

**Does Electricity (and Heat) Network Regulation
have anything to learn from Fixed Line Telecoms Regulation?**

Michael Pollitt¹

Judge Business School

University of Cambridge

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Abstract

The purpose of this paper is to examine the lessons from the recent history of telecoms deregulation for the electricity (and by implication heat) network regulation. We do this in the context of Ofgem's RPI-X@20 Review of energy regulation in the UK, which considers whether RPI-X based price regulation is fit for purpose after over 20 years of operation in energy networks. We examine the deregulation of fixed line telecoms in the UK and the lessons which it seems to suggest. We then apply the lessons to electricity networks in the context of a possible increase in distributed generation directly connected to local distribution networks. We conclude that there is the possibility of increasing parallels over time and suggest several implications of this for the regulation of electricity and heat networks.

Section 1: Introduction

The purpose of this paper is to examine the lessons from the recent history of telecoms deregulation for the electricity (and by implication heat) network regulation. We do this in the context of Ofgem's RPI-X@20 Review of energy regulation in the UK. This review explicitly seeks to consider whether RPI-X based price regulation is fit for purpose after over 20 years of operation in the UK gas (from 1986) and then electricity sectors (from 1990). The RPI-X@20 Review initial consultation document highlights two areas, in particular, for the current regulatory regime to address going forward. First, the need to engage consumers more than at present in decisions about investment and output . Second, the need for the electricity sector to facilitate the move to a low carbon economy (Ofgem, 2009a). Alistair Buchanan (Ofgem's CEO), in his foreword to the document, highlights a third important area where networks may need to change: in delivering the scale and scope of innovation required to meet the challenges they face.

¹ The author acknowledges the support and encouragement of Ofgem in the writing of this paper as part of their RPI-X@20 project. However all the views expressed in the paper are the views of the author and should not be taken to be the views of Ofgem. The comments of Martin Cave, Martin Crouch, Rachel Fletcher, Cloda Jenkins, Hannah Nixon and Steve Unger (and colleagues at Ofcom) are acknowledged. The superb research assistance of Karim Anaya is also acknowledged.

The reason for looking at telecoms sector regulation is because regulatory reform in the UK started with the privatisation of British Telecom in 1984 and the creation of UK's first independent regulatory agency, Oftel. RPI-X price control for utilities was first instituted for British Telecom. Subsequently Oftel and its successor, Ofcom, have continued to push forward with regulatory reform in the telecoms sector and the sector consequently has the longest experience with price control and deregulation (both in the UK and globally). As part of any review of RPI-X in the energy sectors it seems appropriate that the lessons from the telecoms sector for the electricity and gas sectors are carefully considered.

Telecoms remains the lead sector in terms of utility deregulation by any plausible indicator of both form, process and outcome of regulation (see Green et al., 2006). Telecoms reform has stimulated large amounts of innovation, customer choice, price reductions and quality improvements. Incumbent telecoms firms have become significantly more efficient and innovative, while entrants have made substantial investments in both infrastructure and in the development of new consumer products. Meanwhile RPI-X regulation, invented for the specific purpose of controlling incumbent prices 'until competition arrives' (Littlechild, 1983) has been gradually rolled back. In the UK no final consumer prices of fixed line telecoms services remain regulated, while many wholesale markets have also been significantly deregulated. Looking across the world some jurisdictions have moved towards complete price deregulation of all telecoms services, relying only on the process of competition and, if necessary, general competition law to ensure fair prices. Telecoms deregulation may therefore offer lessons as to how (de-)regulation might promote innovations which could improve price and quality (which in the case of electricity might include emissions reduction and security of supply). Such innovation would bring benefits for consumers and the environment.

Turning to energy network regulation, Pollitt (2008) suggests there are three potential elements of any new system of energy network regulation. First, future regulation might involve a significant change in the role of the regulator within the regulatory process with the more use of 'constructive engagement' or 'negotiated settlements' between buyers and sellers of network services. This would reduce the role of the regulator in 'choosing' investments in regulated sectors but significantly shift decision making about which investments get made to agreements between parties within the industry. Second, consideration should be given to how competition might be increased in energy network provision. Here an obvious way forward is to make more use of competitive tendering for new assets and to drop the monopoly right of the incumbent to undertake new investments. In addition, consideration should be given to whether some network elements are contestable or competitive and hence should not be covered by monopoly price controls. Third, future regulation needs to pay due attention to climate change concern. The need to almost completely decarbonise the electricity sector is a key implication of the UK government's ambitious GHG reduction targets (see Committee on Climate Change, 2008). Network regulation needs to facilitate the decarbonisation of the electricity sector via incentivising demand reduction and low carbon generation at the local level. It also needs to facilitate decarbonisation in the heat and transport sectors, which will also need to be substantially decarbonised to meet the overall emissions reduction targets.

In the spirit of the last of these elements, the UK electricity regulator, Ofgem, has been engaged in a substantial scenario building exercise via its Long-term Electricity Network Scenarios (LENS) project. The LENS project has developed five plausible, but very different, scenarios for electricity networks in 2050 (Ault et al., 2008). These scenarios provide visions of the future. The five scenarios range from a development of the current system with much more large scale wind and carbon capture fossil plant whose output would be delivered using a significantly larger transmission and distribution grid (scenario: Big T&D) to a scenario which envisages reduced use of the main transmission grid and much more local CHP and micro-generation supplied across micro-grids (scenario: Micro-grids). Such distributed generation (DG) would be connected at lower voltages and typically lie deep within the network architecture of traditional distribution network operators (DNOs). The LENS scenarios are briefly summarised in Table 1.

