UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

The prospects for smart energy prices: observations from 50 years of residential pricing for fixed line telecoms and electricity

EPRG Working Paper 1611

Cambridge Working Paper in Economics 1622

Musiliu O. Oseni and Michael G. Pollitt

Energy Policy Research Group

Judge Business School, University of Cambridge, CB2 1AG, UK

Abstract This study focuses on how energy and communications have evolved over the last 50 years and what we can learn from history in order to examine the prospects for smart energy pricing by 2050. We begin by discussing the nature of energy and telecoms products and why price discrimination should be expected. We then review various business and pricing strategies that have evolved in the two industries. We find that business models for both the telecoms and energy sectors have changed from the traditional services business model (i.e., offering of calls and messages for telecoms, and utility supply services for energy) to more dynamic, integrated and complex business models. These new business models include the managed services provider model, the bundled services model, and the prosumer business model, among others. Similarly, several changes in pricing structure have evolved. There has been a reduction in the number of distanced-based and increasing time-based price differentiation in fixed line telecoms and the abolition of residential floor area-based differentiation in residential electricity pricing. We conclude with a discussion on how the rollout of the next generation of electricity meters (smart and advanced meters) may further shape electricity pricing in the future.

Keywords smart pricing, business models, telecoms, energy, residential, UK

JEL Classification L94, L96

Contact m.oseni@ucl.ac.uk; m.pollitt@jbs.cam.ac.uk
Publication March, 2016
Financial Support EPSRC Autonomic Power System Project

The prospects for smart energy prices: observations from 50 years of residential pricing for fixed line telecoms and electricity

Musiliu O. Oseni and Michael G. Pollitt[1]

Energy Policy Research Group

Judge Business School, University of Cambridge, CB2 1AG, UK

Abstract

This study focuses on how energy and communications have evolved over the last 50 years and what we can learn from history in order to examine the prospects for smart energy pricing by 2050. We begin by discussing the nature of energy and telecoms products and why price discrimination should be expected. We then review various business and pricing strategies that have evolved in the two industries. We find that business models for both the telecoms and energy sectors have changed from the traditional services business model (i.e., offering of calls and messages for telecoms, and utility supply services for energy) to more dynamic, integrated and complex business models. These new business models include the managed services provider model, the bundled services model, and the prosumer business model, among others. Similarly, several changes in pricing structure have evolved. There has been a reduction in the number of distanced-based and increasing time-based price differentiation in fixed line telecoms and the abolition of residential floor area-based differentiation in residential electricity pricing. We conclude with a discussion on how the rollout of the next generation of electricity meters (smart and advanced meters) may further shape electricity pricing in the future.

[1] The authors acknowledge the financial support of the EPSRC Autonomic Power System Project. They also wish to thank Ivana Kochar for her encouragement and EdF Energy for their help with data collection. Comments from anonymous referee are appreciated. EPSRC data statement: there is no data associated with this paper, beyond that reported in the paper. All remaining errors are the responsibility of the authors.

Correspondents: m.oseni@ucl.ac.uk (M. O. Oseni); m.pollitt@jbs.cam.ac.uk (M. G. Pollitt)

1. Introduction

Active consumer participation is essential for harnessing demand flexibility, improving the integration of intermittent solar and wind renewable energy resources and achieving low carbon power systems without excessive costs related to network reinforcement and the provision of reserve generation and storage capacity. With an increase of renewable generation integration, demand flexibility can significantly improve the viability and value of renewable generating resources (Awerbuch, 1997). The seminal work by Schweppe, Caramanis, Tabors, & Bohn (1988) on spot pricing of electricity discusses responsiveness of demand since as being the best remedy for market power that generators may have. One way to achieve this active consumer participation is through smart energy pricing – the pricing of energy in real or near-real time – made possible by effective data communication between suppliers and consumers.

Potentially, smart pricing can promote the use of dynamic pricing (i.e., time of use pricing), and can trigger or improve efficient energy use among consumers. Consumers' response to smart pricing, such as real- or near-real time tariffs, can further be promoted by smart appliances, which can be connected to a system that remotely controls the operations of such appliances with minimal or no end-user intervention. Although it is expected that increasing automated smart appliances and introducing smart energy pricing could potentially raise consumer response/engagement, consumers' concerns about privacy of the use of smart appliances remain (Oseni et al., 2013). However, addressing consumers' concerns plus improvements in technology in the future is expected to further improve the roll-out of smart prices.

Smart pricing is about information and involves the integration and/or reinforcements of energy networks with information technology. Thus, it would be important to review the evolution of price changes in telecoms vis-a-vis the energy pricing in order to examine the prospects for future smart energy pricing. This paper reviews the evolution of price changes in residential fixed line telecoms and electricity in the last 50 years in the UK and what we can learn from history in order to examine the prospects for smart energy pricing by 2050, based on past behaviour of firms and their customers. This study is structured as follows: the next section looks at the nature of telecoms and energy products that allow for price discrimination. Section 3 reviews various business models and pricing strategies that have evolved in the two industries. This is followed by a brief discussion of methodology. Section 5 discusses the changing structures of residential electricity and fixed line telecoms pricing in London from 1960, while the last section concludes.

2. Theory of Pricing

Pricing is an important element of marketing because it determines what a firm would receive in exchange for its product or service. Pricing constitutes the only profit-generating element of the four Ps of marketing mix.[2] Because consumers' wants or desires can be converted into effective demand only if they have the willingness and ability to buy the product, pricing becomes a very important tool in marketing. A pricing strategy refers to the process of selecting an appropriate price for a product for the purpose of achieving a firm's objective. According to Tellis (1986 pp.147), "a pricing strategy is a reasoned choice from a set of alternative prices (or price schedules) that aim at profit maximization within a planning period in response to a given scenario". This definition implies that a firm may have a different set of alternative pricing choices, but it has to decide on the best pricing option(s) that would satisfy its objective given a particular circumstance – a firm may adopt a combination of pricing strategies.

In theory, differential pricing is to be expected in telecoms and energy because of the time and place varying nature of demand. In telecommunication networks, components and facilities are geographically located in relation to final consumers, and time of demand often varies from one consumer or one geographical area to the other, which often commands varying costs of service delivery. Similarly, energy networks are located on the basis of the geographic positions of both energy sources and of final consumers. Because energy services must be produced in (near) real time and are largely non-storable, energy (electricity and gas) service companies have to supply different locations, and at different times. The need to efficiently supply a time-varying demand would require a balancing of production across several generating units having different capital/fuel cost ratios.

Moreover, both (telecoms and energy) services are capital intensive, with large fixed costs that have to be recovered. The capital-intensive nature of the industries means that service providers need to recover the fixed costs of the network without undermining scope and scale effects. Thus they must design an appropriate pricing system. In designing appropriate pricing to recover these costs, there are a number of options available for service providers to choose from: they can charge a fixed sum for network access independent of consumption (e.g. by charging everyone equally regardless of consumption); they can charge consumers progressively based on their consumption and time of demand; they can charge (some) retail consumers more in line with Ramsey pricing (by taking into consideration the variation in customers' price elasticity of demand); they can use two part pricing (comprising a fixed lump sum and a 'pay as you consume' portion), or charge time varying tariffs.

Notwithstanding the similarity between the two sectors, there are potential differences between them, which suggests that time of use and greater use of differential pricing would be expected to be of greater use in the electricity sector. Unlike energy services, telecoms services have very small variable costs because production facilities have well-determined capacities, and the costs of operation do not necessarily reflect the flow of services through those facilities (Mitchell & Vogelsang, 1991). "Due to

[2]The other three elements of marketing mix (including product, promotion, and place) can only indirectly influence firms' revenue and profits by influencing product pricing through their effects on price elasticity.

the extensive use of electronic components [in telecoms], maintenance and energy costs are mostly the result of simply operating a facility and are nearly independent of its actual use" (Mitchell & Vogelsang, 1991: pg. 9). In contrast, the short-run marginal costs of generation is dependent of the (costs of) energy used by the generating unit, this marginal costs varies significantly in time and space. Apart from the volatility in fuel prices, meeting peaking energy demand commands greater marginal/variable costs as less efficient and expensive (generating and distribution) facilities are operated in order to meet consumer needs.

