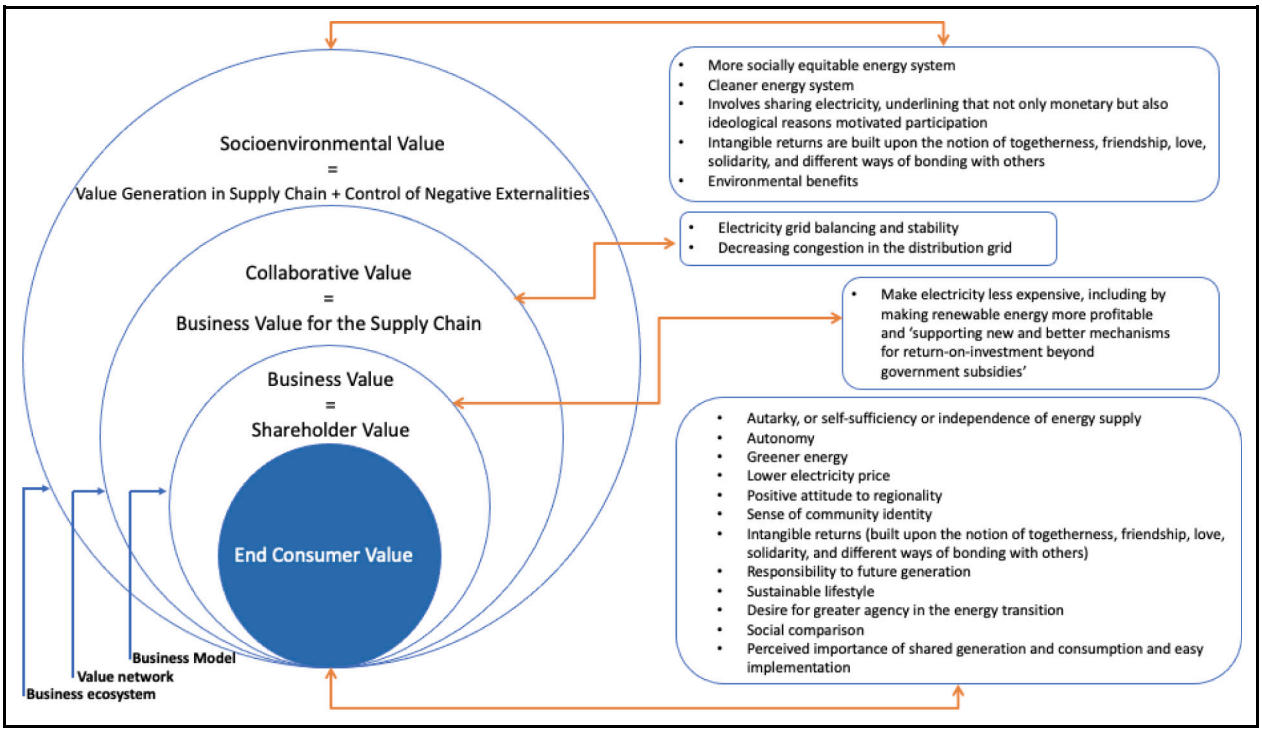

Fig. 1. Value proposition of P2P, CSC, and TE models for electricity and/or flexibility trading [7].
Note: Each circle represents the limits of different tools (see the left bottom of the picture).

Market models' values generation capacities (Table 2 and Fig. 2)

Table 2 is built based on interviews with experts from the five sub tasks of the Global Observatory on peer-to-peer, community self-consumption, and transactive energy models (i.e., Power systems integration, Hardware, software & data, Transactions and markets, Economic and social value, and Policy and regulation). Twenty one interviews were conducted. At least two experts are interviewed from each subtask. In interpreting the results, we focused on the reasoning behind the values assignments by experts (low, medium, or high). We observed that in some cases the reasoning of different interviewees were aligned, but the qualitative scores which they assign were not the same. We focused on highlighting commonalities and anomalies in experts' reasoning.

Table 2
P2P, CSC, and TE models potential in generating value for prosumers.

Prosumers' value[a,b]	P2P			CSC	TE		Traditional	
	i	ii	iii		i	ii	Retail	Balancing
Autarky	M	M	M	H	M	L	L	L
Autonomy	M	L	M	L	H	H	L	L
Green energy	H	H	H	M	L	L	L	L
Lower electricity costs	H	M	H	M	M	L	L	L
Positive attitude to regionality	M	H	H	H	L	M	L	L
Sense of community identity	M	H	M	H	L	M	L	L
Responsibility to future generations	H	H	H	H	H	H	L	L
Sustainable lifestyle	M	L	L	H	M	M	L	L
Desire for greater agency in the energy transition	H	M	M	M	L	L	L	L
Social comparison	H	M	M	M	L	M	L	L
Perceived importance of shared generation, consumption	M	M	M	H	L	L	L	L
Easy implementation	L	L	L	M	M	M	H	H

[a] Different scenarios for each market model as explained in the previous section.
[b] Note: Autarky refers to self-sufficiency or the proportion of energy demand met by the prosumers consuming their own energy, or independence of energy supply [71]. Autonomy refers to a way for individuals and communities to take ownership of sustainability; It implies the sense of oversight and decision-making power [72]. Green energy (Kubli, Loock and Wüstenhagen, 2018) refers to more environmentally- friendly produced energy. Positive attitude to regionality [72] refers to benefits for local communities or regions [73]. Sense of community identity refers to intangible returns built upon the notion of togetherness, friendship, love, solidarity, and different ways of bonding with others [74]. Responsibility to future generations refers to environmental benefits which are often cast in ethical terms [75]. Sustainable lifestyle refers to environmental benefits in cultural terms [76]. Desire for greater agency in the energy transition refers to new roles and relationships that the participant can have in these models [73]. Social comparison refers to people comparing themselves with their peers [77]. Perceived importance of shared generation and consumption and easy implementation are mentioned in contrast to financial factors [72].