Table 1: The LENS scenarios for GB electricity networks in 2050

<p>Big Transmission and Distribution (T&D) – in which transmission system operators (TSOs) are at the centre of networks activity. Network infrastructure development and management continues as expected from today’s patterns, while expanding to meet growing demand and the deployment of renewable generation.</p>
<p>Energy Service Companies (ESCOs) – in which energy services companies are at the centre of developments in networks, doing all the work at the customer side. Networks contract with such companies to supply network services.</p>
<p>Distribution System Operators (DSOs) – in which distribution system operators take on a central role in managing the electricity system. Compared to today, distribution companies take much more responsibility for system management including generation and demand management, quality and security of supply, and system reliability, with much more distributed generation.</p>
<p>Micro-grids – in which consumers are at the centre of activity in networks. The self-sufficiency concept has developed very strongly in power and energy supplies. Electricity consumers take much more responsibility for managing their own energy supplies and demands. As a consequence, microgrid system operators (MSOs) emerge to provide the system management capability to enable customers to achieve this with the new technologies.</p>
<p>Multi-purpose Networks – in which network companies at all levels respond to emerging policy and market requirements. TSOs still retain the central role in developing and managing networks but distribution companies also have a more significant role to play. The network is characterised by diversity in network development and management approaches.</p>

Source: Ault et al., 2008, Ofgem Forward by Stuart Cook.

The intellectual motivation for the subject matter of this paper is idea that the electricity sector might develop along the lines envisaged by some of the more radical LENS scenarios: in particular the ‘Micro-grids’, ‘DSOs’ and ‘ESCOs’ scenarios. These scenarios imagine significantly more competition at the local level between own generation, local generation and large central power plants (or large renewable power parks) than at present. They also suggest that networks will be a part of much more flexible electricity system where consumers will be given choices between complete reliance on the main grid, partial reliance (via micro-grids) or total disconnection. Micro-grids may make use of private wire networks where they install their own wiring between local power plants and their customers or they may wish to make use of parts of existing distribution

network operator (DNO) networks to supply their customers. It is in this context that fixed line telecoms deregulation becomes of interest. Indeed energy network deregulation and telecoms deregulation may indeed be technologically related by the fact that micro-grid or 'island' power and heat systems might rely heavily on communications infrastructure to match local supply and demand. Such 'smart' energy systems will use communications technologies (rather than back-up production capacity as at present) to maintain their quality of service.²

While the LENS scenarios model the electricity sector out to 2050. The policy environment in the UK is evolving rapidly. The Committee on Climate Change's first report envisages almost complete decarbonisation of the electricity sector by 2030. The electricity distribution price control review for prices from 2010 to 2015 (DPCR5) is ongoing and identifies a number of current government policies and initiatives which suggest substantial change for the electricity sector is envisaged in the very near term (Ofgem, 2008b, p.28). These policies/initiatives cover the UK commitment to EU 2020 renewable targets, planning targets for new developments, zero carbon homes, government heat strategy, micro-generation feed-in tariffs, domestic smart meters, electric cars and electric storage. All these actual or potential policies imply significant increases in distributed generation and more active grid management by distribution network operators.

It is worth pointing out the relationship between the discussion in this paper and the existing concepts of Independent Gas Transporters (IGTs) and Independent Distribution Network Operators (IDNOs). These types of networks currently exist in UK usually in the form of separate ownership of new local distribution assets largely arising from the connection of new housing estates. These networks are built, owned and managed by parties other than the incumbent regional gas distribution network operator (GDN) or electricity distribution network operator (DNO). Such networks arise from tendering for the new connections and remain independently managed due to the favourable regulatory regime that they face which gives them an advantage in bidding for extensions to the over incumbents.³ These independent networks are usually (but not always) different from the sort of energy service driven investments that this paper envisages, where independent networks may arise as part of the optimal asset configuration of a new entrant supply company (e.g. a local energy service company based on a local combined heat and power scheme) and where existing rather than new grid customers may be involved. It is also the case that IGTs have been more successful than IDNOs in winning contracts for network extensions (see Ofgem, 2008c) and that the IDNOs supply significantly fewer customers than IGTs (c.200,000 vs c.1million)⁴.

While Ofgem's RPI-X@20 review is about gas and electricity transmission and distribution networks this paper focuses on electricity distribution (and by association heat distribution).⁵ The paper proceeds as follows. In section 2 we examine the history of telecoms deregulation and the

² It is already the case that electricity network companies rely on leased telecoms lines to support protection applications within electricity networks currently.

³ See Ofgem (2004) and Ofgem (2009b, p.45, 80).

⁴ This represents less than 1% of electricity customers and around 4% of gas customers.

⁵ Gas might be thought of a declining network in the evolution of the low-carbon energy sector to 2050, while electricity is likely to benefit from the switching of energy demand in heat and transport to electricity (see Ault et al., 2008). As an example of the significant potential for switching from other fuels (including coal and open wood fire) for heating to electricity, between 2003 and 2008 the percentage of households in Christchurch, New Zealand, heating via heat pumps has increased from 8% to 35%, with the figure projected to 70% by 2015-18 (Orion, 2008, p.6).

architecture of the telecoms network. In section 3 we reflect on the regulatory lessons from telecoms reform. Section 4 discusses the extent to which the comparison between telecoms and electricity networks is valid in the context of distributed generation. Section 5 discusses regulation for electricity networks in the light of the telecoms experience. Section 6 offers some concluding comments.

Section 2: Telecoms Deregulation and the Architecture of the Fixed Line Telecoms Network

The UK history of telecoms reform begins with the introduction of a 'Duopoly policy' in 1981 (see Summanen and Pollitt, 2003). This created a licensed competitor to the incumbent British Telecom (BT). The competitor, Mercury, initially struggled in the market due to the issue of access to the incumbent telecoms network. Mercury built its own trunk lines and marketed services directly to consumers, but needed to buy access to the local loop, the local copper wires from the local telephone exchange, which largely remained a monopoly. The duopoly policy remained in force until 1991. In the meantime BT was privatised, beginning in 1984, and subjected to RPI-X regulation of its basket of final prices. This formula was invented specifically for BT by Littlechild (1983) as a way of preventing the Averch-Johnson (1962) investment gold-plating effect associated with US style rate of return regulation. US rate of return regulation apparently incentivised over-investment and failed to incentivise operating cost reductions, both of which RPI-X regulation fixed for a number of years specifically counteracted.⁶ The economic regulation of BT was overseen by an independent regulatory agency, Oftel (later Ofcom).