An important factor that might determine the pricing strategies of a firm is its business model. "A business model articulates the logic and provides data and other evidence that demonstrates how a business creates and delivers value to customers" (Teece, 2010, p. 173).[3] It includes the way in which the technology and human capital are combined, plus the pricing system to create value for consumers while ensuring an acceptable profit margin. Many scholars refer to a business model as a statement of how the firm makes profit (Stewart & Zhao, 2000) and/or how technological inputs are transformed into economic outputs (Chesbrough & Rosenbloom, 2002; Chesbrough, 2003). Magretta (2002) refers to business models as how physical, human and other resources are combined and transformed into value for customers and other parties, and how the value generating firms are rewarded by the parties that receive the value from it. Teece (2010) argued that a good business model must be able to deliver value propositions that are appealing to (i.e. create value for) customers, cost effective and relatively less risky, and enables considerable value capture by the business that generates and delivers products and services.

Value proposition, value creation and value capture interact with one another and do not necessarily imply traditional marginal cost-based pricing is the optimal strategy. Value proposition is a firm's promise or commitment to deliver a good or service (value) – e.g., a promise to connect an area to energy network, or a promise to deploy smart meters to customers. Value creation refers to the development of the goods or services to be delivered, while value capture is about how the benefits of the value created are shared by the firm, customers, society, etc. This implies that a business model deals with the development of new products, so this is not all about pricing energy, but also power quality and distributed generation access, among other things. An effective business model often makes firms go beyond traditional marginal cost-based pricing considerations. This is because the size of the value a firm is able to capture is determined by a number of factors including their market power, e.g., exercised through structural and strategic barriers to entry, and the ability to engender differentiation vis-à-vis its competitors (Bain, 1956; Pitelis, 2008).

[3] The literature on business models has grown significantly. However, a comprehensive review of this literature is beyond this study. Readers interested in this literature are advised to see Zott, Amit, & Massa (2011) and Wikström, Artto, Kujala, & Söderlund (2010).

A business model can be either operationally focussed or profit generation driven. An operationally driven business model focuses on the internal processes that enable the business to create value, such as production or service delivery methods, administrative processes, resource streams, knowledge management, and logistical flows (Morris, Schindehutte, & Allen, 2005). A profit generation driven business model typically identifies revenue sources, pricing strategies, expected volumes, cost structures and profit margins as the main targets (Wikström, Artto, Kujala, & Söderlund, 2010), suggesting that a firm's business model goes a long way in determining the pricing technique it adopts. For instance, a firm using the 'razor-razor blade business model' would likely price low its core item but aggressively mark-up the supporting products or services.

Noble & Gruca (1999) and Tellis (1986) identified product differentiation, economies of scale, capacity utilisation, switching costs, heterogeneity among consumers, nature of firms/industry, and the product features as the major determinants of pricing strategies. Based on these factors, Tellis (1986) classified pricing strategies into three broad groups: differential pricing – selling of the same brand at different prices to different consumers; competitive pricing – setting of prices to exploit competitive opportunity; and product line pricing – selling of related brands at prices that exploit mutual dependencies or complementary. Noble & Gruca (1999) broadly grouped the existing pricing strategies into four including cost-based, new product, competitive, and product line pricing. Table 1 shows a number of pricing strategies and what they mean for energy pricing. Only some of these pricing strategies suggest an increasing price differentiation.

Table 1: Price theories and application to energy pricing

Name	***Definition***	***Application to energy***
1. Cost-based pricing	Price of a product is set at a point that yields a specified profit margin over cost. This was previously the most widely used pricing strategy (Kaplan, Dirlam, & Lanzillotti, 1958; Noble & Gruca, 1999).	Energy tariff is set at the cost of provision plus a certain profit margin. It's based on the internal costs of providing electricity, and does not signify price differentiation.
Marginal cost	Price of a product or service is based on the extra cost of a unit.	Tariff is set at cost of providing an additional kWh.
Ramsey pricing	Prices of products are set based on their elasticities.	Consumers with inelastic demand are expected to pay more for a kWh.
2. Differential Pricing	Identical or largely similar products are sold, by the same provider, at prices that are in different ratios to their marginal costs (Stigler, 1987).	Prices are discriminated among consumers.
a) Second-degree differential pricing	Different prices are charged for different quantities, such as quantity discounts for bulk purchases.	Examples are rising block and decreasing block tariffs. Prices are differentiated over a set block of units.
b) Third Degree Differential Pricing	Prices are based on the heterogeneity in consumers' demands	Tariffs are set based on the heterogeneity in demand, e.g. commercial vs. residential, peak vs. off-peak, old age tariffs, etc.

Second market discounting	Used when there are potentially two differentiated markets or market segments in which a firm can sell its product at different prices.	Tariffs are differentiated between two groups of consumers (e.g., residential vs. firm), or geographically (e.g., outside the former incumbency area discounts).
Periodic discounting	Exploits differences in the timing of consumers' demand (and their willingness to pay) to sell the same product at different prices.	Peak-load pricing is a common example of periodic discounting pricing technique often adopted by utilities – electricity, gas and telephones (Houthakker, 1951). Peak-load pricing charges a higher price at the periods of peak demand but charges a lower price during off-peaks. The peak load pricing by utilities is made possible by being able to split the market into peak and off-peak use. Other examples include time of use, critical peak, etc
3. Product Line Pricing Strategy	Product line pricing strategies are used by a multiproduct firm, which offers a set of related products. The firm uses product line pricing to maximise profit by pricing its product to match consumer demand. However, the application of a particular form of product line pricing depends on the nature of either the demand or the level of cross-subsidies existing among the firm's products.	E.g., Selling gas at zero margin within dual fuel electricity and gas bundle.
Price bundling	Several products and/or services are offered for sale as a single combined product. This combined product is offered at a discount price, so that it is more attractive to buy the products and services as a bundle than buying them separately (García-mariñoso, Martinez-giralt, & Olivella, 2008).	The dual fuel product, where a consumer gets his electricity and gas supplied by a single supplier at a discounted tariff. Discounts could be lump-sum or per unit.
4. Complementary pricing	This pricing technique is adopted when a firm faces consumers with higher transaction costs for one or more of its products.	Two-part pricing, where tariff comprises a fixed lump-sum charge (e.g., connection/metering charge) that does not vary with usage and variable charge that is consumption or usage dependent (e.g., per kWh charge).

3. Evolution of Business Models and Tariffs Plans in the UK Telecoms and Energy Sectors

Business models

Advances in technology coupled with the aggressive competition and falling prices, which resulted from the liberalisation of the communications and energy industries, have led to significant changes to the traditional telecommunications and energy business models. Exploring new business models that generate new revenue became just as important for operators as achieving operational efficiency and retaining customers. Several business models have emerged in the communications industry. Advancements in wireless network technology, the continuously increasing number of users of hand-held terminals and changes in data usage patterns, gave rise to a wide set of innovative internet and mobile business application services (e.g. internet-banking, e-commerce, mobile banking, etc) (Olla & Patel, 2002; Tsalgatidou & Pitoura, 2001). These radical changes in communications (due to the advent of new technologies and market regulation) resulted in the reconstruction and redesigning of the established value chains, evolving into more complex value networks, with the entry of new innovative and powerful players and the transformation of the role of traditional players.

There has also been a wave of changes in the business models operated in the energy sector. Energy utilities have changed from their traditional function of sending energy over long distances to passive end-customers to rendering of services that are essential for an effective energy market. This change was necessitated by increasing competition, rapid technology innovation, the need to improve consumer engagement and the changing policy environment, which aims at ensuring environmental sustainability. Table 2 presents some of the business models that have emerged in telecoms and energy over the last 50 years.

