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Keywords Platforms, balancing services, electric vehicles, retail electricity markets

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Platform markets and energy services

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Abstract

A structural shift from transaction-based, marginal cost pricing to fee-based service business models often accompanies the emergence of “platform” markets, i.e. multi-sided markets where an intermediary captures the value of the interaction between user groups. The many examples include telecommunications, data storage, cinema, music and media, and the automobile industry. Why not electricity? In this paper, we explore how the electricity supply industry can be conceived of as a platform-mediated, two-sided market and the consequences for pricing. Through two cases, a balancing services provider for smart home energy management systems and an electric vehicle charge manager, we show where a platform entrant could position itself in the retail electricity markets between supply companies and end-users. The drivers of such a transition include increased volatility due to renewable generation, the new complexity of roles for end-users, and the introduction of information and communication technologies. Conceiving of electricity as a platform market where new entrants provide an energy optimisation and management service may stimulate a competitive ecosystem and innovation. We suggest that fee-based pricing would enable the objectives of time-varying pricing to be achieved without adversely affecting the most vulnerable customers.

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Introduction

The general motivation behind this paper is to explore the application of platform pricing strategies in retail electricity markets. Current structural transitions in the electric power industry introduce new actors and new roles for existing actors that may give way to the development of one or multiple platform markets. Household consumers are expected to take a more active role and become producers, such as through selling small-scale photovoltaic energy production or participating in demand response contracts (UK Department of Energy and Climate Change 2012a; Kohrs et al. 2012). Other changes in the competitive landscape include new entrants in retail electricity supply, such as service companies that design business models on the basis of smart metering data. Established firms in industries such as retail and finance, such as Sainsbury's and Lloyds Bank in the UK, for example, are also entering the electricity market by selling power in multi-product offers and packages. The increasing differentiation of electricity consumers by type and elasticity of demand, as well as the new complexity of interactions between actors on the distribution network, may lead to the emergence of "platform"-mediated interactions as has been the case in other industries whose business models have been radically affected by information and communication technologies (ICT).

In this paper, we explore how the definition of a platform market applies to new business models in retail electricity supply for balancing services and electric vehicles. We compare current pricing structures for retail electricity supply contracts based on marginal cost pricing to multi-sided platform pricing strategies. We suggest circumstances when it is more profitable to charge a flat service fee akin to a network connection fee and to subsidise some user groups rather than charge all consumers a marginal cost-based price in £/kWh. Other markets such as broadband, Internet, software applications and credit cards, where a two-sided pricing structure is already applied, are used as comparative examples.

This paper is organised in 3 sections. In the first, we review the current understanding of the definition of a "platform" market in the literature. So far, there is little rigorous clarity linking the concept with oft-quoted examples and the definition of "platform" markets seems to be liberally applied to a growing and diverse set of industries in the literature (Eisenmann et al. 2011). We revisit the commonly cited list of platform markets in the literature, adding a discussion of examples of what are not platform markets, and examples of markets that "could be considered" or "may be becoming" platform markets. We discuss the following closely related concepts and how they link with platform markets: platform technologies, multi-sided markets, network externalities, bundling, and general purpose technologies (GPT).

In the second section, we take three examples in retail electricity supply and explore the implications of conceiving of them as platforms. The first two cases are electricity balancing services and electric vehicle charging management. We find that platform pricing is an appropriate business model in these two cases and discuss the associated re-allocation of economic value. Platform pricing in electricity markets is presented in relation with the dominant pricing method, based on marginal costs. The third case is the entire electricity supply chain from wholesale generation to end-users. We discuss where the platform analogy fails in conventional electricity markets (section IV.).

INSERT FIGURES 1-3 HERE

I. What is a platform, and what is not a platform?

The "platform" label is applied to an increasing number of industries and businesses, often quite liberally. A "platform" market by definition must be different from a simple market, where goods or services are exchanged via a broker or mediator, who collects revenues through a commission-type fee for the service rendered in enabling the interaction between two parties. In this section we investigate which additional elements differentiate a platform market from any market, based on the definitions of platforms from industrial and network economics and strategic management. We revise the dominant definition that includes interaction mediation and network externalities as necessary and sufficient conditions by adding *complementary innovation, inherent added-value,* and a role for ICT as necessary criteria for the definition of a platform. We then revisit examples and past applications of the definition (Tables 1- 4). The relationships of the concept with two-sided and one-sided markets, business ecosystems, platform technologies, and GPT are discussed.

The two most widely accepted elements of the definition of a "platform" market are 1) the existence of one or more user groups linked by a service or product provider that mediates their interactions, and 2) the existence of network externalities (Eisenmann et al. 2011; Eisenmann, Parker & Alstyne 2006; Rochet & Tirole 2003; Evans 2003; Armstrong 2006; Katz & Shapiro 1994). Platform interactions are triangular rather than linear, with users interacting with each other and with the platform provider (Eisenmann, Parker & Alstyne 2006) (Fig. 1-3). **Hagiu & Wright (2011) emphasise that the platform provider must be a mediator that enables distinct user group(s) to interact with each other *directly*, thus differentiating it from typical sellers or input suppliers**. Examples of platform markets include credit cards, video game consoles, online matchmaking such as recruiting and dating services, and text processors. For more comprehensive lists, see (Parker & Van Alstyne 2005; Rochet & Tirole 2003; Eisenmann, Parker & Alstyne 2006; Evans 2011; Hagiu & Wright 2011).

The existence of network externalities in platform markets implies that the utility of users of a platform is related to the number of other users. Cross-side externalities are externalities between users on each side of the platform, such as game players and developers, where game players are better off, the more developers use their platform, and vice versa. Same-side externalities, which have also been referred to as “intraplatform competition” (Armstrong 2006) occur when users on one side of the platform are affected by other users from the same side, often negatively (Eisenmann, Parker & Alstyne 2006). For example, software developers for one operating system are in competition with each other and may be affected by negative, same-side externalities. Network externalities affect the utility of various user groups (Armstrong 2006) and, as a result, the pricing strategy which the platform provider must adopt to attract users on each side (Evans 2003; Armstrong 2006). Subsidising one user group by charging the other is current practice in platforms such as credit cards and software as a way of attracting and retaining a critical mass of users (Evans 2003; Economides & Katsamakas 2006).

Modern examples of platforms are often associated with highly innovative business ecosystems, e.g. Apple’s AppStore or Android OS. Do platform markets foster innovation? The importance of complementary innovation is a third element often related to the definition of a platform market in the strategy literature (Gawer & Cusumano 2008; Ceccagnoli et al. 2012; Suarez & Kirtley 2012). A platform market is a system (service or product) that combines a core component whose functionality is extended by innovation in complements (Suarez & Kirtley 2012; Gawer & Cusumano 2008). Following Gawer & Cusumano (2008) who go so far as to say that there is a relation of mutual dependence between the platform and complementary innovation, in addition to network externalities and the mediation of interactions between user groups, we suggest that utility for user groups in a platform market depends on complementary innovation which is often technology-driven and affects the business models in a wide range of industries. Consider the examples of online music platform iTunes and e-mail service Google mail. iTunes meets all three criteria of a platform including active complementary innovation through applications that increases the value to users. Google mail has fostered high levels of complementary services and innovation such as Google labs and social network and chat Google +, all free for users. iTunes and Google challenge established business models in many other industries than their primary focus industries, music and Internet services. In particular, platforms such as internal combustion engines, newspapers, and shopping malls would not be included in our definition of a platform market while they have been in others (Eisenmann, Parker & Alstyne 2006), since complementary innovation is not necessary to increase customer benefit in these markets. A platform must allow for innovation in complementary services, products, or business models.

Interestingly, platform competition does not necessarily rely on Schumpeterian innovation (Eisenmann et al. 2011), since competition in a platform can be done through the reconfiguration of existing technology or services with other services or products, rather than *de novo* technological innovation. The reconfiguration of services offered by a platform is described as “bundling” in economics (Nalebuff 2004) or platform “envelopment” in strategy (Eisenmann et al. 2011). Platform envelopment is the combination of functionality from one platform within another platform in a bundle, aimed at “absorbing” the first platform’s customer base. Envelopment is an effective competitive strategy due to the high switching costs and network effects that prevent entry in a platform market (Suarez & Kirtley 2012). Rather than radically new functionality or technology, innovation in a platform market occurs therefore mainly 1) in complementary products or services, and 2) in the form of business model innovation, when a platform is enveloped by another. Achieving platform status in an industry comes through building relationships with external complementor firms and establishing leadership in a broader business ecosystem (Gawer & Cusumano (2002)).

The concept of platform markets is closely related to the concept of multi- or two-sided markets. **Not all two-sided markets are platform markets and not all platform markets are two-sided**. One-sided platform markets have one user group only, such as PDF readers who are also PDF creators or peer-to-peer exchanges sites like Craigslist, where buyers are also sellers. These examples bring up the need to differentiate between two-sided platform markets and markets where customers are all of the same nature but express heterogeneous demand. The cases of platform markets often discussed in the literature usually can be argued in multiple ways. For example, PDF has been listed as a two-sided market with readers and writers on each side, where some writers subsidise readers by paying for the professional PDF maker software (Rochet & Tirole, 2003). According to our understanding, however, PDF is a one-sided market with customers of heterogeneous willingness-to-pay for the platform and its full functionality. Free PDF software solve the same problem by getting their revenues from advertisers.