Following the end of the duopoly period there was significant new entry into fixed line telecoms by resellers of leased access and by cable operators who rapidly rolled out cable networks, which also offered telecoms as well as TV services. The take-off of the mobile market also occurred with the introduction of GSM (2G) services in 1992. Fixed line networks could also be used for narrow-band (dial-up) internet services which showed strong growth through the 1990s.

A major product innovation offered across fixed line telecoms networks was broadband internet service, which offered a much faster internet service which could be simultaneously used with voice telephony. Cable based broadband was offered first in the UK in 1999, with BT offering DSL technology broadband across the conventional telephone network in 2000. In the background the EU was also pushing telecoms deregulation. The 2000 EU regulation (2887/2000/EC) forced unbundling of the local loop in all member countries. This meant that BT had to offer to rent the copper wires from the local exchange to the individual customer to competitors. Thus competitor providers could seek to attract customers on the basis of a combination of rented local loops and their own trunk networks.⁷

⁶ Joskow and Schmalensee (1986) suggested that the ability of US regulators to disallow additions to the regulated asset base ex post may have actually under-incentivised electricity investment in the US context in spite of the Averch-Johnson effect.

⁷ It is important to note that 'deregulation' is usually a misnomer. This description illustrates the importance of regulatory changes ('reregulation') in introducing effective competition via legal changes and new regulatory

There was a major review of BT's regulation in 2004 and 2005 – 'Strategic Review of Telecoms' – by the communications regulator Ofcom. This resulted in a major restructuring of BT in order to facilitate competition across BT's network by ensuring non-discriminatory access, particularly to the unbundled local loop. BT agreed to this in lieu of a reference to the Competition Commission (the UK competition authority). The restructuring involved the creation of a separate business within BT (Openreach), operated at arms length from it, which provided local network access services (access to 'the first mile').⁸ This business was therefore separate from BT's retail arm (BT Retail) and BT's wholesale arm (BT Wholesale) which continues to provide trunk access. The retail/wholesale arms of BT have to contract with Openreach in the same way as any competitor company, with BT Openreach providing a schedule of prices for wholesale access to the local network and for unbundled access to the local loop. The provision of access is subject to regulatory monitoring to ensure that requests for access are handled promptly and in a non-discriminatory way. An Equality of Access Board has been established within BT to act as an appeal board for competitive providers who want to complain about the quality of service received from Openreach (see Equality of Access Board, 2008).

Following the creation of Openreach in early 2006, all final consumer prices charged by BT Retail were deregulated in July 2006 (the culmination of a process which began in 1997 with the restriction of the price cap to the '80% residential basket'). Many prices charged by BT Wholesale are now deregulated. Openreach's prices for local access and for unbundled access are subject to price limits, fixed since 2006. Currently (April 2009) these are under review.⁹ We discuss the nature of these charges in Section 4 in order to draw out the contrast with electricity. A new EU directive on Communications is expected in 2009 which may further reduce the number of services that would normally be subject to ex ante price regulation in fixed line telecoms. The list currently includes 18 services (under the 2003 legal framework on the Regulation of Electronic Communication Services - 2002/21/EC).

Figure 1 shows three different telecoms network architectures for the UK. The 'Existing model' is the architecture as it is today with the number of nodes at each level. There are 88,000 street cabinets and around 5000 local exchanges. Local loop unbundling (LLU) occurs at these local exchanges. Exchanges where LLU has occurred are physically split between different providers (such as BT Retail and Tiscali) with different entry points into the exchange and different 'sides'. One of the early obstacles to LLU was the need to physically reengineer the local exchange.¹⁰ The 'Core NGN' is the architecture proposed by BT to upgrade the existing network making use of new internet protocol based technology (VoIP). This will involve reconfiguring the trunk network (and reducing the number of core exchanges substantially), it may also involve somewhat fewer local exchanges. In the future a more radical reconfiguration is shown under 'Access NGN'. In this network architecture there is much deeper deployment of fibre optic cables – to the street cabinet level. LLU unbundling as it is now would be largely irrelevant and unbundling would need to occur as 'Sub-loop' unbundling (SLU),

concepts (such as embodied in EU Communications Directives and the concept of Significant Market Power – SMP in communications sub-markets).

⁸ http://www.openreach.co.uk/orpg/aboutus/Downloads/web_corp_brochure.pdf

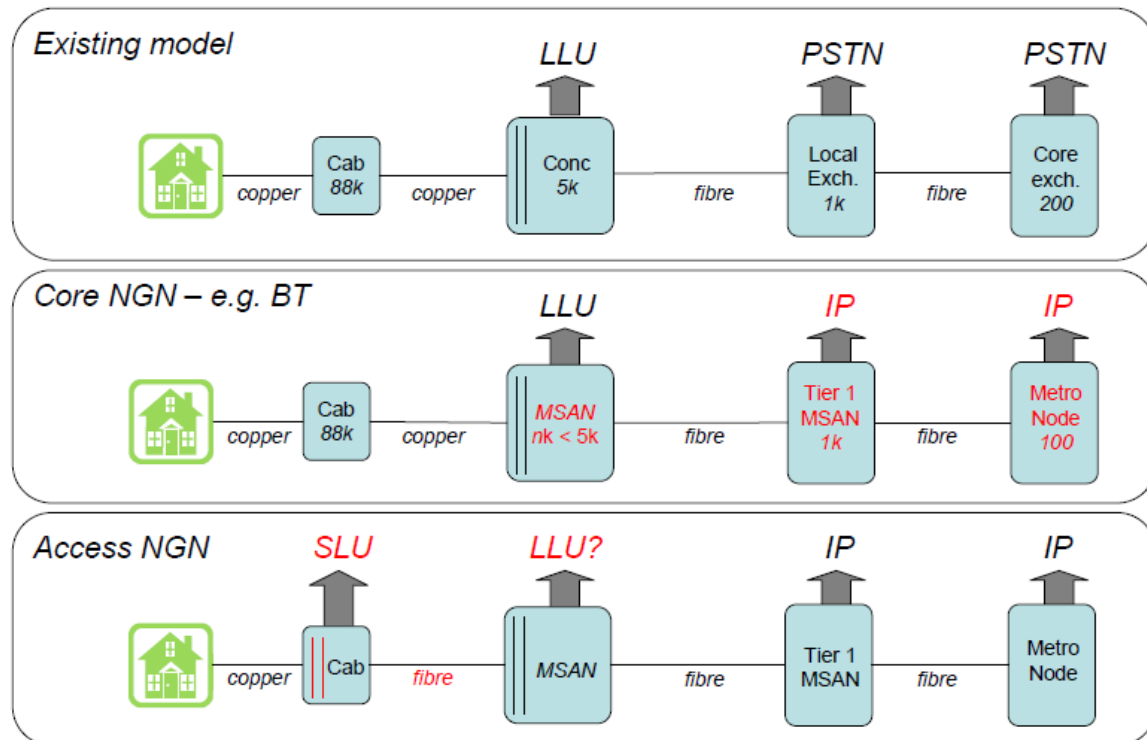
⁹ See Ofcom (2008b) for latest consultation document.