Table 2: Business models in energy and telecoms

Telecoms	
Name	Short description
1. Integrated business model	Integration and introduction of new services. Fixed operators have moved to mobile markets, mobile and fixed operators have included fixed broadband services in order to raise revenue. Operators have also introduced new services, such as content delivery, with the launch of Internet Protocol Television (IPTV) and mobile TV. Many operators have moved from being single service suppliers to multiple services providers in order to diversify their portfolio. As at 2012 for instance, BT (the former fixed line monopoly incumbent) was the largest broadband provider with a 30% share of the total UK broadband market including cable, 37% share of the Digital Subscriber Line (DSL), LLU and fibre broadband market, 4% of the IPTV, 67% of the Satellite TV, 26% of the Cable TV, and at the same time constituted the largest (47%) provider of fixed lines to households (BT, 2012). Similarly, providers such as O2, Everything Everywhere (EE) and Vodafone still have a significant share of the fixed broadband subscribers despite being the major operators in the mobile market.
2. Managed services provider model	A system where a network assets owner (the incumbent) offer a complete suite of services to others including traffic management, billing, end user connects and disconnects, and charge them (other service providers) for the services rendered. This practice has evolved in the UK telecoms industry over the years due to regulatory requirements and increasing competition. Services currently provided by BT include a broad range of voice, broadband and data communications services for fixed and mobile network operators (MNOs), internet service providers (ISPs) and telecoms resellers in the UK, managed network services (MNS) for fixed and mobile CPs, mobile virtual network operator (MVNO) services and mobile voice and data sale services to other providers (e.g. Vodafone), among others (BT, 2012).
3. Bundling	Providers have been using discounted pricing and other incentives that encourage customers to purchase their entire bundle of telecommunications services from a single supplier. Globally, bundling of services has become popular in the communications industries and the proportion of consumers who purchase service bundles has risen steadily over recent years. In a recent survey of broadband users in six countries, Ofcom found that between 68-86% of broadband customers purchased the service in a ‘bundle’ (Ofcom, 2011). The most popular additional service was fixed voice (35% of respondents across all the countries), followed by fixed voice and pay TV (14%), and fixed voice and mobile voice (10%). A ‘bundle’ of two services, known as ‘dual-play’ was the most popular choice accounting for 45% of broadband subscribers, followed by 25% with three services (triple-play) and 5% with four services (quad-play). Evidence has suggested upward trends in the bundling of services among the UK homes. Ofcom found that, compared to 57% in 2012, 60% of UK households purchased more than one communications service from a single provider during the second quarter of 2013 (Ofcom, 2014).
Energy (Electricity and Gas)	
1. Community energy model	This is defined as community projects or initiatives focusing on energy use reduction, better energy management, increased energy generation, and energy purchase (DECC, 2014). An example of such new business model initiatives is the Scottish government’s draft Community Energy Policy Statement (The Scottish Government, 2014), which focuses on projects that are led by constituted non-profit-distributing community groups established and operated across a geographically defined community. Another example of such community business models is evidenced in the Welsh government’s support programme for community energy, Ynni’r Fro,[1] which supports the development of community-owned renewable schemes. It is estimated that up to 3 GW of community electricity generating capacity could be installed in the UK by 2020 (DECC, 2014).
2. Municipal energy model	This refers to a number of municipally owned and operated energy companies. These organisations take several forms and include ownership of generation and supply of electricity or gas as a licensed supplier, purchase of electricity and gas on the wholesale market and supplying to the retail market, provision of electricity through private networks (or even potentially becoming licensed Distribution Network Operators), or in partnership with licensed suppliers (Ofgem, 2015). The major goal of such business schemes is to eradicate poverty or improve environmental sustainability through carbon emissions reduction.

3. Energy Service Companies (ESCos) model	Energy companies have moved from their traditional functions of supplying energy to consumers to being energy services providers/companies. They now provide energy services (such as hot water or lighting) as part of bespoke, value-added, long-term contracts in order to maintain a close and open relationship with their customers. These new business models include financing, designing, building, operating and maintaining small-to-medium scale demand management and/or low carbon energy projects, as part of either energy service contracts (focusing on provision of useful energy streams such as hot water) or energy performance contracts (focusing on providing final energy services such as light). The ESCos and traditional utility companies differ in a number of ways: the first is that the ESCo revenue is incentivised to reduce its customers' energy consumption by promoting energy efficient programmes. Another key difference is that ESCos activities can fall outside the current regulatory arrangements. For instance, heat delivered through heat networks is not currently regulated by Ofgem (Ofgem, 2015). Some municipal energy supply organisations operate under an ESCo model.
4. Multi-service provider model	As it is in the telecoms sector, one of the business models that currently characterise the retail energy (electricity and gas) sector in the UK is bundling of energy services, known as dual fuel contract. This refers to a system where a single energy company is responsible for the supply of both electricity and gas to a customer, often at a discounted rate compared to when different companies offer the two energy services. Evidence suggests that over 70% of domestic energy consumers surveyed now have both their electricity and gas supplied by a single supplier (Moon, Rodgers, & Mchugh, 2015). Moreover, multi-service provider model also refer to an arrangement where energy firms offer multiple services. For instance, energy firms may offer telecoms services and/or entertainment in addition to their original energy service provision.
5. White label	In this arrangement, a white label provider partners with a licensed supplier to supply energy (electricity and gas) to consumers using its own brand. Under this business arrangement, Sainsbury's Energy has partnered with British Gas (the former monopoly gas incumbent) to offer energy to consumers, while Woodland Trust Energy and M & S Energy have respectively partnered with OVO Energy and SSE (Ofgem, 2015).
6. Prosumer business model	An arrangement where consumers generate electricity, by engaging in micro-generation, for their own consumption and/or to sell to the grid. Thus, in the UK, domestic consumers are becoming producers in their own right, generating electricity through solar PV panels and other technologies (e.g., small wind, hydro and anaerobic digestion, etc.). These business arrangements are promoted by government through a subsidy scheme known as a Feed-in-Tariff. The model is also supported by some organisations who allow households to enjoy these technologies through various financing schemes, such as rent-a-roof PV schemes. Other technologies that have aided the operation of this model include smart thermostats and other smart grid devices (e.g., smart meters, in-home displays) that can be operated remotely and could deliver energy cost savings.

[1] See http://gov.wales/topics/environmentcountryside/making-a-difference-on-the-ground/mid-and-west-wales/ynni-r-fro/?lang=en

Tariffs

The last few decades have witnessed radical technological and institutional changes in global telecommunications. These developments – including fiber-optic cables and digital switches, cellular telephones, long distance service competition, and the divestiture of dominant firms (such as BT in the UK) – have deeply affected the practice of telecommunications pricing. New and modified methods of pricing services have been developed and designed to achieve increased economic efficiency and socially acceptable, welfare enhancing distributive outcomes.

In telecoms, as a result of advancement in technology, there have been remarkable cost reductions particularly in long-distance transmission, where high-capacity fiber-optic cables and improved multiplexing have greatly increased capacity. There have been changes such as fewer distance bands and less price sensitivity to distance, and smaller differences between peak and off-peak rates. Optional tariffs, offering simplified and uniform per-minute rates regardless of distance, have become popular with residential and small business users. Providers have expanded these tariff plans, by offering a variety of packages, some of which include giving discounts on standard rates on daytime and evening period services (Mitchell & Vogelsang, 1991).

The introduction of toll-free-number services, such as 0800-numbers, constitutes a form of business and pricing innovation that provides automatic call payment by the receiving customer. This service has been attractive to a very wide size range of customers due to increased network flexibility and volume-pricing plans. Many local exchange carriers have also introduced some type of per-call or per-minute pricing for the most local calls by residential consumers, as an option or replacement for the often-standard fixed monthly rate charged for an unlimited number of local calls. This plan is often available to customers on pay-as-you-go service contracts. Also, fixed payments contract have been extended to mobile calls. At least 45% of phone owners and up to 83% of smart phone users currently use fixed contract plans in the UK (Nielsen, 2013).

Another pricing scheme associated with the long-standing features of local service tariffs is applied by grouping of consumers into residential and commercial users, upon which tariff rates are based. For instance, monthly business rates are significantly higher – typically two to four times those for residential subscribers. Also, residential and business customers are often supplied under different tariff structures, with residential service bundling access and local calls, while business customers are billed for each call.