The exact relationship between platforms and two- and multi-sided markets has not been explicitly clarified in the literature on platforms. We suggest that **the role of a platform intermediary is distinct from simple commercial brokerage**, i.e. an intermediary that facilitates transactions between two user groups (whether direct or indirect). A platform provider differs from a commercial broker in multi-sided markets in that the value created by the platform contains an intrinsic component that adds to its users' utility independently of the facilitation of their interaction. Therefore, newspapers, shopping malls, real estate agents, and night clubs, which are examples of two-sided markets (see Armstrong, 2006), are not platform markets. Shopping malls are two-sided markets where customers and retailers interact and cross-group externalities take place (a consumer is better off if there are many retailers in a mall, and a retailer benefits from high numbers of consumers in a mall). However, the mall owner is only a commercial broker that enables the direct transaction between buyers and merchants. As a simple *lieu* of exchange, the mall itself does not have a relationship or transact with customers, thus the triangular structure of transactions in platform markets is broken. The mall owner does not influence innovation in complementary markets or have a transforming impact on a larger set of industries as, for example, other exchange platforms such as stock exchanges would.

The "information economy" has clearly participated in the spread of platform markets to a wider share of the economy. As noted by Eisenmann (2007, 2011), "ranked by market value, 60 of the world's 100 largest corporations earn at least half of their revenue from platform markets". Often, as shown in Tables 1-4, this value comes from the transmission of added-value digital information, such as recruiting sites pre-scanning professional profiles before suggesting matches, or new functionality such as credit cards allowing users to make purchases earlier than they otherwise would (Rochet & Wright, 2010) and to avoid the inconvenience of cash transactions. We suggest that the introduction of ICT is a main factor of the creation of platform markets in an increasing number of non-related sectors including retail fashion, music, social entrepreneurship, and electricity. The value of information is also a key element in the energy service platform markets discussed in this paper. With Google, eBay, Amazon, Microsoft, and Intel, many examples of platform markets in the literature are based on information and communication technologies (Ceccagnoli et al. 2012; Gawer & Cusumano 2002; Economides & Katsamakas 2006).

ICT is also defined as a General Purpose Technology (Pearson & Foxon 2012; Crafts 2004). Just as platforms have been seen as "engines of growth", GPTs have been presented in the economics literature as foundations of accelerated economic growth (Evans et al. 2008). The table of examples (Tables 1-4) shows that some elements of the definition of GPTs, namely pervasiveness, innovational complementarities, and scope for improvement, may also be characteristic of platform technologies. The platform market supposes the existence of a platform technology, which shares common features with the GPT: versatility and impact on a broad range of related and unrelated industries, and opportunity for high levels of complementary innovation (Moser & Nicholas 2004). The platform technology has been considered the "core" of an industry in the literature (Gawer & Cusumano 2002). GPTs can be distinguished from the platform technology by their level of complexity: the GPT is a fundamentally simpler component with an inherent scope for technical improvement (Bresnahan & Trajtenberg 1995).

Drawing on existing definitions in business and economics, our definition of a platform market is therefore summarised in the following points:

Definition. *A platform market is a market where user interactions are mediated by an intermediary, the platform provider, and are subject to network effects. As opposed to a marketplace or trading exchange, a platform intermediary must offer inherent value beyond the simple mediation process for the two sides of the market. This added-value usually comes from ICT and the associated complementary innovation that increases utility and attractiveness of the platform to all user groups.*

INSERT TABLES 1-4 HERE

II. Platform pricing

Pricing strategies for two-sided markets call for different considerations than typical markets and have been the focus of a number of economic studies (Eisenmann, Parker & Alstyne 2006). In this section, the factors that affect the equilibrium pricing structure in two-sided platform markets are discussed: network externalities, intrinsic value, fee structure, user group subsidisation, the competitive structure of platform markets, single- vs. multi-homing, and proprietary vs. open platforms. We extend the intuition behind the definition elements offered in the first section of this paper to a more formal analysis of pricing strategies in platform markets. We focus our discussion on two-sided platform markets as most relevant to the case of electricity markets.

II. 1 The utility of cross-side interactions and elasticity of demand: which user group to subsidise?

The basic premise in two-sided markets mediated by a platform is that two user groups benefit from a service or product, implying that the platform provider has the choice to collect rents from both sides (called "consumers" and "producers" here) or to subsidise part or all of the cost of the platform for one side in order to attract a sufficient number of users on the other. The strategic options are that both sides pay positive prices (e.g. newspapers), one side pays positive prices and the other accesses for free (e.g. some credit cards), or one side pays positive prices and the other side pays negative prices, i.e. is compensated for using the platform (e.g. nightclubs or dating websites). For example, nightclubs or online dating websites may subsidise women by offering free entry or drinks to attract more male customers. The existence of two different tariffs for different user groups of a platform has been called price "discrimination" (Armstrong 2006). The price difference reflects asymmetries in cross-side externalities, i.e. one side benefitting more than the other from the interaction. Armstrong (2006) suggests consumers overall are made better off from price discrimination.

The level to which subsidisation is effective or necessary depends on the strength of cross-group network externalities. When the network externalities are high enough, i.e. when the marginal cost of connecting an additional user to the platform is lower than the marginal value of its connection for existing and prospective users, the platform provider can apply negative prices to one user group and still collect overall positive profits in equilibrium (Caillaud & Jullien 2003; Economides & Katsamakas 2006). In this case, the most profitable pricing strategy for a platform provider is sometimes to charge below marginal costs for access (Caillaud & Jullien 2003; Economides & Katsamakas 2006; Eisenmann et al. 2011) and for the producers' applications (Economides & Katsamakas 2006), simply to attract a wider user base.

The formulation of optimal pricing for each side using a platform also depends on the elasticity of demand of users (consumers and producers) for the platform service and for the other side's offering. The elasticity of demand of users of a platform has been assumed in the literature to be dependent on price (Rochet & Tirole 2003) and on the utility of interacting with members from the other side of the platform (this is the cross-side network benefit discussed above) (Armstrong 2006), but also on the net utility users obtain from the platform (Hagiu 2009). For example, the net utility for an operating system platform derives both from its own features and from the utility from the applications it can offer. Sometimes, most of the benefit of using a platform comes from the applications it gives access to, such as operating systems Windows, Linux, and Apple's OS X. This relative distribution of utility determines who the platform subsidises. When the willingness-to-pay of consumers is higher for the platform than the applications, the platform provider should subsidise application providers, whereas when the attractiveness of the applications is high relative to the attractiveness of the platform, the platform should subsidise consumers (Economides & Katsamakas 2006). In addition, when consumers have a preference for application variety, producers (application providers) have a higher rent extraction power, so a larger share of the profits in a monopolistic equilibrium fall onto the producer side (Economides & Katsamakas 2006). The platform can choose to extract more of its profit from the applications side in this case to subsidise consumers.

Similarly, Hagiu (2009) finds that the platform must extract relatively more profit from the side that "has more power" over the other. If consumers extract more surplus from an increased competition between producers, higher consumer prices should be charged by the platform in equilibrium. The first proposition in Hagiu (2009) states that the relationship between the measure of market power of producers over consumers, the elasticity of the surplus for each consumer, and the elasticities of demand for consumer and producers, explicitly determines which side the platform should subsidise.

Platform pricing strategies are in fact a re-allocation mechanism of costs and value, without any change in total economic surplus. "The platform adjusts its pricing structure to account for the relative division of economic surplus between consumers and producers" (Hagiu 2009). User groups differ in their elasticities of demand for the platform, for the platform's product, and for the interaction with the other users on the platform (cross-side and same-side network externalities). The side with the highest utility from interacting with the other side ends up subsidising the other side's access to the platform. The side with the lowest elasticity of demand ends up subsidising the other side's access to the platform.

The effect of *same-side* network externalities have been mentioned but not analysed in detail in the literature (Eisenmann, Parker & Alstyne 2006). We suggest same-side network externalities could be added to the utility function similarly to cross-side effects, but since they are usually directly related to economies of scale, they can be neglected (as internalised in the marginal costs of the platform). Same-side network externalities in the context of power networks are discussed further in section IV. .

II. 2 Intrinsic benefit?

The existence of a benefit that is intrinsic to the platform itself independently of network intermediation can be found explicitly in two articles, Armstrong (2006) and Caillaud & Jullien (2003). In Armstrong (2006), the term ζ_j^i represents the fixed benefit agent i obtains from platform j. In Caillaud and Jullien (2003), the term λ represents the "quality of the matching process, the likelihood that there are no mistakes or errors in registration and data processing". In Rochet & Tirole (2003), this fixed utility has been set to 0. It is also possible that the intrinsic value is higher for one side of the market than the other, as suggested in Hagiu (2009): consumers may benefit from platform differentiation while to sellers, the installed consumer base in a platform is the only advantage. We suggest that in information-based, two-sided markets that are most similar to the cases discussed in energy such as smart phone operating systems, online retail exchanges or social matchmaking websites, the platform must provide a benefit beyond the matchmaking process to win market share (this benefit could be superior design, superior functionality, etc.).