¹⁰ For an excellent description (with helpful pictures) of the physical characteristics of local exchanges and their relationship to local loop unbundling see www.kitz.co.uk/adsl/equip.htm (accessed 23 January 2009).

with competitive providers who wished to use their own trunk networks needing to connect at this level.

Figure 1: Fixed line telecom network architecture

(Source: Cave, 2007,p.19)



Local Loop unbundling has been viewed as a success in the UK since the creation of Openreach by Ofcom (see Ofcom, 2008a). There has been substantial new entry and investment by new entrants. Full unbundling involves the competitive provider renting access to the copper wire from the exchange and connecting it to its own network. The rented pathway is called a Metallic Path Facility (MPF). See Figure 2 for a representation. This would usually occur where the competitive provider is offering broadband and voice services. Alternatively the competitive provider may only wish to offer broadband service leaving voice services to be provided by BT. In this case access is only required to part of the bandwidth of the copper wire. This is referred to as a Shared Metallic Path Facility (SMPF). In other countries, such as New Zealand, bit-stream access has been a significant form of competitive providers accessing the local loop (involving reduced use of the competitor network as compared to SMPF and MPF and less competitor infrastructure investment). In the future unbundling may take the form of Sub-loop unbundling (SLU) as above. By February 2008, over 4 million out of around 29.6 million fixed lines have been partially or fully local loop unbundled. Ofcom expects MPF unbundling to continue to grow and SMPF to eventually decline by 2012 (see Figure 3). The major driver of this growth in competitor providers has been the high degree of competition in the market for telecommunications. Real prices have declined significantly of all telecoms services since 2002 (see Figure 4). The quality of broadband services has also significantly improved, as measured in terms of connection speeds.

Figure 2: Full local loop unbundling

(Source: OECD)

Full Unbundling (MPF)

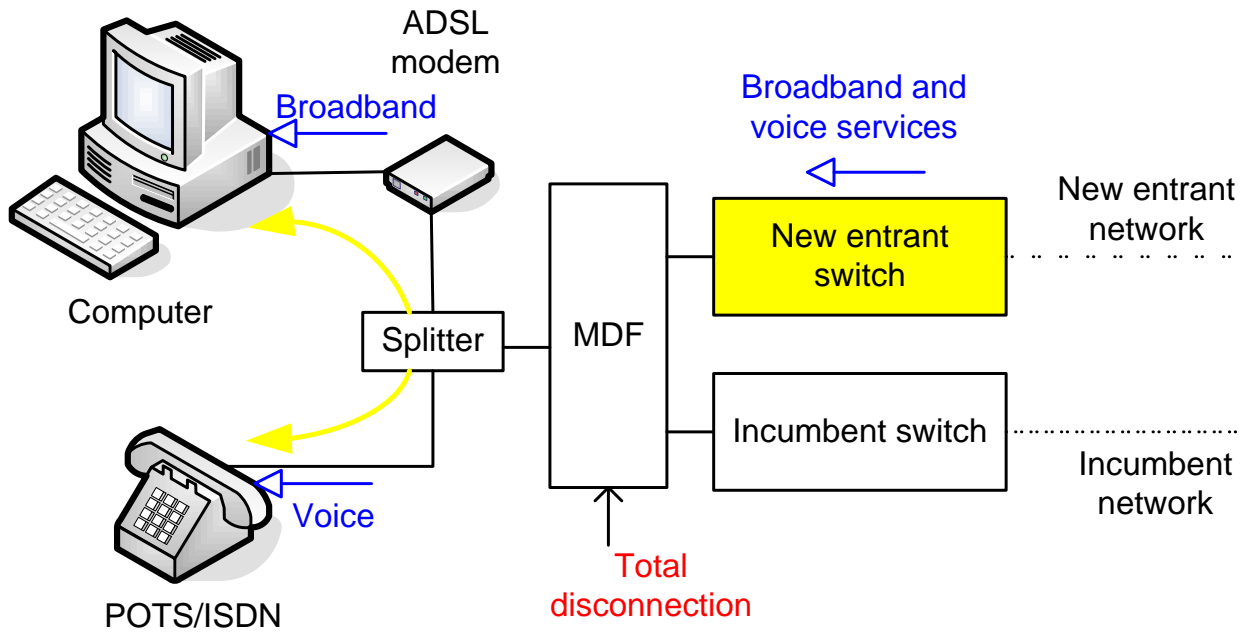


Figure 3: Progress with LLU in the UK

(Source: Ofcom, 2008a, p.14)