In energy similar changes in business models and smart technological innovation have necessitated a move away from cost reflective pricing. Several pricing strategies have been introduced. An example of such tariffs is the *fixed tariff* plan where the unit price is set at a certain rate for the life of the tariff. Consumers on this tariff plan pay the same price per unit of energy consumed regardless of wholesale price changes over the period of contract. According to Moon, Rodgers and McHugh (2015), fixed tariff is the second most popular tariff contract in the UK (38%) after the standard variable tariff (57%). *Rising block tariffs* or *increasing block tariff*, a pricing structure in which the unit price of electricity or gas rises as consumption increases, has also been introduced. The increases in tariff occur at stepped intervals, with a low- (or zero) priced block(s) to cover basic/essential energy use, and subsequent blocks charged at higher unit prices. This tariff structure provides incentives to reduce demand among higher energy users while also ensuring that supplier costs are recovered through the higher charges for larger energy users. The tariff system is commonly operated in South East Europe, as well as part of Belgium (Energywatch, 2006) but is currently less common in the UK. The government suggests suppliers may consider introducing a rising block tariff under the Supplier Obligation, particularly if the more radical 'cap and trade' option is launched (Defra, 2007). However, effective implementation and acceptance of this tariff are not likely to be effective unless the government mandates all suppliers to structure their tariffs in this way (Thumim, White, Redgrove, & Roberts, 2007). Otherwise, many high-use consumers may switch to suppliers that offer a different tariff structure.

Energy companies have also introduced (or experimented with) time-of-use tariffs, where prices differ according to the time of day. The main objective for implementing these variable tariffs is to encourage consumers to reduce demand during regular peak periods. Consumer can respond to this pricing system by shifting their consumption to the lower priced (i.e., off-peak) periods of the day, for example by changing the time at which they use their appliances. Other time varying tariffs include 'critical peak pricing tariffs', which have high per-unit rates for usage during designated 'critical peak periods', and 'real-time pricing tariffs', which reflect the wholesale price of electricity and therefore vary continuously over time. The operation of real-time and other time-of-use tariffs are aided by smart technology. These tariffs account for uncertainty in demand that could lead to random network congestions due to high demands at certain periods. Instead of using rationing methods, the real time tariffs can be continuously and instantaneously adjusted depending on the rate of network utilisation and the duration of congestion. It is expected that the rollout of next generation technology (e.g., advanced smart meters) will significantly enhance the ability to offer this tariff structure.

The *Economy 7* tariff represents an existing, simple form of time-of-use tariff practised in the UK. This tariff was first introduced in October 1978 and featured a seven hour night-time rate which was about 20% cheaper than most night-time tariffs at the time (The Electricity Council, 1987). This tariff is structured to offer low rate electricity during 'off-peak' hours (typically midnight to 7am), with higher rates during 'peak periods'. Cheap night tariffs are made possible by economies in the night-time operation of the system due to low night demand. The tariff plan is common among households with electric heating system. Dynamic teleswitching is another existing time-of-use tariff, used by around 550,000 of domestic electricity consumers in the UK, especially in Scotland and East Midlands (Ofgem, 2013). Consumers on this tariff use a particular type of electricity meter that allows the supplier (or distribution company) to switch supply remotely. Because this tariff requires a special meter, consumers cannot switch to suppliers who do not offer this tariff and are therefore locked into the few main suppliers unless they pay for a new meter.[4]

[4] In the Northern Scotland, SSE has a market share of 70% of domestic consumers accounts, but 95% of the consumers on dynamic teleswitching meters, Scottish Power with a market share of 47% of domestic electric users has 93% of the dynamic teleswitched meter users in Southern Scotland, while E.ON which has 35% of consumer base in East Midlands accounts for 40% of the dynamic teleswitched meters users (Ofgem, 2013).

4. Methodology and Data Sources

Apart from raising demand flexibility through effective data communication, smart technology also promotes increasing energy price differentiation. In fact, increasing number of prices is an obvious consequence of the smarter electricity world. We examine the prospects for smart energy pricing by reviewing the evolution of residential electricity and fixed line voice calls pricing in the UK over the last five decades. The reason we look at telecoms is because a lot of the smart world is about bringing telecoms infrastructure into energy. We use adaptive and rational expectation approaches, combining a critical review of the past pricing behaviour with the current information about smart technology.

Our analysis focuses on the pricing of residential fixed voice call services and electricity in London. The Post Office was responsible for fixed line telecommunications from 1912 until 1980, when British Telecommunications (BT) was created as part of The Post Office. BT was then privatised in 1984. The residential retail market was successively opened up to competition. London Electricity Board was formed in 1948 to sell and distribute electricity in London. It was privatised in 1990 as London Electricity and finally acquired by EdF in 1998. The residential market was opened up to competition in 1998-99. The current owner of London Electricity's successor retail business is EdF Energy.

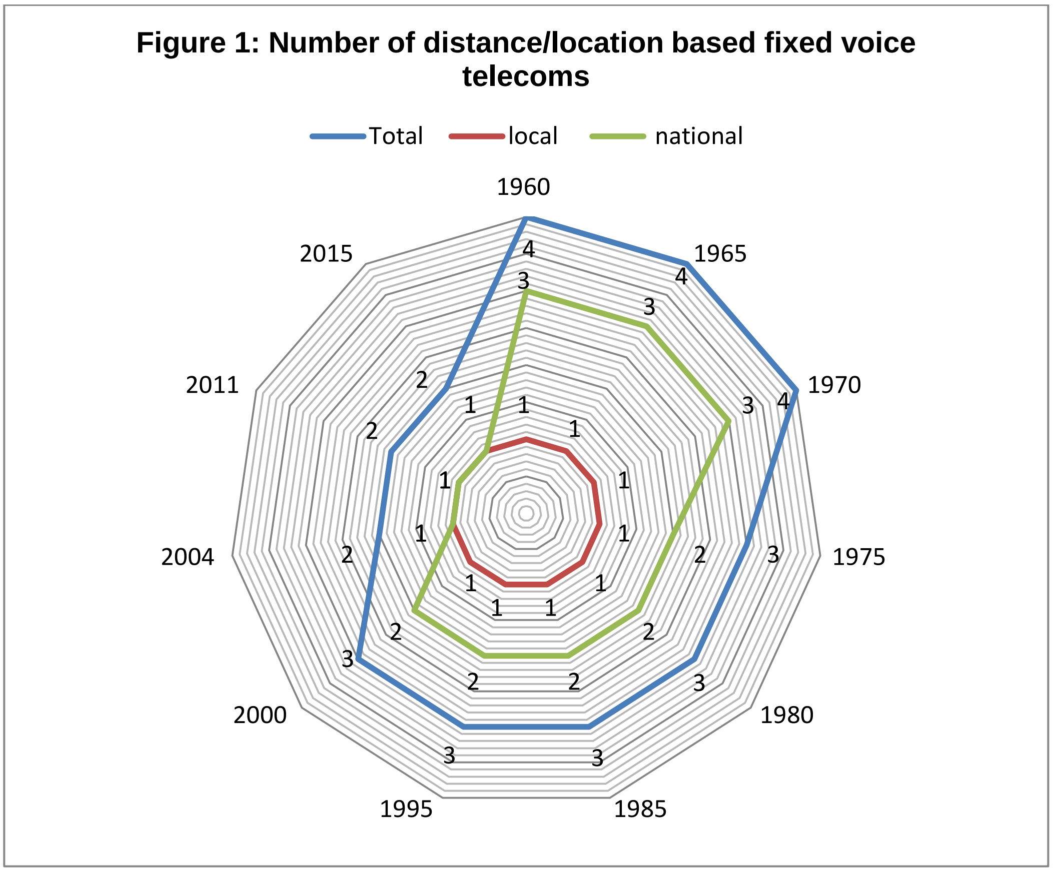
Data and other information on residential fixed voice telephone services were obtained from both the BT's Annual Statistics and Price Lists. These documents were obtained from the BT Archives in London. Electricity prices data for 1970 – 1996 were obtained from the London Electricity Board's tariffs annual announcements in the 'London Evening Standard' Newspaper. EdF Energy supplied the post-1996 electricity prices data directly to the authors. We report data from specific years below, drawing on these sources. We attempt to do this at 5 yearly intervals, except where data is unavailable, where we use an adjacent year. The operational date for electricity tariffs is April 1st each year. However, the operational dates for telecoms tariffs vary: for the years we report, we take the tariffs that pertained to the most part of the year in the event of their being more than one operated tariff regime.