II. 3 Pricing structure: Pure registration fee, pure transaction tariff, or two-part tariffs

One of the main issues with platform pricing is whether adopting a fixed registration or subscription-like tariff, or a transaction-based tariff, or a mix of both, is optimal. We represent the decision space on a continuum in Figure 4.

Rochet and Tirole (2003) exclude fixed tariffs from their analysis of the equilibrium cost allocation balance and pricing under monopoly or competing platforms. In effect, they "take as given the matching process" that the platform provides, and discuss the pure transaction-based fees that arise as a result of platforms' already realised market share of the other group.

Caillaud and Jullien (2003) find different optimal strategies depending on the case. In the case of pure equilibria under multi-homing, where all users of the same group make the same choice of platform(s) but can use more than one platform, a provider "does not have to impose a transaction fee to make a profit, registration fees are sufficient" to deter entry (Proposition 5). This result contrasts with the case of platform competition for exclusive services (single-homing), where charging maximal transaction fee and no registration fee is the only option for equilibrium (Proposition 1). In some cases, transaction fees may be difficulty to implement, such as when the transactions themselves are purely informational and give rise to no direct physical or financial exchanges (Caillaud & Jullien 2003). **Transactions may also be difficult or costly to monitor, rendering transaction-based pricing unfeasible.** Platforms then have to resort to undercutting registration fees in competing in multi-homing equilibria (Caillaud & Jullien 2003), which reduces their profits.

Hagiu (2009) explained the use of usage fees, i.e. transaction fees, as a response to the sequential adoption of a platform by its two sides, which he calls the "holdup" problem. If a platform is adopted by producers first, the system of royalties guarantees a certain revenue to the platform from the producers. The ideal would be that the platform internalises all the revenues that producers derive from their interaction with consumers.

The pricing structures and relevant parameters are shown in Figure 4. Note that the formulae are based on (Armstrong 2006) only.

INSERT Figure 4 PRICING STRUCTURE IN A PLATFORM HERE

In the case of energy, the question is which of these competitive equilibrium scenarios for a platform provider would arise. As a network industry with a natural monopoly in the transmission and distribution segments, electricity markets can currently be seen as a case of exclusive services in a monopoly equilibrium, where producers (generators) and consumers transact through a single network provider. In this case, pricing is transaction-based (Figure 4). However, the entry of competing platform providers offering new services such as renewable energy contracts or energy management services could lead to a dominant-firm equilibrium where generators multi-home and residential customers multi-home (or, most likely, single-home). In this case, the pricing structure would follow the evolution of telecommunications service pricing and move to two-part tariff structure with a subscription fee and a transaction-based component. We discuss this issue in practice in the section on platform pricing in electricity markets (p. 20).

II. 4 Monopoly vs. market-sharing competing platforms

Interestingly, the efficient (welfare-maximising) market structure in a platform market can be monopolistic or duopolistic, i.e. characterised by one or up to a few dominant firms sharing the user base (Caillaud & Jullien 2003). When a platform's services are exclusive, in equilibrium, one dominant firm captures all users, "charges the maximal transaction fee, subsidises registration, and makes zero profit" in order to deter entry (Caillaud & Jullien 2003). "In intermediation markets, and particularly Internet-based markets, [...] concentration does not necessarily carry strong inefficiencies. Users' surplus may have better protection in concentrated markets where one large intermediary dominates, provided that there is enough contestability. Intermediation profits may be higher in market-sharing configurations." Consumers' welfare "is higher under exclusive services than in any equilibrium with nonexclusive services" (Caillaud & Jullien 2003).

II. 5 Single-homing and multi-homing: Effects on pricing strategy

The ability of users to adopt one or multiple platforms changes the outcome of competitive pricing strategies. In some platform markets such as online match-making or exchange platforms, e.g. Amazon and eBay, buyers can increase their probability of finding an item and sellers can increase their probability of selling their item, by subscribing to multiple platforms. When one side multi-homes and one side single-homes, which has been called "competitive bottleneck", the interests of the multi-homing side are completely ignored in equilibrium (Armstrong 2006). The case of one side multi-homing and one side single-homing has been a common example in the literature.

II. 6 Pricing decision: Not just the platform

The pricing of the seller or producer side, which in the case of software applications and operating systems is the side of application developers, is usually considered exogenous to platform pricing. Indeed, the elasticity of demand of consumers or buyers in a platform is usually linked to the benefit of interaction with the seller side, without considering how much that benefit is affected by the price of the service or good provided by the other side. Economides & Katsamakas (2006) model the effect of applications pricing as endogenous to the pricing behaviour of the platform and find that it makes a "very significant difference in firms' competitive interactions and the evaluation of the platform applications' competitive landscape". In the case of energy, there are two options for the price of electricity sold from suppliers to consumers: the platform provider could fully internalise the costs of electricity transactions into its fees, or the platform could set its fees independently from the suppliers' selling price of electricity. This is discussed in section III. 3 .

II. 7 Proprietary vs. open-source

An important part of the strategy of a platform is in deciding whether to be proprietary, i.e. to charge for complementary innovators' and direct suppliers' access to the platform, or whether to allow open-source, free development around it. The debate is raised in Economides & Katsamakas (2006) around software platforms and in Boudreau (2008) around handheld computer platforms. Proprietary platforms have been found to be associated with higher total industry profitability while open-source platforms lead to higher social welfare (Economides & Katsamakas 2006). Interestingly, proprietary platforms tend to win in the competitive race against open-source platforms in terms of market share "even when the consumers' cost of adopting the open source platform is zero". Economides & Katsamakas (2006) explain this dynamic by the fact that proprietary platforms internalise users' preference for application variety, while the profit of open-source platforms does not (p. 1067). In fact, they find that open-source platforms lead to more product variety. However, consumers may value product quality over quantity in which case another explanation for users' preference for a proprietary platform may be that proprietary platforms provide higher quality products.

Boudreau (2008) studied handheld computer platforms (e.g. Palm Pilot, Psion EPOC) as systems comprised of hardware and (platform) operating system providers, to assess whether loosening control and integration, i.e. opening a platform, would lead to an increase or decrease in innovation.

The results suggested a non-monotonic relationship between increasing access to a platform and hardware innovation, which the author explained as follows: "the benefits of a more diverse developer pool are quickly overwhelmed by reduced investment as openness increases, all else being equal". No strong relationship in either direction was found between opening and platform innovation, due to counteracting forces of greater incentives to improve the platform technology but diminishing returns on product development due to a higher number of hardware complement developers.

Figure 5 offers a summary of the benefits for innovativeness and distribution of economic surplus between proprietary and open platforms.

Proprietary platforms can also be distinguished from not-for-profit *associations* (Rochet & Tirole, 2003). An association selects an access charge with the objective of maximising volume of transactions rather than profit. Examples of association-type platforms are Visa and MasterCard, which are set up by members of the banking and financial services sector and centrally set interchange fees that are proportional to transaction volume. In this case, cardholders are usually favoured by the competition between banks issuing the cards, and receive benefits in the form of low card fees and high card benefits (Rochet & Tirole, 2003). In electricity markets, a platform could be conceived as an *association* between the various suppliers. The provision of the optimisation service of electricity does have a public good aspect to it, in that it creates benefits for the generality of electricity consumers.

INSERT FIGURE 5 PROPRIETARY VS OPEN SOURCE PLATFORMS HERE

III. The case of retail electricity markets

Can the electricity supply industry be conceived of as a platform-mediated, two-sided market? It has been suggested, almost in passing, that electricity markets are evolving into platforms matching "consumers with specific power producers, allowing them to express their preference for cheaper coal or renewable power" (Eisenmann et al., 2006). While electricity retail markets feature two basic elements that define a two-sided platform market, i.e. network externalities and the mediated interaction of two user groups, they have never typically been considered as "platform" markets. Electricity has always been charged to consumers on a transaction basis where per-kWh costs of energy delivered are added to a distributed share of fixed costs of investments in the network

(Steiner 1957). The question of subsidising the consumer user-group has never been considered and financial transactions have always flowed linearly from consumers back to generators. Why, and why might this change?

In light of the definition offered in the first part of this paper, we suggest that electricity retail markets have the potential of witnessing the entry of platform providers as they acquire two features. The first is volatility. The unpredictability of renewable energy generation implies that the service of information and energy management contains added-value for the market, in particular for generators and grid operators (the supply side). There is a systems-level benefit of balancing supply and demand of electricity in the market. An optimally balanced electricity market maximises social surplus. Introducing the idea of a “platform” market for electricity implies that the value and costs of the balancing service should be re-allocated over the market actors. On the consumer side, consumers are increasingly being shifted away from regulated fixed tariffs and exposed to time-varying market prices. Time-varying or “dynamic” pricing including real-time, time-of-use and peak pricing, is a way of getting domestic and commercial consumers interested in their energy consumption behaviour and encourages them to take a more active role in the market (Faruqui 2010).

The second feature is the possibility for complementary innovation in services and products due to the introduction of ICT. Currently, the dimension of “information” that would be needed to allow the matching or intermediation process to take place is limited to wholesale electricity markets. ICT introduced at the micro-scale, e.g. smart appliances, smart meters and EV charging, opens business model opportunities in the retail market for a service provider positioning themselves as a “platform” intermediary. The intermediation process can take place in the retail market which, despite low profit margins, offers value capture potential due to its large market size and large transaction volumes.