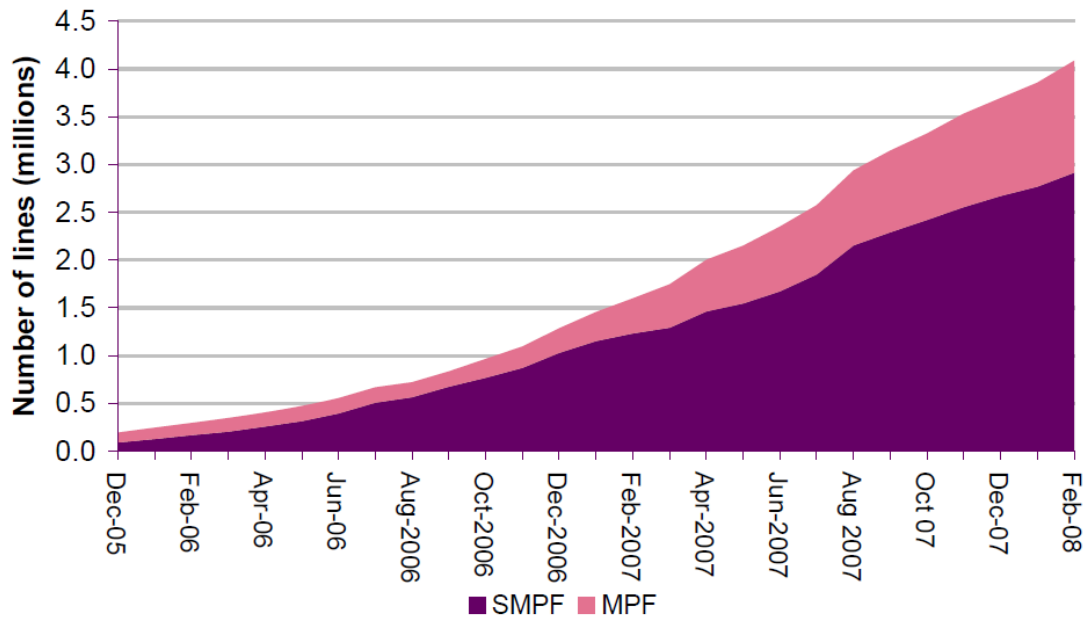
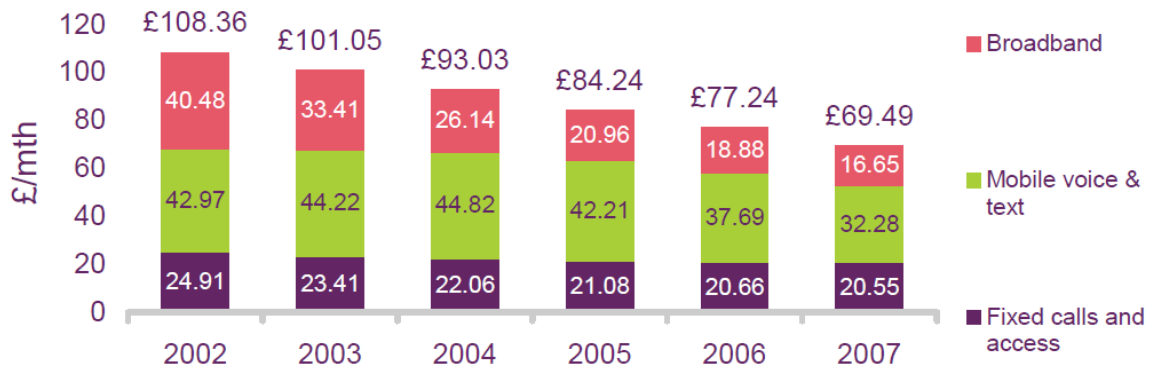


Figure 4: Real cost of a basket of residential telecoms services in the UK

(Source: Ofcom, 2008a, p.15)



Source: Ofcom / operators (Note: Includes VAT; excludes NTS)

The UK's experience with the growth of competition, particularly in broadband provision, is mirrored across the EU. There has been a substantial growth in total broadband connections and in the provision of services by the incumbent, by resellers, unbundled competitive providers and by cable companies (see Table 2).

Table 2: Broadband penetration in the EU

(Source: Cave (2007, p.15))

	2003 (July)	2004 (July)	2005 (October)	July (2007)
DSL, of which	12.5	22.5	40.8	56.4
Incumbent	9.6	15.6	24.3	31.4
Non-incumbent	2.8	6.9	16.5	25.0
Based on:				
Resale	1.5	2.3	4.9	9.1
Bitstream	0.7	2.4	4.6	3.9
LLU	0.7	2.2	6.9	12.0
Cable	4.1	5.6	8.2	10.1
Other Technologies	0.9	0.7	1.1	1.3
TOTAL	17.5	28.8	50.1	66.3

Source: EC, Implementation Reports

Section 3: Lessons from Telecoms (de-)regulation

Telecoms deregulation seems like a notable success. However it is important to reflect on some of the criticisms that have been raised about it. This is because while the market has been extremely dynamic compared to other utility sectors the pace and extent of deregulation has been widely criticised. In particular critics have suggested that the telecoms market would have developed much more rapidly in the absence of much of the price regulation that has continued to be a feature of the deregulated telecoms sector.

Hausman and Sidak (2007) raise the issue of the extent to which forced unbundling and access regulation of fixed line telecoms network regulation was necessary (as mandated in the EU by the 2000 Regulation). They suggest that the sort of access regulation of MPF and SMPF prices which exists in the UK has actually slowed the growth of genuine facilities based competition where parallel networks compete for customers (and incumbents provide negotiated access). They begin by noting that the rationale for unbundling is based on four premises. First, retail competition as measured by loss of market share by the incumbent is desirable. Second, competition cannot be achieved without unbundling of the local loop. Third, unbundling provides a 'stepping stone' to facilities based competition, which will emerge in the longer term. Fourth, competition in wholesale access markets is desirable in itself. Hausman and Sidak then subtly challenge each of these premises.