5. Products and Price Differentiation in the UK Residential Fixed Line Telecoms and Energy

5.1 Residential Fixed Line Voice Calls

Figure 1, Tables 3 and 4 below show the snapshot of changes in telecoms products on offer and pricing for standard fixed voice calls from 1960. The key result is that there has been increase in the number of products on offer (considering various premium services and internet voiced call products) and the degree of time-varying prices even-though the numbers of location varying prices have decreased.

By 1960, there were four differentiated standard fixed voice call services (1 local and 3 national) offered by BT's predecessor. Local calls refer to calls made within an exchange area whereas the national calls are those calls made within two or more exchange areas.[5] In the 1960s, the national calls were differentiated on the basis of distance – up to 35 miles, 35-50 miles and over 50 miles. By 1975, these products have been reduced to 3 comprising one local call and two distance-based nationally differentiated services – up to 56 kilometres (35 miles) and over 56 kilometres (>35 miles). By 2004, however, the national calls were no longer differentiated on the basis of distance and BT offered only two standard fixed voice call services comprising one local and national call each (Figure 1 and Table 3).



However, there was an increase in demand/time dimension price differentiation over the period under review (Table 3). Demand/time dimension differentiation increased from two to three. For instance, prices were charged on the basis of daytime/standard full rate and cheap rate ('all other periods') in 1960. By 1975, however, BT had begun to differentiate prices on the basis of peak, standard and cheap periods. This peak, standard and cheap rates price discrimination continued until 1993 when BT abolished the peak rate charges. It however introduced a weekend call rate, and call rates were grouped as daytime (standard), evening and night time (cheap), and weekend by 1995. These three time dimensions – daytime, evening and night, and weekend – have remained till date.

[5] Local and national calls are determined by the distance between the exchange area the call is made from, and the exchange area the call is made to.

Table 3: Number of core products offered for standard fixed voice calls

	Number of products Total	local	national	Nominal differentiation # of time dimension (e.g. off-peak, etc) local	national	Actual differentiation # of duration groupings (e.g. 6am- 2pm) local	national
1960	4	1	3	2	2	3	3
1965	4	1	3	2	2	2	3
1970	4	1	3	2	3	2	5
1975	3	1	2	3	3	4	5
1980	3	1	2	3	3	4	4
1985	3	1	2	3	3	4	4
1995	3	1	2	2	3	2	3
2000	3	1	2	3	3	4	4
2004	2	1	1	3	3	4	4
2011	2	1	1	3	3	4	4
2015	2	1	1	3	3	4	4

	Potentially possible diff. (Pricing periods)	multiple periods with equal tariffs local	national	Number of distinct price points local	national	Total distinct price points
1960	12	2	2	2	6	8
1965	11	0	0	2	6	8
1970	17	2	2+2	2	9	11
1975	14	2	2+2	3	6	9
1980	12	2	2	3	6	9
1985	12	2	2	3	6	9
1995	8	0	0	2	6	8
2000	12	2	2	3	6	9
2004	8	2	2	3	3	6
2011	8	2	2	3	3	6
2015	8	2	2	3	3	6

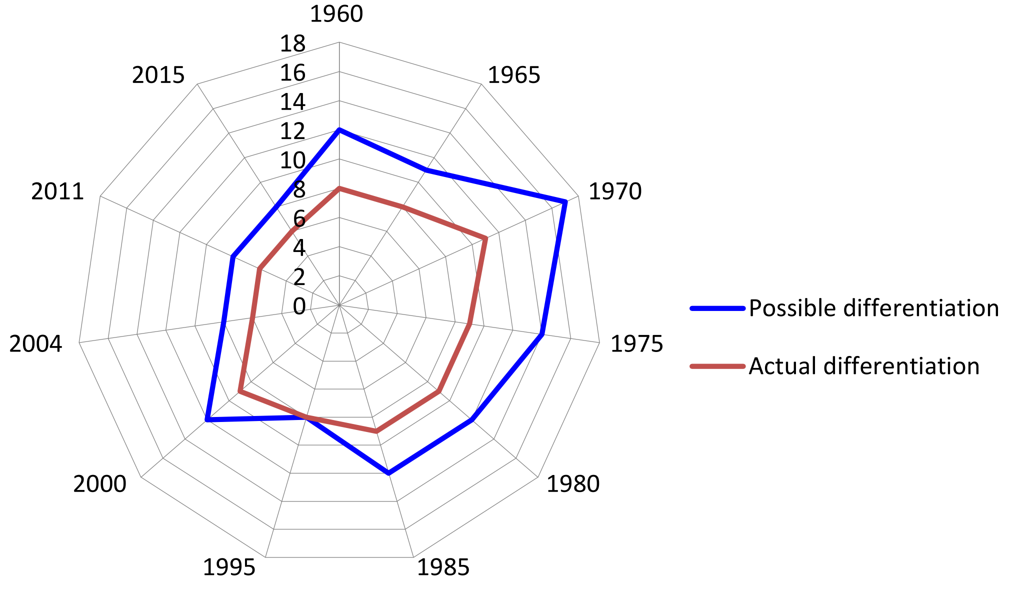
Source: Authors' Elaboration on BT Products Offered
Potentially possible differentiation is the number of local products*actual diff. + number of national products*actual differentiation.

Table 3 also shows evidence of multi-period single tariff rates, and suggests that period or product differentiation (e.g., 6am-1pm, 3pm-5pm, etc) might not necessarily reflect price discrimination. It reveals that it is possible to charge a similar tariff for multiple periods. For instance, local calls had three period/duration classification in 1960 but only two distinct price points were offered because two of the distinct periods –from 6am-6pm on Monday-Saturday and from 6am-2pm on Sunday – were grouped together under full rate tariff. In the last decade and a half, the incidence of multi-period single rate tariffs for local calls has not been less than two. In 2015 for example, there are four period/duration classifications for local calls but there are only three distinct price points because a single rate is applied to two of the four durations.

For the national calls services, the number of duration/period classification increased from three in 1960 to five by 1970 but has come down to four. With the exception of 1965, multi-period single tariff rates were offered for at least two of the durations per annum. While the distinct price points for local calls have increased from two to three which correspond to the changing structure of demand/time dimension, the price points for national calls have reduced from six in 1960 to three in recent times after increasing to nine by 1970. This reflects the reduction in product differentiation (and price discrimination) for national call services due to the reduction in the number of distance-based differential prices for national calls.

Figure 2 compares the potential and actual price differentiation based on BT's time classification. It shows that the actual price differentiation has always been less than potential differentiation, given the number of time steps available. The number of the observed time-varying price differentiation falls short of the potentially possible differentiation.[6] In other words, the number of time-based price differentiation could be increased to reflect more accurate time of use, but consumers do not reveal a preference for this.

Figure 2: Possible and actual price differentiation by BT



[6] This looks at how many pricing periods (i.e. possibly different prices) vs. the number of actual price points.

Local vs. National Voiced Calls Price Discrimination

The price discrimination between local and national call services has reduced (Figure 3 and Table 4). In 1960 for instance, the national call services were between 6 – 20 times more expensive than the local calls depending on the distance and time period. However, this price differential has reduced to between 1.5 – 3.9 times by 2011 and has remained so, to date (late 2015). It is interesting to note that the discrimination between local and national call charges are usually less for daytime charges (full rate charging periods) relative to evening and night times (cheap rate period). In 1960 for example, the daytime (standard) calling rates for national calls were between 6 – 15 times more expensive than local rates whereas off-peak (cheap calls) charges for national calls were between 8 – 20 times more expensive depending on calling distance. Similarly, in 2015, daytime national call charge is 2 times higher than the local call rate, whereas the evening call rates stand at ratio 3.9 to 1. However, the price discrimination between the two products (local and national) at the weekend is less relative to daytime charges such that the national call is only 1.5 times more expensive.