We describe two cases for platform services, electricity balancing services and EV aggregators, that are made possible with the progressive transition to an ICT-intensive “smart” power system. We discuss the positioning of the platform entrant in the market, and how platform pricing may be an increasingly sensible strategy in the future compared to traditional marginal cost pricing. The focus of the discussion is on distribution and retail supply, i.e. the distribution system (Figure 6). We begin with a brief overview of the market actors in a typical electricity market at an advanced stage of liberalisation: England and Wales.

III. 1 Market actors and changing roles in the competitive landscape

The value chain of electricity distribution and supply has traditionally been linear from generation, transmission and distribution, to retail supply. A schematic representation of the current market and its actors in England and Wales is shown in Figure 6.

INSERT Figure 6 ABOUT HERE

Market liberalisation and recent policy-driven changes are transforming the system into a decentralised value constellation. From a vertically bundled supply chain, electricity network industries are morphing into value networks "with multiple entry and exit points" and new business models, as did the telecom industry following liberalisation (Li & Whalley 2002). The telecommunications sector has seen the emergence of competing platforms, e.g. for mobile smart phones and home service bundles with broadband, TV and telephony, that have all been shifting revenues to all-inclusive subscription tariffs. The retail electricity sector has yet to experiment with similar business models.

A particularly important change is the role of residential and small commercial consumers, who increasingly hold value as *resources* for the grid system as loads (energy "sinks"), generators (micro-generation in homes), and storage devices (e.g. electric vehicle batteries). Consumers are encouraged by current regulation to provide "demand response" services (as electricity sinks that can be switched on or off) through participative contracts (Ofgem 2010). Residential and commercial end-users are starting to be informed of their real-time costs, consumption patterns, and of the origin of their electricity. The partial self-supply of household users from solar panels and combined heat and power plants (CHPs), particularly if coupled with batteries such as electric vehicle batteries, is also expected to affect the dynamics of the national market. The value of domestic consumers as grid resources is at the heart of the transition to a platform market for electricity. The complexity of the "consumer" side, as uptake devices, generators, and flexible resources, with differentiated elasticities of demand, is what makes a platform mediator coming with smart optimisation capabilities viable and even necessary.

On the supply side, legally-binding policies to reduce CO_2 emissions from the electricity supply sector
[1] are supporting the integration of renewable energy generation. The decarbonisation of electricity is accompanied with increasing volatility of supply, which requires adjustments in business models

[1] Target:- 90% of CO2 emissions form the electricity sector by 2030 (UK Department of Energy and Climate Change 2011).

and market mechanisms. Wind and solar energy, which could provide up to 40% of the energy needed to meet the 15% target production from renewable sources in the UK by 2020 (UK Department of Energy and Climate Change 2011), are both intermittent and unpredictable in timing and quantity. Financial incentives such as those laid out in the Electricity Market Reform (EMR) are necessary to increase the attractiveness of such investments for power producers.[2]

The main drivers for the changing electricity market landscape are therefore regulations and policies encouraging the transition to a low-carbon, competitive, and innovative electricity system. The introduction of smart meters creates opportunities for innovation in new services, products, and business models, based on newly available consumption data. Increasing the efficiency of the distribution system through smart energy management solutions reduces the need to invest in reinforcements of distribution lines, transformers, and other assets (Anaya & Pollitt, 2013). These elements create opportunities for complementary innovators to solve some of the issues with the volatility; two examples are discussed in the next section.

III. 2 Cases

III.2.1 Case: Balancing services

The idea of a platform provider for balancing services is that a company or market player could manage the electricity load from household and commercial consumers and sell the service to the market players who benefit from the certainty of uptake and the maintenance of grid stability, namely generators, suppliers (also referred to here as ESCOs), and distribution network operators (DNOs). Under ongoing RIIO[3] regulation of DNOs in the UK, quality of customer service and efficiency of operations and investments will be factored into the calculation of network operator revenues. However, the ultimate beneficiaries of increased predictability and flexibility (or quick reaction times) of domestic load on the system are the ESCOs and generators, who enter advance delivery agreements. They bear the costs of lost (renewable) production and the penalty of sourcing additional power from the balancing market for end-users. For an estimate of the frequency and

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[2] First, contracts-for-difference guarantee that producers of renewable energy generation units at both the micro-/residential scale and at small-scale (1 to 2 MW) will be compensated for the energy they produce, whether or not it is in excess of market demand. The establishment of a market for capacity also manages the production risk that is associated with the volatility of supply from renewable energy plants, by compensating asset owners for making the capacity available, whether or not it is running.

[3] Revenues= Investment + Innovation + Outputs, the new regulatory framework for DNO revenues in the UK (Ofgem 2010).

magnitude of shortages in the UK electricity market, see Figure 2 in (Strbac 2008). The total size of the balancing services market was £623 million in the UK in 2012[4] (National Grid, 2013).

Currently, the balancing market in the UK is managed at the level of the transmission system by the transmission system operator (National Grid) who sends requests to producers (wholesale) and suppliers (retail) to ensure frequency and voltage stability. The balancing mechanism manages the intra-day hourly adjustments for physical power when the day-ahead market has not accurately forecasted the load on the system. Power traded on the balancing (and reserve) market is more expensive than pre-scheduled power (Newbery 2011). Imbalance energy prices, or the price of buying or selling power on the balancing market relative to the day-ahead power market, are estimated at £4/MWh in the UK, and could rise up to £8/MWh with increasing wind generation. The costs of handling intermittency make it a highly valuable proposition to suppliers and generators to avoid last-minute variability.

There is no such service at the level of the distribution system. Due to the integration of micro- and small-scale generators with intermittent production, in order to avoid last-minute adjustments through the current balancing market, an intermediary service provider acting between households and retail suppliers could offer a buffer for excess supply by managing large household appliances and a virtual power plant "reserve" in the form of loads connected on the consumer side that can be switched off in times of undersupply (Silva et al. 2011). The enablers of such an intermediation service are the introduction of smart meters and the equipment of domestic appliances with IP addresses. Studies have shown that the value of energy savings from individual household appliances increases as the installed capacity of wind power increases; a typical fridge could provide savings from £2 to £32 per year as installed wind capacity increases from 10 to 40 GW (Silva et al. 2011). While the individual savings to consumers are low, the availability of dishwashers, refrigerators and freezers, and space heating and cooling for scheduling delays or temporary interruptions is highly valuable for grid operators and suppliers, who avoid curtailing their energy or having to sell at negative prices. Since both sides of the market benefit from what is essentially an optimisation service based on information intermediation, the balancing service provider can price its service on both sides of the market. We discuss the details of a pricing strategy in section III. 4 .

It is interesting to consider in further detail who the specific actors are in this platform market configuration (Figure 2). Who could be the balancing service platform provider? Clearly, incumbent

[4] In 2008 the value of the balancing services market was £563 million. We leave for a future study to assess whether the market is undergoing a positive growth trend in real terms.

electricity suppliers have a competitive advantage to provide the service of energy management to their customers themselves. ESCOs already have the customers and know their energy consumption patterns. In the UK, it is also likely that ESCOs will maintain ownership of their customers' smart metering data (IBM 2013) which constitutes a barrier to entry to a third party entrant. ESCOs have all of the operations, knowledge and capabilities to supply electricity to customers. Adding a smart demand management service to their current value proposition would simply be a matter of implementing current optimisation strategies at a finer level of detail (household appliances rather than households, or blocks of households). If the ESCOs take on the role of platform service provider, the other side of the market would be generators who sell the electricity to them.

However, existing ESCOs have little interest in reducing demand and limiting their sales. New entrants could challenge the incumbency advantage of ESCOs and attempt to attract a larger user base that belonged to multiple ESCOs. Start-up companies and established ICT solutions companies in retail electricity markets could be interested by the balancing service role, as long as they can afford the regulatory licences to qualify as electricity suppliers.

Another main barrier to entry here would be to get access to sufficient customer data to create significant value from the service. Access to data from smart meters is planned to be highly regulated to protect consumer privacy in the UK (Anderson & Fuloria 2012). In other countries, such as Norway, the data will be available to the public provided some reference checks are passed (Statnett 2012). Finally, balancing services could be provided as part of an energy service contract offered by any retailer with direct customer relationships, such as financial institutions and supermarket chains. The technical ability to control loads to switch them on and off, finally, is outside of the remit of data management or other retail companies. Any such third-party entrant would have to partner with an ESCO for the operational side of their business to control domestic loads.

Each of these potential platform providers of balancing services are listed in Figure 2. The platform would alter the structure of the electricity market in Figure 6 as shown in Figure 7.

INSERT Figure 7 ABOUT HERE

III.2.2 Case: Electric vehicle aggregator

Electric vehicles (EV) can be seen as one particular device connected to the distribution grid in homes or in other locations that can offer a flexible source of demand, storage, and generation. The concept of an EV aggregator has been discussed in the literature as an entity that would manage and control the charging and discharging of EVs optimally for the grid (Quinn et al. 2010). We present the idea of the EV aggregator business model as a platform that mediates between the needs of drivers of up to millions of grid-connected vehicles and the suppliers, generators, and distribution network operators in the retail market.