A small amount of actual switching may be consistent with a large amount of competitive discipline on incumbent networks. This is because fixed line networks involve large fixed costs which need to be covered. Thus fixed line networks need to be careful not to lose too many customers or else the

viability of their network may be threatened. Attempts to raise prices will only accelerate loss of market share to competitive providers and threaten their viability, the best defence against this is competitive prices. This is particularly true in the presence of cable and mobile operators as alternatives to the incumbent. Weisman (2006) has suggested that fixed line telecoms markets can be fully price deregulated when as few as 5% of customers have switched to alternative networks. This result relies on the entrants increasing the elasticity of demand with respect to price, to the point where incumbents lose net revenue by raising prices. It also relies on preventing incumbents from segmenting the market such that prices in areas vulnerable to switching are reduced while prices in other areas remain high (price discrimination).¹¹ Price elasticities of demand may initially be low in the absence of value added services and competitors. However the presence of high quality competitors will substantially increase the price elasticity of demand for the incumbent's network services.¹²

Competition does not require unbundling. New Zealand had a very successful experience with fixed line competition without proper access regulation, due to a combination of infrastructure investment by alternative providers and unregulated access agreements. In the US cable companies have competed successfully with incumbent operators in many states. Indeed the state of California recently removed access price regulation because sufficient facilities based competition was present.

The 'stepping stone' hypothesis is yet to be fully realised with unbundled telecoms systems. Indeed Hausman and Sidak suggest that the opposite is the case: regulation of unbundled access slows investment in competing facilities and puts back the day when all price regulation can be removed from the sector. It also reduces incentives to invest in new network configurations which will result in stranding the investments of the competitive providers using the unbundled parts of the existing network. Australia provides a good example of this where the incumbent, Telstra, offered to invest in a modern Fibre to the Home (FTTH) network, but only in return for a regulatory holiday on its access charges, given the investment costs and the risk of the project. The regulator agreed that the investment was in the public interest but refused to grant the regulatory holiday and as a result Telstra abandoned its initial plans for rolling out the new network (see Cave, 2007).

Finally, one can argue that competition in wholesale access service provision is not actually desirable in itself, but is only a means to an end. It is therefore only desirable if it leads to better final services and lower prices. If it prevents facilities based competition from emerging, then the longer run dynamic effect on competition is debateable.

These are powerful challenges to the idea of the necessity of regulated access to the incumbent's networks in the context of telecoms. However they are a US-centric view. The thinking in Europe is more relaxed about the efficacy of access price regulation (see Cave and Vogelsang, 2003).

¹¹ Regulators in telecoms have put a lot of effort into monitoring submarkets within telecoms where wholesale competition is deemed to be sufficient and continuing regulation in areas where incumbents have significant market power (SMP).

¹² It is also worth noting that a move from competition based on short to long-run contracting substantially increases price elasticity of demand. This is because price differentials are more meaningful if locked in for a longer period (their expected NPV is higher) and switching is a more credible threat. Comparing price elasticity in telecoms and electricity there does not appear to be a great difference, except perhaps for international calls (see Wheatley, 2003, and Espey and Espey, 2004).

The European view can be justified by appeal to some theoretical concepts (see Cave and Vogelsang, 2003). Theoretically it is clear that cheap access to non-replicable assets is desirable to promote competition in the final customer market. Theory also suggests that one way to encourage entry and new investment in alternative facilities is to have initially cheap but increasingly expensive access charges. This allows entrants to gain final customers by pig-backing on incumbent assets, but encourages them to extend their own networks over time. The figures presented earlier seem to clearly indicate that broadband penetration in the EU has not been unduly hindered by access regulation – though one could dispute whether cable network roll out would have been accelerated in the absence of access regulation and the outcome for broadband penetration would have been the same (though the market shares of the different providers might have been different).

In spite of the potential disincentive effects of access price regulation in the UK and other European countries there has been significant deregulation of prices e.g. the removal of price controls on all residential customer prices (in August 2006) and the removal of SMP conditions on 235 international wholesale charges (in July 2006). The wholesale broadband access charge was deregulated in May 2008. This is the price for a broadband retailer with no trunk network (including BT Retail). This is completely deregulated at exchanges where there are four or more broadband service providers are present at a local exchange (each of these providers may use a combination of their own networks, BT Wholesale and BT's LLU backhaul product (provided by Openreach) to collect traffic). The price of MPF/SMPF access (the local component of the whole network access charge) is still regulated and subject to maximum price regulation (and this is currently under review – see Ofcom, 2008a and 2008b).

The 2003 EU Communications Directives covering telecommunications deregulation have significantly reduced the number of markets that can be ex ante regulated in member states. Ex-ante regulation by national regulatory authorities (such as Ofcom) should only occur in local markets where Significant Market Power (SMP) is deemed to continue. Ofcom has been applying the SMP methodology in its reduction of the number of regulated markets. There does seem to be some prospect of moving towards relying on general competition policy law rather than specific regulation of access pricing. Competition Law is generally unable to adequately force incumbents to provide access to their networks when alternatives exist, however with the emergence of facilities based competition such specific regulation would be unnecessary (Cave, 2007). Hausman and Sidak (2007) suggest that in the US the 'End is in Sight' for telecoms regulation, whereas in Europe, 'Regulation forever' is still a strong possibility, even in the UK, as a result the failure to deregulate access. However this view does seem rather pessimistic especially given the pressure of new network configurations, which would seem to hasten the end of any price regulation.