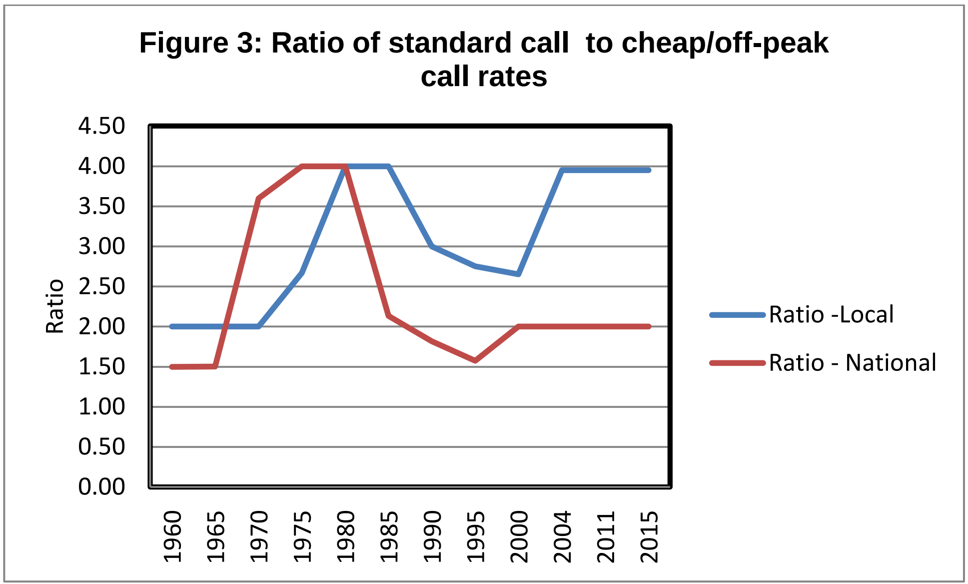
Table 4: Fixed voice telecoms products prices (Pence per minute)

		Local calls			National calls (longest distance)			National-local ratio	
	Set-up fee per call	Standard	Cheap/ Off-peak	Standard/ Off-peak ratio	Standard	Cheap/ Off-peak	Standard/ Off-peak ratio	Standard	Off-peak
1960		0.28	0.14	2.00	4.17	2.78	1.50	14.89	19.86
1965		0.14	0.07	2.00	5.00	3.33	1.50	35.71	47.57
1970	1.00	0.17	0.09	2.00	6.25	1.74	3.60	35.92	19.95
1975	1.80	0.60	0.23	2.67	7.20	1.80	4.00	12.00	8.00
1980	3.50	1.17	0.29	4.00	14.00	3.50	4.00	12.00	11.99
1985	4.40	2.50	0.63	4.00	13.33	6.25	2.13	5.33	10.00
1990		3.00	1.00	3.00	8.50	4.68	1.82	2.83	4.68
1995	4.20	3.15	1.15	2.75	7.88	5.00	1.57	2.50	4.37
2000	4.20	3.95	1.49	2.65	7.91	3.95	2.00	2.00	2.65
2004	4.20	3.95	1.00	3.95	7.91	3.95	2.00	2.00	3.95
2011	2.50	4.03	1.02	3.95	8.08	4.03	2.00	2.00	3.95
2015	3.30	4.03	1.02	3.95	8.08	4.03	2.00	2.00	3.95

Source: BT Annual Statistics and Price Lists for various years. Authors' elaboration on BT prices

Within Product Price Differentiation

In contrast to the between-products (i.e., local-national calls) price differentiation, the within-call time differential has increased significantly and suggests that relative gains from off-peak (cheap) calls are currently higher compared to five decades ago. The average tariff for local calls under full rate was 2 times the cheap calling rate in 1960. By 2011, however, the daytime local calls were approximately 4 times more expensive than the evening and night-time call rate (Figure 3). A similar trend is observed for national calls. The daytime calling rates for national calls in 1960 were 1.5 times the evening and night-time (i.e., cheap) calling rates regardless of distance. This cost differential has increased to 2 times by 2011 and has remained so to date. Notwithstanding this increase in standard and off-peak rates price discrimination, the prices of telephones services have been relatively stable in recent years compared to the 1960s and 1970s. Between 2011 and 2015, the standard calling rates have remained fixed in nominal term and have fallen in absolute term.



5.2 Residential Electricity Service

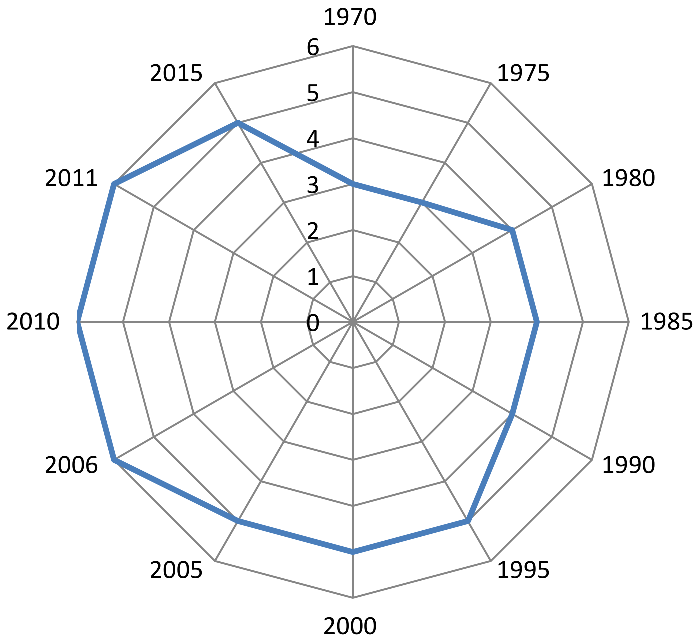
Figure 4 and Tables 5 and 6 show the evolution of changes in the pricing structures of residential electricity products between 1970 and 2015. The key finding is that there has been no increase in the degree of time or location varying prices, though there has been some increase in the number of products on offer. In the 1970s, there were three main residential electricity products, namely general purpose, white meter and off-peak-hours restricted products (Figure 4 and Table 5).[7] The pricing of electricity products was differentiated based on unit, space (housing unit area) and time. *General purpose* represents the standard product where consumers get electricity services at a rate without time discrimination while the *White meter* product charges different tariffs for day (peak) and night hours. By 1980, *Economy 7* product, where consumers are charged less for the consumption during the off-peak hours (similar to the white meter product), had been introduced.[8] This raised the total number of

[7] Off-peak hours products are offered to customers who require heating/power only for certain (off-peak) periods of the day. Other products offered to residential consumers include the services for purposes other than lighting.

[8] The white meter and economy 7 products are different in one aspect and the former appears to be less complex in nature going by the clear distinction between the peak and off-peak in the former. The peak period for the white meter product is 7am-11pm while the off-peak ranges from 11pm-7am. For Economy 7, however, night indicates

the residential electricity products to four by 1980 as against the three main products offered in the 1960s and 70s. By 1995, the products offered to households have increased to five because of the introduction of Economy 9 product. The introduction of Economy 10 product, which offers off-peak tariffs for 10 hours of the day, in 2006 raised the number of products offered to customers to six. However, the number of distinctly differentiated products stands at five in 2015 due to the re-alignment of white meter product with Economy 7.

Figure 4: Number of electricity products on offer



Electricity Pricing Structure

There have been significant changes to the pricing structures of electricity products on offer over the period under review. In the 1970s, the General purpose product operated a 3-part tariffs system, comprising quarterly standing charges and two block units' differentiated rates. Space (floor area) dimension of the General purpose products has four classifications in which standing charges were differentiated based on the space area of a residence. The classifications include (residential floor) areas up to 800sq.ft, between 800-2000 sq.ft, from 2000-3000 sq.ft and over 3000 sq.ft. The unit dimension on the other hand includes two consumption blocks, namely up to 195 units and over 195 units per quarter, at which unit prices were differentiated.