A fleet of plugged-in vehicles represents a very attractive resource for grid operations as each connected vehicle can be switched on and off quasi-instantaneously (SCE 2012). EV batteries have a storage capacity of 24 kWh for most 100-mile range vehicles going up to 85 kWh for higher performance EVs. This energy storage capacity therefore represents more than the daily demand of two average UK households (11 kWh/household/day in 2013[5]). An individual EV is sufficient for a back-up power source of up to 2 days of power supply in an energy efficient home (KEPCO 2013). EVs have a wide range of charging power acceptance, from 1.4 kW in North American households up to 120 kW with “superchargers”.

An EV aggregator is a platform service provider that offers added-value to consumers through the use of their car to benefit the grid. The EV aggregator monetises the resource of the EV battery on behalf of the customer (driver) by optimising its charging behaviour as is beneficial for the distribution grid operator and/or electricity supplier.

The “platform” here is in the charging management service, which individual consumers are unable to carry out directly themselves but helps them capture value from their EV battery. Batteries represent up to 40% of the costs of a new EV (Tanaka 2013), so the value of using the battery for auxiliary energy services can potentially decrease the initial cost to consumers and improve the economics of purchasing an EV (Move About 2012). The platform provider would therefore be selling cost savings to consumers: this is the case of negative or 0 prices discussed in section II. , where the supply side of the market subsidises the other. Indeed, the supply side (grid or retail suppliers) can multi-home and is indifferent to which platform it chooses, as long as the platform gives them access to as many EV batteries as possible. The supply side can subscribe to multiple EV

[5] Department of Energy and Climate Change, 2013. Statistics publication series: Energy consumption in the UK. Chapter 3: Domestic data tables, Table 3.11 Household average daily electricity use. Publication URN 13D/157.

aggregators as long as it is efficient to do so: it is thus the subsidising side and its interests are neglected in the platform's strategy to attract users.

Similarly to the case of balancing services, the second side of the market that would be willing to pay for the service from EVs are the electricity supply companies, if they need to manage imbalances due to renewable generation, or the DNO who needs to manage sudden power demand surges. In contrast with other domestic appliances, EVs pose a risk on local distribution networks and assets. The connection of multiple EVs in a neighbourhood around the same time, for example, may overstress the network locally[6]. These risks are associated with high financial stakes. DNOs are therefore potentially direct users of an EV aggregating service platform.

Considering what type of firm might enter as a platform provider of EV services, *de novo* entrants could be service companies specialised in EV charging management, or existing charging infrastructure companies that add the service to their offering (Figure 2). Incumbent business solutions and data management could also enter the business of EV charging management. Finally, EVs could simply be managed by a balancing service platform as described above, as a component or a particular type of household appliance.

The platform technology for EV aggregation services is the charging "network", which includes the ICT with or without the hardware network. Most charging infrastructure companies do or plan to integrate smart charging solutions. Beyond the role of the traditional aggregator, which is to bundle multiple EV reserves to sell in the wholesale or balancing markets, a platform market here suggests the existence of diverse added-value services through complementary innovation and ICT.

III. 3 Platform pricing in electricity

The first salient conclusion from these cases is that having a single electricity market price for all residential and small commercial consumers could become obsolete in the new competitive landscape. Instead, electricity pricing should reflect the new realities of the system:

- differentiated needs for quality (consumer)
- differentiated elasticities of demand (consumer)
- differentiated environmental preferences (consumer)
- differentiated service preferences (consumer)

[6] In terms of total national energy demand, a mass shift of private transportation to EVs would not represent more than a 5 – 10 % increase in demand (Statnett 2012; Electric Power Research Institute 2007; Autolib' 2013). This additional energy demand could be met with no or little additional investment in generation assets.

- differentiated ability to provide services as resources (consumer)
- differentiated service offerings (supply)
- increased volatility (supply)
- availability of more granular data (supply).

The introduction of ICT that will allow information such as the origin source of electricity flows to be "attached" electricity will be the enabler of such product differentiation (Abe et al. 2011).

The second apparent conclusion from the cases is that a fee-based pricing method may best reflect the new interaction dynamics between generators, distributors, suppliers and end-users, as opposed to traditional marginal cost, transaction-based pricing. The allocation of electricity and value flows between market agents has the aspects of a platform service for two main reasons. First, the complexity of transactions and interactions in retail electricity markets can be expected to increase significantly in the next years, which makes it more costly to keep track of transactions. The complexity and lack of transparency of tariffs for customers could be simplified into simple fixed fee-type pricing. Second, the intermediation service makes it possible to achieve an optimally balanced system and benefit both sides of the market. This raises the need to re-allocate value and costs in such a platform.

Just as pricing strategies in telecom networks have moved away from call-based charges to subscription plans to access the network, offering various options for unlimited calls to certain phones, or unlimited text messages, we suggest it makes increasing sense to charge customers for electricity supply plans under the emerging market conditions. **The plan prices would be designed so as to encourage certain behaviours and to give up certain rights such as an unlimited, undifferentiated supply of electricity.** The next section explores platform pricing theory in a general case of balancing services in electricity retail markets.

III. 4 Cost allocation in a monopoly platform for electricity services

In retail electricity markets the number of suppliers can be considered as fixed as there is a limited number of potential suppliers of retail electricity, whereas the consumer group is potentially very large – up to 28 million households in the UK (Silva et al. 2011). A platform could acquire up to all consumers and all suppliers in the market.

The savings on the domestic electricity bill which a consumer can obtain are finite and reduced by the platform fee, so consumers have an interest in single-homing in electricity service platforms. In contrast, the energy supplier could decide to join multiple energy management platforms, so as to cover all customers in a country or region. As suppliers may multi-home they are not being courted by the platform; the rents they collect for supplying electricity are reduced by the price set by the platform to guarantee uptake of their production. The case of electricity markets is therefore similar to a competitive bottleneck case in Armstrong (2006) where one side single-homes and one side multi-homes.

In the case of electricity, as opposed to platforms such as operating systems, telecoms networks, file-sharing/cloud services, and online databases, the consumer does not *need* to go through a platform intermediary to obtain the good: he could stay with a traditional direct relationship to a supplier. However, a platform provider that internalises the price of energy would improve the efficiency of the market and reduce transaction costs. The services featured in the platform must therefore bring an added-value to the user. In economic terms, the implication of the consumer-related differentiation factors mentioned in section III. 3 above is that traditionally inelastic demand for electricity becomes elastic as a function of quality (reliability, flexibility, and security of supply) and environmental benefits (the demand for renewables vs. fossil fuels for each consumer will depend on the price differential). On the supplier side, we assume that the utility obtained from the platform depends on its intrinsic features, on the benefit from the number of consumers the platform reaches: the network externality parameter, on the value the supplier firm place on efficiency[7], and on the value they place on reducing volatility[8].

In practice, **households that are more sensitive to price changes and are willing to give up more control to the platform to shift, interrupt, or reduce their energy consumption, offer higher potential for volatility reduction and efficiency gains**. Consumers with higher elasticities of demand are therefore a more valuable resource to the system and should be compensated proportionally.

If two-sided market pricing strategies are applied in electricity markets, a long history of marginal cost pricing in the sector would be overturned. While marginal cost pricing was found to be the most effective solution in electricity to deal with the problem of sizing the system's (generation and T&D) capacity for peak load (Boiteux 1960; Houthakker 1951; Ruggles 1949; Steiner 1957; Williamson 1966), the entry of a platform service provider for balancing services in the retail market provides an alternative solution to the peak load problem. **A platform service provider could use stricter controls than price-based incentives to limit the demand at peak times, by effectively**

[7] As mentioned previously, the new RIIO regulation incentivises efficiency by factoring part of the gains into the distribution network operators' revenue calculation.
[8] The value of reducing volatility is high for generators with intermittent renewable power who must stay as close as possible to their production programme to avoid balancing costs and penalties, as mentioned above.

making some decisions on behalf of the consumer (constrained by pre-specified preferences). The alternative would be to provide an information service only, such as a web application that informs consumers of how to change their behaviour in real time to generate savings. If electric vehicle penetration remains low, the platform firm could purchase assets such as storage devices of its own to adjust capacity for times of peak demand.

IV. Electricity platforms: A new concept?

The electricity market has always had a network element that was a natural monopoly and acted as an intermediary between electricity generators and retail suppliers: the grid (Figure 6). In the physical electricity market, the transmission and distribution network operator could be seen as a platform "intermediary" as he is responsible for ensuring the balance of supply and demand at all times in the system. The equivalent in financial markets for electricity would be the trading mechanism (such as a power pool). Residential and small commercial loads are only considered in aggregate as loads, however, and so far the power system optimisation only takes places at the wholesale level. Our cases suggest this might change.

The electricity network or grid is characterised by economies of scale, where the high fixed costs of grid assets are paid for by consumers through T&D fees per kWh of energy consumed. The more consumers connect, the lower the average cost distributed over them. Consumers also benefit from same-side network externalities, as electricity network investments are more justified in areas where more people connect. Economies of scale are in fact a subset of same-side network externalities: users benefit from the presence of more users on the system due to lower prices and more capacity investment. This effect takes place up to a point at which the positive network externality becomes negative and the connection of additional marginal customers requires grid reinforcements and additional investments in generation capacity (Ruggles 1949). One might also affirm that the fact that consumers benefit from competition in retail supply is a type of cross-side network effect, as price-based competition should reduce final energy prices. Both of these effects take place in traditional electricity markets.