In closing this section, we underline four emerging regulatory approaches in UK telecoms, worth highlighting for electricity. First, there has been tighter access regulation of the core network as exemplified by the creation of Openreach. This has involved an attempt to make it easier for competitive users of the local loop to gain access to it. This access has been physical and has involved the connection of competitive provider network equipment to the incumbent network. It was resisted for years as being technically difficult and unnecessarily expensive.¹³ Second, in order to

¹³ It is worth noting that Openreach helps address the problem of what price to charge for access by clearly identifying total costs in the local access business. Getting the price right is important. If access charges are too high incumbents can anti-competitively exclude entrants, but if they are kept too low this encourages cream

monitor access arrangements, a new governance structure has been created – the Equality of Access Board. This is an interesting development in that it devolves some of the regulatory dispute function to a board of the incumbent. Third, there has been a move away from typical RPI-X based price control based on efficiency analysis of operating costs (opex), modelling of capital expenditure (capex) and a weighted average cost of capital (WACC), towards maximum prices with a target rate of return. The latest review of Openreach notes the difficulty of doing cost comparisons (due a lack of real comparators to Openreach) and the hope that competitive discipline will keep prices down in the longer term.¹⁴ Finally, there has been growing pressure for regulatory holidays to allow incumbents (and competitive providers) to make large risky investments in new networks. Thus in the presence of competing networks and higher risks it is increasingly difficult for the regulator to both select investments and incentivise them within a traditional RPI-X price control framework, such as operated by Ofgem.

Section 4: Electricity networks in the context of Telecoms deregulation

It is clear from the above that there are some basic similarities between the configuration of the network and the debates about unbundling in telecoms and electricity. However it is important to be clear that there are important differences. Joskow and Noll (1999) point out four obvious differences between electricity and telecoms networks.

First, electricity ‘almost never’ relies on facilities based competition (Joskow and Noll, p.1308). This is not quite true in that large users clearly could bypass the electricity grid if they wished to and have their own power plant. Effectively they may do this if they are roughly in balance in export and import volumes from the grid and the value of the services they receive from the grid and that they provide to the grid are in balance. This should ensure that they receive reasonably competitive terms from a monopoly grid provider. Small users can also choose to engage in own generation, though this is rare.

Second, electricity networks are not ‘switched’ in the sense that telecoms networks are. Telecoms networks are switched in the sense that ‘traffic’ can be directed down a particular route between an entry and exit point. This means that it is not as straightforward in electricity to disconnect part of the network from one provider and reconnect it to another. Indeed power flows on the network follow the laws of physics not demarcations of ownership. Thus power may flow down a part of the network unrelated to the buyer and seller of the service (the loop flow effect).

Third, electricity networks have traditionally had unsophisticated metering and equipment control and many customers have not had real time metering. This means the charging mechanisms are not

skimming and entry of inefficient competitors. In the early days of telecoms deregulation the danger was that regulators, in order to stimulate competition, would prevent incumbents from charging high enough prices to cover the fixed costs of access. Access deficit charges were used to discourage inefficient entry and to compensate for the lost of contributions to fixed costs from switching customers.

¹⁴ Revised regulated charges for Openreach will still be set with reference to actual cost and incorporate potential efficiency improvements, it is simply that the analysis underlying this will be less sophisticated than in the past (see Ofcom, 2008a).

as granular as they have been for telecoms and that there have been few incentives for most users to make use of smart appliances capable of being remotely switched on and off according to electricity prices.

Fourth, there is little scope for technical change and innovation in products and services in electricity, compared to telecoms. Thus the introduction of mobile services, the availability of broadband and competition for pay TV have been major drivers of investment in alternative telecommunications networks. Innovative competition has motivated customer switching between networks and has provided public support for the deregulation process in telecoms. No comparable innovations have been forthcoming in electricity service provision.

The important point to make about the above is that they all may be in the process of changing and by 2050 the situation may be radically different from today. Thus it is possible to imagine facilities based competition in the supply of energy services, with enough contestability in local markets between grid supply, own and micro-grid generation. This does not have to result in large amounts of actual customer switching, just enough of a competitive threat to discipline the incumbent which would seek to keep prices down to prevent mass switching to alternative sources of energy service provision. It is true that electricity networks are less easy to 'switch' than telecoms ones, however control technology may make this more possible by preventing loop flow (using capacitors). But more importantly distributed generation within the distribution network may provide reserve capacity services to the distribution network and central power station customers which make their output valuable to the grid (thus improving their viability). Metering is becoming more sophisticated. Smart metering is becoming a reality and the UK government have recently announced a plan for a ten year roll out of smart meter technology to all electricity and gas customers, meaning that much more sophisticated locational and time of day pricing will be possible. Finally, there does seem to be significant scope for increased energy services products to be offered in the market, whereby customers might be offered lighting, power and heating services rather than energy per se (these are only offered to large industrial and commercial customers at present). This would involve innovative products combining raw energy, low energy equipment, control technology services and monitoring services (e.g. for security or the monitoring of the status of elderly relatives). Local combined heat and power (CHP) schemes offering electricity and heat, rather than conventional electricity and gas would be an obvious significant innovation in the UK. This highlights potentially important scope economies between electricity and heat which would parallel the scope economies between telecommunication and television which partially drove the roll out of cable networks.¹⁵

There are interesting cost comparisons to be made between telecoms and electricity. MPF rental charges constitute 21% of the retail value of broadband and voice services for a household customer in the UK (before VAT)¹⁶. The one off switching costs are also significant. By contrast electricity distribution network charges are only around 18% of the value of a domestic electricity bill (before

¹⁵ It is worth noting that one potential difference between telecoms and electricity is that telecoms competition has been driven by competition in trunk access provision and retailing leading to an interest in access to the last mile. In electricity interest in access to the local network would not be driven by competition in upstream access provision (transmission) as this is a local monopoly (onshore) and also a very small part of total value added in the sector (less than 5% of final price).

¹⁶ MPF rental equals £81.69 per annum while total residential bill for broadband and fixed calls and access is £380 per annum excluding VAT in 2007 (Ofcom, 2008a).

VAT)¹⁷. The percentage of the bill attributable to the low voltage network (less than 132kV) is even lower, say 70% of the total DNO assets and therefore say 13% of the total bill). This suggests that if anything local network costs are much less than in telecoms.¹⁸ This is significant because the standard textbook argument against facilities based competition is the costs of duplication of 'monopoly' networks. However in telecoms these are potentially relatively larger than in electricity but we have been willing to duplicate networks on the basis of the competitive benefits this provides. In 2007 total telecoms company retail revenue was around £30bn in the UK¹⁹, while electricity and gas expenditure was £40bn²⁰. Thus the retail telecommunications and energy sectors are roughly comparable in size.