To identify the value generation capacity of the new market models as well as comparing them to the traditional trading model, a multi-method approach [81] was followed. Initially we conducted expert interviews and introduced each type of value as a question and asked them to rank each model with regard to setting a value as High, Medium, or Low. Subsequently, in order to assess expert evaluations of the four alternative energy

trading models along the twelve value types (i.e., evaluation criteria), we adopted the Analytic Hierarchy Process (AHP). The AHP, introduced by [82], is a multiple criteria decision-making tool facilitating individuals to make a difficult choice between various alternatives along a set of distinct evaluation criteria. In our situation, a choice must be made about the preferred energy trading model based on its environmental, economic and social impact.

The central idea of the AHP is to disentangle the complex decision process into a sequence of simple pairwise evaluations of opposing attributes at different levels of the decision process. These evaluations were subsequently used to assign weights to the different attributes. At the bottom level, the attributes refer to the alternative choice options, i.e., the four energy trading models. The higher levels, in contrast, consist of evaluation criteria for the different choice options.

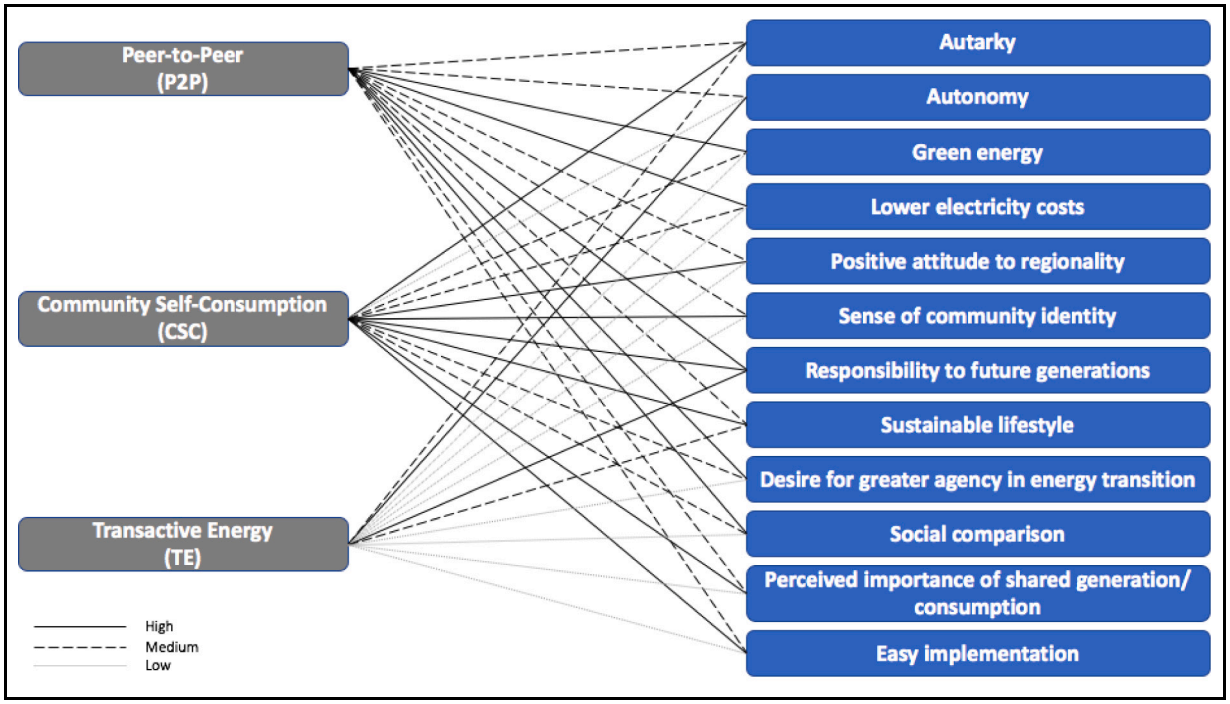

Fig. 2. Overview of P2P, CSC and TE model capacities in generating different types of values.

Limitations

- This perspective takes an abductive approach in theory building which to some extent required speculations. Therefore, a follow up deductive approach in applying the outcomes of this study on an extensive number of cases is a path for future research.
- Another limitation of this study is the limited number of filled questionnaires in applying the AHP model. This does not considerably impact the purpose of this study in theory building. However, conducting this part of study on a bigger sample size will increase the robustness of results.
- Finally, prosumers were not directly involved to systematically explore and test the value-centric based approach.

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