The establishment of a true platform market for retail electricity **with cross-side network externalities is limited, however, as long as electricity is considered an undifferentiated commoditised product**. The platform services described in our cases can only occur as a result of the differentiation of consumer preferences for electricity based on source, price, and quality of supply. The transition to a smarter system with real-time pricing, ICT, smart meters and appliances, leads to the possibility (and value) of an intermediation service provider to match consumers with specific energy services based on the newly available energy data. Cross-side network externalities start to become significant if suppliers can rely on participative consumers as resources. In this case, platform pricing makes sense in order to redistribute the costs in the system based on the cross-side and same-side network externalities.

Who bears the costs in a platform market for electricity? As we have seen, the supplier side benefits from the reduction of volatility and losses as well as from the stimulation of innovative activity in the electricity market which can attract new entrants in complements and open opportunities for new specialised services. We have shown that the supplier, due to the network externality effect, has an interest in helping the platform attract as many consumers as possible to gain control over their devices (appliances or EVs). In addition, there is a collective social benefit to increased platform adoption by consumers, because the solutions to the optimisation problem are more robust when more players participate, echoing Caillaud & Jullien (2003)'s point that a consolidated platform market does not necessarily carry inefficiencies. As for consumers, we have shown that consumers with higher elasticities of demand, who offer the most flexibility to the platform service provider, should be favoured in the pricing strategy. Customers with high overall demand are the most interesting to attract for balancing services (Strbac 2008) and should receive priority for lower platform fees. Further research should explore if demand elasticity is correlated with income to understand the distribution of impacts of such a strategy on lower income groups.

How many consumers should an electricity platform aim to acquire and at what cost? As with the current network effects, there is likely to be a saturation point for balancing services at which the value of each additional customer for the balancing service decreases (Silva et al. 2011). Smart metering data on energy consumption will help platform entrants identify which customers are the most valuable to integrate in the balancing service or smart EV charging system.

One reason to support third party entry for platform services, rather than internalise an equivalent optimisation service within existing electricity suppliers, is to stimulate innovation in electricity markets (Jacobides et al. 2006). Outsourcing the energy management service is a way of ensuring that new entrants and complementary providers will capture value in this market. Entry in the market between electricity distributors and end-users was previously inefficient due to low profit margins and relatively invariant consumer tariffs. In this paper we have argued that the match-making service is now becoming valuable and platform competition in electricity markets would drive innovative, value-added services that would be necessary to incentivise consumer adoption in the first place.

There are two possible configurations of the balancing service platform**: one where all the electricity transactions in the household are entirely managed through the platform, and one where the consumer still purchases most of its electricity from the supplier but also joins a platform for the extra service of optimal energy management**. In a two-sided market subscription-based tariff where the platform provider controls all of the electricity transactions between consumers and suppliers, as described in section III. 4 , the price of electricity sold from supplier to consumer can be internalised in the platform fee.

If the electricity platform provider internalises the price of the product, it would set a very different competitive structure than in other platform markets such as operating systems/applications, video game/consoles, and mobile phones/networks, where the platform and its associated products are paid for independently. The most clear comparison point would be mobile phone subscriptions. Another similar case to electricity services might be that of online music platforms such as Spotify or Soundcloud. Spotify accounts provide unlimited access to music via online streaming for a flat monthly subscription fee as well as music recommendations based on friends' playlists and personal history. The comparison with electricity platforms becomes interesting where ownership is concerned: despite the unlimited access to music, Spotify customers cannot download the pieces and therefore choose "use" of the music over ownership. In the case of electricity balancing services, customers relinquish some control over their household appliances and energy demand, which is equivalent to giving up a small part of ownership. A simpler tariff structure might reduce costs by avoiding the need to track the exact response of every household and would reduce the costs of customer complaints in billing.

One important point is the similarity of the outcome for consumers between a pure subscription-type fee for a platform retail energy service and the current fixed tariffs. The platform provider effectively shields consumers from variable time-of-use prices that are both inconvenient for them to track and understand, and that expose them to price risks that are beyond their control. In exchange for this "protection", consumers offer the platform the right to control – fully or partially – their load according to the optimal production times in the system. In this sense, the platform would allow the introduction of real-time pricing of electricity in the retail market to bring about its intended efficiency benefits to the system without the ethical concern of adversely impacting the distracted consumer (Hogan 2010; Faruqui 2010).

V. Conclusions

In conclusion, this paper shows that platform business models and two-sided pricing strategies can be expected to be part of the transition to a low-carbon efficient electricity system. The electricity retail market is emerging with the elements of a platform market, namely a need and high added-value for one or more “match-making” intermediaries between suppliers who cannot predict their generation and consumers who start participating in active energy demand management. This type of market matching service is currently in place for wholesale electricity markets and could be replicated as an optimisation service for the retail market with the entry of platform providers. The “matching” service of balancing supply and demand on local distribution networks would maximise social surplus in the system by enabling an efficient, low-loss, sustainable electricity market. As such, we found that an electricity platform could follow a two-sided pricing strategy where one side subsidises the other. In the context of electricity, a competitive bottleneck is likely to occur where suppliers can adopt multiple platforms to increase coverage and efficiency of the optimisation service, while consumers single-home. In this case, suppliers benefit from cross-side positive network externalities and are expected to partly or fully pay for the platform service and subsidise the consumer side.

We highlight that the entry of platform service providers as described in this paper through the cases of electricity balancing services and electric vehicle charging management, has the effect of shielding consumers from the unintended consequences of smart metering. The view that real-time pricing, enabled by the introduction of smart meters in the retail electricity sector, will be beneficial to the system, is often found in the literature (e.g. Faruqui et al. 2010). However, the unintended consequences of real-time pricing may overwhelmingly affect the more vulnerable consumers who do not have the capabilities to manage their energy demand. The introduction of a platform market to optimise household electricity management has the potential to reduce customer energy bills while providing demand-response services to electricity suppliers, the cost of which can be primarily distributed on the supply side who can increase their profits from higher value-added services. Subscription-based fees in an electricity platform market protect households from the volatility of real-time prices, while allowing these signals to be reacted upon by the platform mediator.

We also conclude that while the platform service could be provided by incumbent utilities and ESCOs, the value of the service justifies the entry of third party entrants distinct from existing players. These new entrants will have the additional benefits of stimulating innovation and new capital investment in the sector. ICT companies, for example, can bring new capabilities for smart energy management as well as for fostering complementary innovation in the market.

The optimal level of platform adoption by consumers remains to be determined. Some consumers will be more valuable resources for the supply side and grid management and the costs of customer acquisition for a platform requires these customers to be targeted by the platform first. In this sense, an electricity platform is different from typical platform markets where the network externality effect is unbounded and the platform's aim is to reach full market penetration. More subtly than in credit card markets, an electricity platform provider still has to convince two sides of the market to subscribe to be able to sell its service. In the case of electricity, a platform could be a partial or a full intermediary between consumers and their electricity suppliers, depending on the exact business model design.

Reviewing the literature on platform markets, we emphasise the "intelligence" aspect of a platform, as well as the opportunity for innovation and the establishment of innovation ecosystems, which distinguish it from ordinary marketplaces or input-supplier relationships in traditional markets. This research extends the intuition that ICT is an important component of a platform in a formal definition (section I.). We also distinguish the platform market from the platform technology (Gawer & Cusumano 2008).

The UK government suggests that a total of £110 billion of investment is needed towards the decarbonisation of the electricity sector in the UK by 2020 (UK Department of Energy and Climate Change 2013). The value of the balancing services market in the UK is on the order of £623 million per year (National Grid 2013), a large share of which could be captured by a platform service provider. A platform intermediary that minimises losses and improves the utilisation of the system in the retail sector therefore offers a valuable service to both consumers and suppliers. Ultimately, despite the competitive threat that new energy management platforms would pose to established utilities' sales and customer base, one objective of the sector is to increase investments in the industry from new players (UK Department of Energy and Climate Change 2013). The entry of new platform-type service providers from the IT and software sectors would allow new capital into the sector and fulfil the objective to develop its innovativeness.