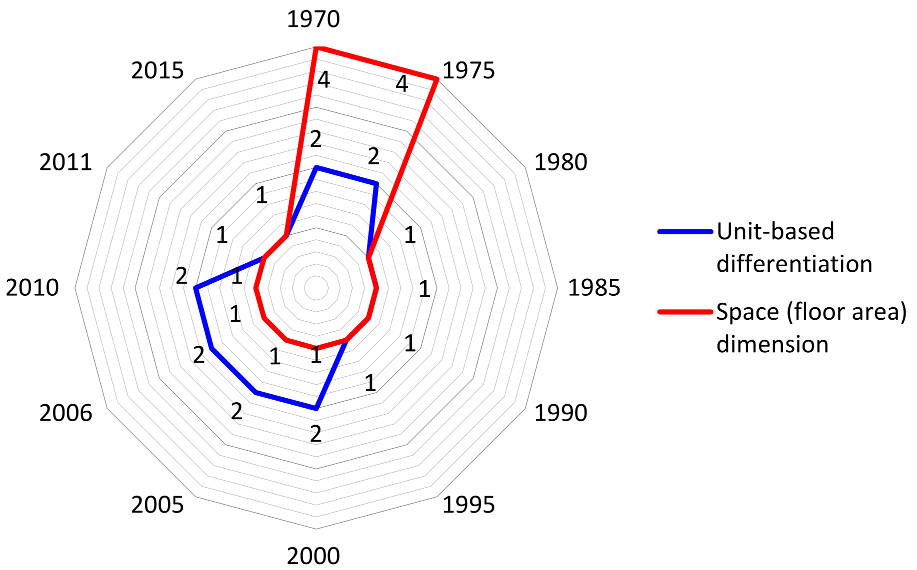
However, the pricing structures of the General purpose product have witnessed tremendous changes and reflect a reduction in pricing complexities. By 1980, for instance, both the unit and space (i.e. floor

any seven hours between midnight and 8am as specified by the electricity company while daytime denotes all hours other than night time as decided by the company.

area) differentiation had been abolished and the General purpose electricity product was no longer differentiated over space (i.e, no standing charge differentiation based on space) and unit blocks.

Asides the space (floor area) differentiation for quarterly standing charges, the White meter product had both time and unit dimensions. Figure 5 shows a snapshot of changes in pricing structures of the White meter electricity product. The product's prices were differentiated based on the first 195 units consumed between 7am and 11 pm, the units in excess of 195 units consumed during the same hours, and lastly the units consumed between 11pm and 7am (off-peak hours). Similar to the General purpose product, however, the White meter electricity product was no longer differentiated by space and units by 1980. The standing charge was uniform and the peak and off-peak prices were no longer differentiated on the basis of the units consumed.

Figure 5: Unit and space (floor area) based product differentiation - General purpose product



By 1990, discrimination was introduced to standing charges paid by both the General purpose and the Economy 7 consumers based on the methods of payment. While the standing charges to the General purpose products were differentiated on the basis of whether a consumer used a credit, coin, or budget meter, the differentiation of standing charges to Economy 7 customers was restricted to credit or budget meter. By 1995 and after introduction of Economy 9 product, discrimination based on payment method continued. In addition to standing charges, unit charges were also discriminated depending on whether consumers used Powerkey meter, monthly direct debit, or used quarterly billing.[9] However, this method of payment-based discrimination could be considered relatively less complex compared to the 1960s and 70s when space (floor area), unit and time based products discriminations were used.

Table 5: Products offered to domestic electricity consumers

		Unit-based differentiation		Space dimension		Period differentiation (e.g. peak, etc)		
	Number of products	General purpose/ Single rate	White meter	General purpose/ Single rate	White meter	General purpose/single rate	White meter	Economy 7
1960								
1965								
1970	3	2	2	4	3	1	2	
1975	3	2	2	4	3	1	2	
1980	4	1	1	1	1	1	2	2
1985	4	1	1	1	1	1	2	2
1990	4	1	1	1	1	1	2	2
1995	5	1	1	1	1	1	2	2
2000	5	2	1	1	1	1	2	2
2005	5	2	1	1	1	1	2	2
2006	6	2	1	1	1	1	2	2
2010	6	2	1	1	1	1	2	2
2011	6	1	1	1	1	1	2	2
2015	5	1	1	1	1	1	2	2

Sources: London Electricity Board (LEB) Tariffs Announcements (London Evening Standard Newspaper - various years) and EdF

By 1998, after the introduction of competition into the retail electricity market, unit block tariff discrimination was re-introduced for both the General purpose/Single rate and Economy 7. There were two band block classifications – the first 6,000 kWhs consumed and the consumption over 6,000 kWhs per annum. This initial block band was reduced to 900 kWh per annum in 2002 for the two customer groups (Single rate and Economy 7). By 2005, the initial block units for Economy 7 customers had been raised to 1,000 kWh whereas the block band of 900 kWh was still maintained for General-purpose customers. By 2011, however, price discrimination based on block classification was abolished and the EdF no longer differentiated charges on the basis of block consumption. Meanwhile tariffs are still differentiated based on the method of payment.

Within Product Price Differentiation

The degree of within-product time-varying price differentiation has decreased (Figure 6 and Table 6). White meter peak rate was 2.5 times its off-peak rate in 1970. This ratio has reduced to 2.2 by 2010. Similarly, the peak tariff for Economy 7 customers was around 3 times the off-peak rate when it was first introduced in 1979. By 2015, however, the ratio of Economy 7 peak to off-peak prices is 2.7 (Table 6).

[9] There was no Powerkey meter option for Economy 9 customers.

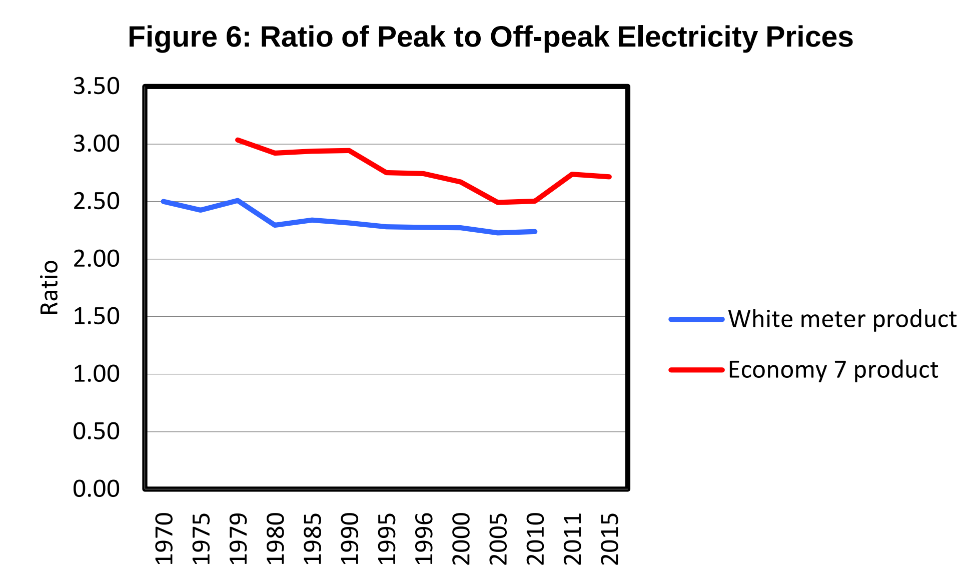


Table 6: Electricity products prices (Pence per unit)

	General Purpose/single rate	White Meter		Economy 7		Peak- Off-peak cost differential- ratio	
		Peak	Off-peak	Peak	Off-peak	White meter	Economy 7
1960							
1965							
1970	0.80	0.80	0.32			2.50	
1975	1.89	1.94	0.80			2.43	
1976	2.13	2.23	0.93			2.39	
1977	2.55	2.70	1.14			2.36	
1978	2.71	2.86	1.14			2.51	
1979	3.26	3.46	1.48	3.46	1.14	2.34	3.04
1980	4.10	4.38	1.91	4.38	1.50	2.29	2.92
1985	5.66	5.99	2.56	5.99	2.04	2.34	2.94
1990	6.78	7.15	3.09	7.15	2.43	2.31	2.94
1995	6.86	7.59	3.33	7.59	2.76	2.28	2.75
1996	7.16	7.76	3.41	7.76	2.83	2.28	2.74
2000	6.08	6.84	3.01	6.62	2.48	2.27	2.67
2005	7.31	8.95	4.02	7.90	3.17	2.23	2.49
2010	10.89	12.04	5.38	12.09	4.83	2.24	2.50
2011	12.20			14.32	5.23		2.74
2015	14.24			17.42	6.42		2.71

Source: London Electricity Board (LEB) Tariffs Announcements (London Standard Newspaper - various years) and EdF.