Figures

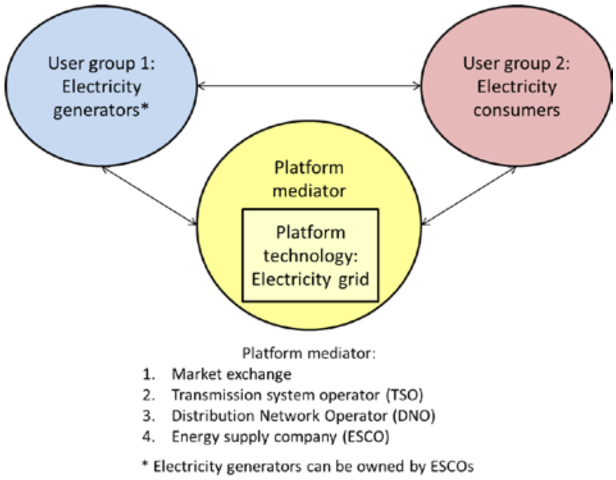
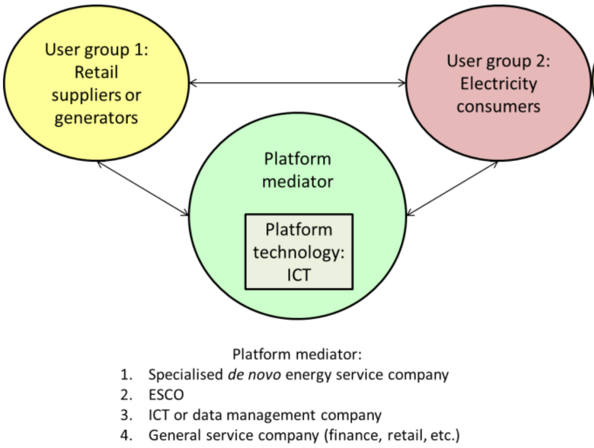


Figure 1. Platform in a traditional electricity market



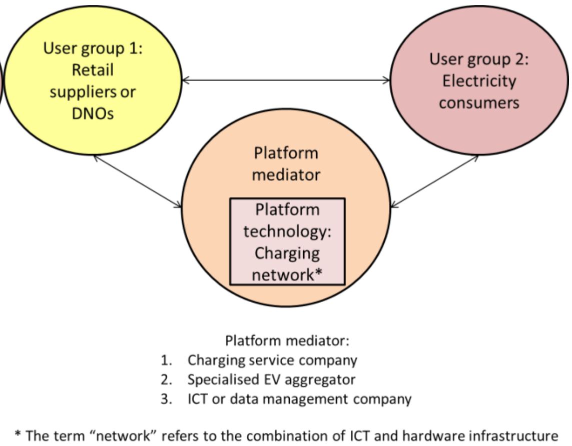


Figure 2. Platform in balancing services market

Figure 3. Platform in electric vehicle market

Figure 4. Pricing structure in a platform: From pure transaction to pure subscription tariffs.

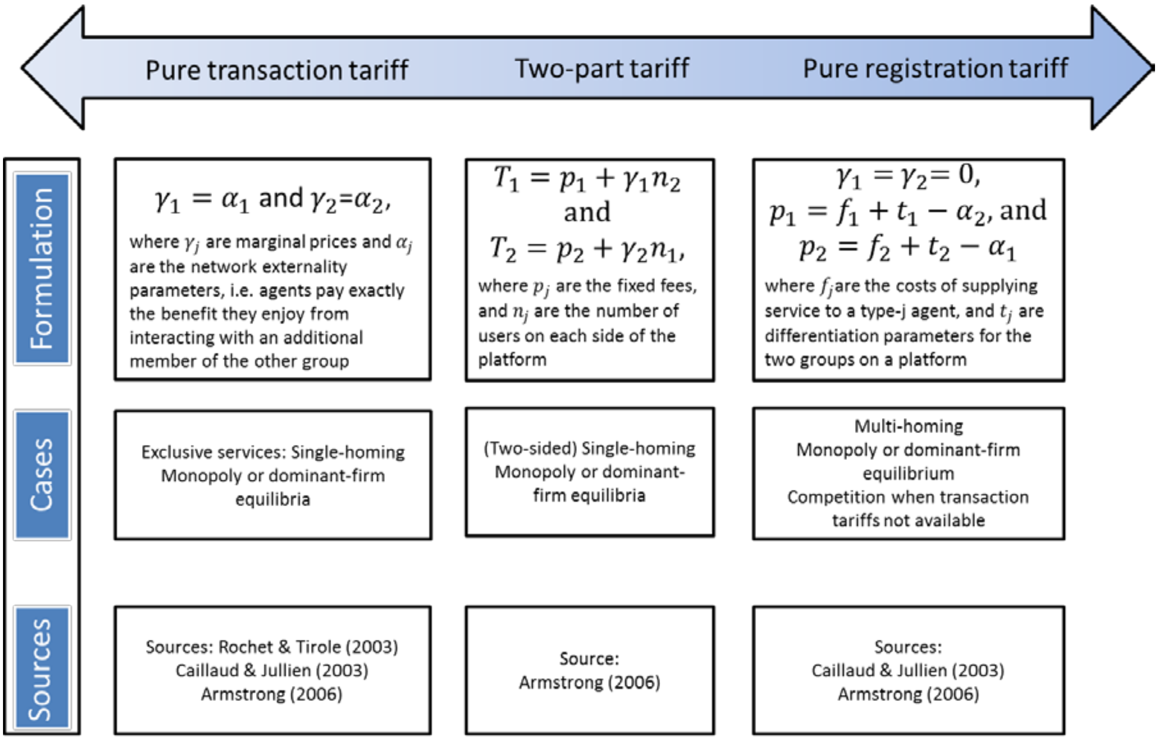


Figure 5. Proprietary vs. open-source platforms

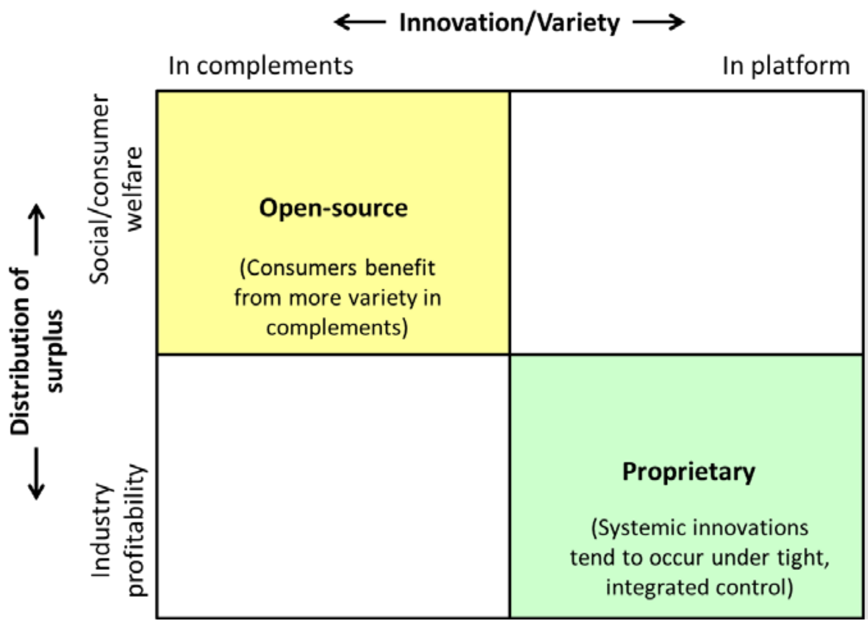


Figure 6. Conventional market structure in the electricity supply industry in England and Wales