6. Conclusion

In this study, we reviewed the evolution of business models and pricing strategies in telecoms and energy (electricity and gas) industries from 1960. We have seen changes in business models from the traditional services business models (i.e., offering calls and messages in telecoms and energy supplies in energy sector) to more dynamic, integrated and complex business models. These new business models include managed services provider model, bundled services model, and prosumer business model, among others. In residential electricity there has been no increase in the number and degree of time or location varying prices, though there has been some increase in the number of products on offer. In fixed line voice calls, however, there has been increase in the degree of time-varying prices, though there has been decrease in the degree of location varying prices.

As the energy sector continues to experience dramatic changes, we don't know exactly what changes and new technologies will shape our energy systems by 2050. But we do know that the rollout of the next generation of electricity meters (smart and advanced meters) will in theory allow households to take control of its energy consumption. They also enable new products and services to be developed, including tariffs that offer more time and space (distance) variation. Multi-period single electricity tariff that reflects time of use is possible with the rollout of next generation of electricity meters (smart and advanced meters). The experience from the pricing of fixed line telecoms products to date suggests the possibility of having a multi-periods electricity tariff rate that reflects time of use. However we observe that in telecoms there is a lot less use of multiple prices than might be expected for a given product, suggesting that smart electricity tariffs will use a limited number of price points.

Although it is possible to differentiate electricity products based on location by introducing locational charges, this form of differentiation would likely fall short of equity and fairness. While people may be able to shift/control their energy use in order to adjust to time varying tariffs, it is difficult to adjust consumption based on location because moving from one location (e.g., higher electricity pricing areas) to another (low pricing areas) may be difficult. Where people live in most cases do not totally reflect their independent choices and are often determined by a number of factors such as the closeness to work and their economic status.

Should energy tariffs be more cost-reflective or be more reflective of consumer preferences? Should energy tariffs be more flat or more discriminatory in the future? Although the answer to the first question is relatively less clear, an answer to the latter may be inferred from the experience in the telecoms sector where consumers are often billed a flat amount every month but are charged for extra usage above their basic consumption bundle at higher prices. More than 40% of fixed line phone owners and over 80% of smart phone users currently use fixed contract plans in the UK (Nielsen, 2013). Clearly there is still a need for energy studies examining which tariffs will appeal most to which consumers, given that past experience with pricing cannot fully reveal what consumers might accept in the future.

References

Awerbuch, S. (1997). *The Virtual Utility: Accounting, Technology & Competitive Aspects of the Emerging Industry*. Kluwer Academic Publishers.

Bain, J. S. (1956). *Barriers to new competition: their character and consequences in manufacturing industries*. Cambridge, MA: Harvard University Press.

BT. (2012). *BT Group plc Annual Report & Form 20-F 2012*. Retrieved from www.bt.com/annualreport

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA.: Harvard Business School Press.

Chesbrough, H. W., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3), 529–555.

DECC. (2014). *Community Energy Strategy: Full Report*. London, UK: Department of Energy and Climate Change. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275169/20140126Community_Energy_Strategy.pdf

Defra. (2007). *The household energy supplier obligation from 2011: a call for evidence*. London, UK.

Energywatch. (2006). *A social responsibility? An energywatch consultation on the nature of social tariffs in the energy market*. London UK: Office of Gas and Electricity Markets (Ofgem).

García-mariñoso, B., Martinez-giralt, X., & Olivella, P. (2008). *Bundling in Telecommunications* (Barcelona Economics Working Paper Series No. 356). Spain. Retrieved from http://research.barcelonagse.eu/tmp/working_papers/356.pdf

Houthakker, H. S. (1951). Electricity Tariffs in Theory and Practice. *The Economic Journal*, *61*(241), 1–25.

Kaplan, A. D. H., Dirlam, J. B., & Lanzillotti, R. F. (1958). *Pricing in big business: a case approach*. Washington, DC: Brookings institution.

Magretta, J. (2002). Why Business Models Matter. *Harvard Business Review*, *80*, 86–92, 133.

Mitchell, B. M., & Vogelsang, I. (1991). *Telecommunications Pricing: Theory and Practice*. Cambridge, UK: Cambridge University Press, Cambridge U.K. Retrieved from http://dx.doi.org/10.1017/CBO9780511599002

Moon, N., Rodgers, D., & Mchugh, S. (2015). *Energy Market Investigation: A report for the Competition and Markets Authority by GfK NOP*. London, UK: Competition and Market Authority (CMA).

Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: Toward a unified perspective. *Journal of Business Research*, *58*, 726–735.

Nielsen (2013). Pay-as-you-phone: How global consumers pay for mobile. Available at: http://www.nielsen.com/us/en/insights/news/2013/how-global-consumers-pay-for-mobile.html. Accessed on 10th October, 2015.

Noble, P. M., & Gruca, T. S. (1999). Industrial Pricing: Theory and Managerial Practice. *Marketing Science*, *18*(3).

Ofcom. (2011). *International Communications Market Report 2011*. London, UK.

Ofcom. (2014). *The Consumer Experience of 2013*. London, UK.

Ofgem. (2013). *The state of the market for customers with dynamically teleswitched meters*. London UK: Office of Gas and Electricity Markets (Ofgem).

Ofgem. (2015). *Final proposals on the treatment of white label providers in the domestic retail market Statutory consultation*. London UK: Office of Gas and Electricity Markets (Ofgem).

Olla, P., & Patel, N. V. (2002). A value chain model for mobile data service providers. *Telecommunications Policy*, *26*, 551–571.

Oseni, M. O., Pollitt, M. G., Reiner, D. M., Richter, L., Chyong, K., & Baddeley, M. (2013). *2013 EPRG Public Opinion Survey: Smart Energy – Attitudes and Behaviours* (EPRG Working Paper 1327 & Cambridge Working Paper in Economics 1352). University of Cambridge, UK: EPRG Working Paper 1327 & Cambridge Working Paper in Economics 1352. Retrieved from http://www.cambridgeeprg.com/wp-content/uploads/2013/12/1327-PDF.pdf

Pitelis, C. N. (2008). *Value capture from organizational advantages and sustainable value creation* (Cambridge Judge Business School Working Paper Series No. 06/2008). Cambridge, UK. Retrieved from https://www.jbs.cam.ac.uk/fileadmin/user_upload/research/workingpapers/wp0806.pdf

Schweppe, F. C., Caramanis, M. T., Tabors, R. D., & Bohn, R. E. (1988). *Spot Pricing of Electricity*. Kluwer Academic Publishers.

Stewart, D. W., & Zhao, Q. (2000). Internet marketing, business models, and public policy. *Journal of Public Policy and Marketing*, *19*(2), 287–296.

Stigler, G. J. (1987). *The Theory of Price*. New York: Macmillan Publishing Company.

Teece, D. J. (2010). Business Models, Business Strategy and Innovation. *Long Range Planning*, *43*(2-3), 172–194.

Tellis, G. J. (1986). Beyond the Many Faces of Price: An Integration of Pricing Strategies. *Journal of Marketing*, *50*(4), 146–160.

The Electricity Council. (1987). *Electricity Supply in the United Kingdom, A Chronology - from the beginnings of the industry to 1985*. London.

The Scottish Government (2014). Community Energy Policy Statement: Draft for public consultation. Available at http://www.scotland.gov.uk/Publications/2014/08/1223. Accessed on 20 August, 2015.

Thumim, J., White, V., Redgrove, Z., & Roberts, S. (2007). *Waste Not, Want Not: Energy Tariffs for Sustainability. A report by the Centre for Sustainable Energy for WWF-UK*. Bristol, UK: Centre for Sustainable Energy.

Tsalgatidou, A., & Pitoura, E. (2001). Business models and transactions in mobile electronic commerce: Requirements and properties. *Computer Networks*, *37*, 221–236.

Wikström, K., Artto, K., Kujala, J., & Söderlund, J. (2010). Business models in project business. *International Journal of Project Management*, *28*(8), 832–841.

Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, *37*(May), 1019–1042.