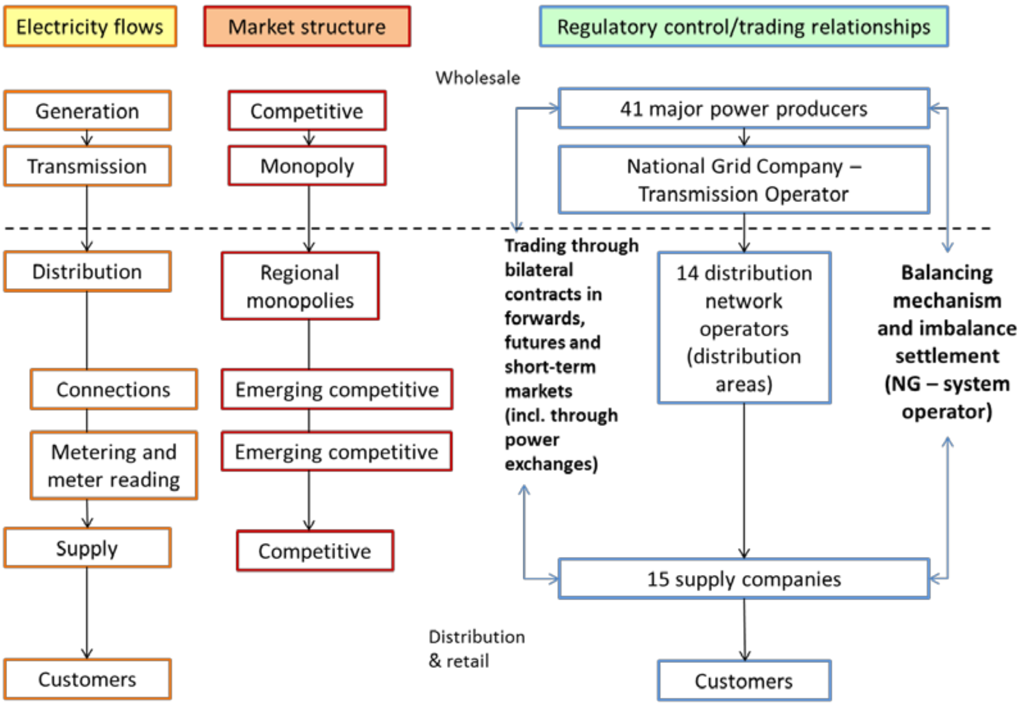
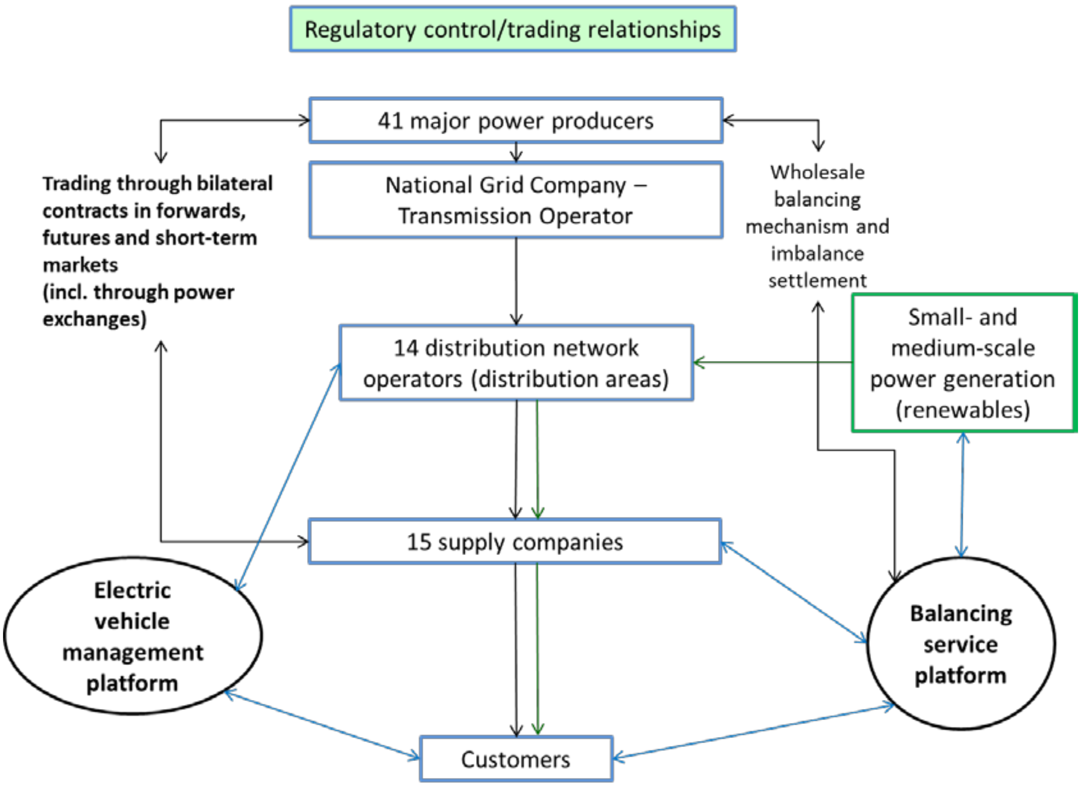


Figure 7. Modification of the market relationships (Figure 6) with two platform entrants: balancing services and electric vehicle aggregating agents.



Sources: Adapted from Simmonds (2002); updated from (UK Department of Energy and Climate Change 2012b; Ofgem 2012)

Tables

Table 1. Examples of industries that have transitioned from non-platform markets (see table below) to becoming Internet-based "platform" markets

Features Examples	Cited in	Number of user groups	Network externalities	Platform technology	Complementary innovation	Added-value platform (inherent)	General-purpose technology	Impact on un-related industries	Facilitates exchange or processing of digital information
Web search	(Eisenmann, Parker & Alstyne 2006)	3 (websites, readers, and advertisers)	Cross-side positive?	Internet	High (e.g. semantic web)	High (customized intelligent search, bundle with other Internet services like e-mail and chat)	Internet	High	Yes
File storage: Cloud computing (e.g. Dropbox, Google Drive, Sugarsync, iCloud)	New!	1 (users)	Same-side positive	Internet	High	High (Remote access, sharing, security)	Internet and ICT	High	Yes
Online retail, music, trading platforms, and auctions (e.g. eBay, Amazon MarketPlace, Rocket Internet, iTunes, Spotify)	(Hagiu & Wright 2011)	1 or more (1 for peer-to-peer selling; 2 for buyers and sellers)	Cross-side positive	Internet	Medium-High	Medium (time saving, information completeness and symmetry, convenience) –these are mostly related to the utility in interaction mediation	Internet	Limited- Mostly on business model of given industry	Yes
News and educational media	(Parker & Van Alstyne 2005)	3 (readers, publishers, and advertisers)	Cross-side positive between readers and publishers	Internet	Medium (online education changes in learning methods, news changes e.g. wiki and contributor blogs)	High (more interactive content, real-time dynamics, unlimited access to news...)	Internet	Limited	Yes
Dating, recruiting, and social networking websites	(Armstrong 2006; Hagiu & Wright 2011; Boudreau & Hagiu 2009)	2 or 3 (generally 2 user groups and advertisers)	Cross-side positive except with advertising?	Internet	Low-medium	Medium (efficiency and symmetry of information) – mostly related to interaction mediation	Internet	Not necessarily – mostly on advertising	Yes

Table 2. Contested examples of platform markets

Features Examples	Cited in	Number of user groups	Network externalities	Platform technology	Complementary innovation	Added-value platform (inherent)	General-purpose technology	Impact on un-related industries	Facilitates exchange or processing of digital information
Electricity networks	(Eisenmann, Parker & Alstyne 2006)	2 (generators and consumers)	Cross-side positive	Transmission grid	Low	Low	Electricity	High	No
TV networks	(Rochet & Tirole 2003)	2 (channel providers and viewers)	Cross-side positive	Television and screen technology	Low-medium	Low	Transistor, electricity	Medium (mostly advertising and media)	No
Shopping malls, retail services, real estate agencies	(Hagiu & Wright 2011)	2 (buyers and sellers)	Cross-side positive	None	Low	Low	None (other than electricity)	Limited	No
Stock exchange, auctions	(Parker & Van Alstyne 2005)	2 (buyers and sellers)	Cross-side positive	None	Low	Low	None	Medium	Yes
Newspapers, academic journals	(Parker & Van Alstyne 2005; Rochet & Tirole 2003)	2 (readers and writers)	Cross-side positive	Print	Low	Low	Printing press	No	No
Yellow page directories	(Armstrong 2006; Eisenmann, Parker & Alstyne 2006)	2 (companies and consumers)	Same-side positive	Print	Low	Low	Printing press	No	No

Table 3. New and confirmed examples of platform markets

Features Examples	Cited in	Number of user groups	Network externalities (other than economies of scale)	Platform technology	Complementary innovation	Added-value platform (inherent)	General-purpose technology	Impact on un-related industries	Facilitates exchange or processing of digital information
Electric vehicle charging infrastructure and service network	New!	2 (car owners and electricity suppliers)	High	Charging infrastructure and ICT (Cloud services)	High	High	Electricity and ICT	Medium-High	Yes
Retail electricity balancing services	New!	2 (distribution grid operators and consumers)	Medium	ICT	High	Medium	ICT	Limited	Yes
Healthcare database systems (Watson)	New!	Multiple (health professionals, consumers, and complementary service providers)	Not necessarily	Database system/software	High	High (improved evidence-based practice, service personalisation)	ICT	Potentially high	Yes
Telephone networks	(Eisenmann, Parker & Alstyne 2006)	1 (call makers and receivers)	Not necessarily	ICT (Wired and wireless network)	High	High	ICT	High	Yes
Credit cards (Amex)	(Rochet & Tirole 2003)	2 (merchants and consumers)	Cross-side positive	Chip and card	Medium	High	ICT	High	Yes
Operating systems	(Rochet & Tirole 2003)	2 (application developers and consumers)	Cross-side positive; same-side (application developers) negative; same-side (consumers) positive when proprietary platform	Computers, smart phone or tablet	High	High	ICT and processors	High	Yes

Table 4. Platform technologies

Features Examples	Cited in	Number of user groups	Network externalities (other than economies of scale)	Platform technology	Complementary innovation	Added-value platform (inherent)	General-purpose technology	Impact on un-related industries	Facilitates exchange or processing of digital information
Video game consoles	(Rochet & Tirole 2003)	2 (players and game developers)	Cross-side positive	Game console or supporting device	High	Low	Graphics processing unit, AI technology	Low	No
Processors (e.g. Intel, ARM)	(Economides & Katsamakas 2006)	1 (electronic device manufacturers)	No	Transistor and processor itself	High	High	Transistor	High	Yes
DVDs (previously, VHS)	(Eisenmann, Parker & Alstyne 2006)	2 (viewers and content providers)	Cross-side positive	DVD and player	Medium	High (quality, durability)	Data compression format	High	No
Wifi equipment	(Eisenmann, Parker & Alstyne 2006)	2 (laptop users and access points)	Cross-side positive	Router	High	High	Internet	High	Yes
Text processors and portable document readers	(Rochet & Tirole 2003)	1 (readers and writers)	Same-side positive	Computers and other supporting devices	Low	High	Computer	High	Yes
Gasoline-powered engines	(Eisenmann, Parker & Alstyne 2006)	3 (car owners, car sellers and energy suppliers)	No	Internal combustion engine	Low	High	Internal combustion engine	High	No

Added-value in the platform considered “low” when it is only a matter of changing user functionality.

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