The potential for micro-grids capable of operating in isolation from the main grid is large. The LENS Micro-grids scenario envisaged 48GW of DG (49% of total generation capacity). Ambitious proposals have been drawn up for London building on the positive experience of Woking, where a private wire network based around a CHP plant has significantly reduced carbon emissions in the local authority area. Leicester City Council also has ambitious plans for the creation of a city-wide heat network building on its existing heat and power plants.²¹ New technologies may supplement gas based CHP and eventually replace it (e.g. solar PV, Fuel cells and biomass CHP). One potential configuration of these is represented in Figure 5.

¹⁷ See Ofgem Factsheet 66, at

<http://www.ofgem.gov.uk/Media/FactSheets/Documents1/energy%20prices%20jan08.pdf>

¹⁸ This does ignore up-front customer contributions to connections for either telecoms or electricity (and may be significant in each case for the 'last yards' and the interface equipment) and simply considers the breakdown of bills.

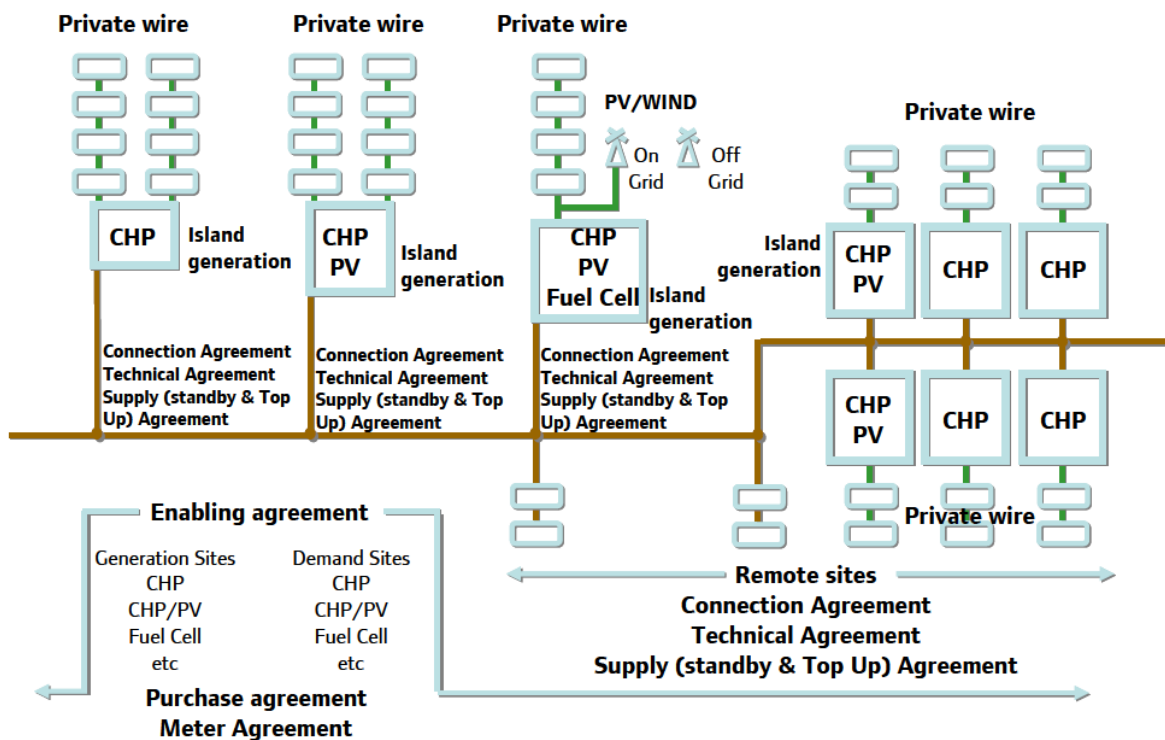
¹⁹ Ofcom (2008c, p.293).

²⁰ See DUKES, Table 1.1.6, at www.berr.gov.uk.

²¹ See Leicester Partnership and Leicester Environment Partnership (2003, p.27).

Figure 5: The Potential for Micro-grids and Distributed Generation

(Source: London Climate Change Agency, 2006, p.4)



Distributed generation and associated micro-grids pose few technical challenges in connecting them to the existing grid. A 5MW DG plant can be connected directly to the 11kV network, while a private wire network is simply connected to the DG plant directly, with the plant then linked to the public grid. There is no need for access to existing public grid sub-stations. Larger DG plant could connect at higher voltages, potentially lowering their grid-connection charges. Indeed DG can provide services to the public grid and hence earn extra revenues for providing backup facilities. This is in contrast to telecoms where unbundling is costly to the incumbent and requires reconfiguration of the existing local exchange.

Small DG schemes which want to sell directly to customers can make use of the 2001 Electricity Supply Order Exemption which allows them to avoid the full costs of applying for a public electricity supplier (PES) licence. Larger schemes above the thresholds in the 2001 Order must apply to for a PES licence.²² Ofgem (together with BERR) have conducted a significant review of the regulatory regime around distributed energy (see Ofgem, 2007, 2008a and 2009c). A major concern of this review was whether the regulations for connection of distributed generation within small supplier schemes were too onerous. The review (Ofgem, 2008a) made a number of suggestions mainly grouped in to two main areas. First, there were a number of recommendations on how the wholesale market arrangements might be altered in order to reduce the transaction costs on small distributed energy suppliers making use of the wholesale market to buy and sell power. Second, a

²² See London Climate Change Agency (2006, p.2).

number of work areas were suggested around the theme of making it easier for new distributed energy suppliers to negotiate terms with incumbents in order to allow non-discriminatory use of their existing networks. Indeed in February 2009, the Department of Energy and Climate Change (DECC) launched consultations on a Heat and Energy Saving Strategy (HESS) and on the Community and Energy Saving Programme (CESP) which among other things would examine the possibility of a renewable heat incentive and a feed-in tariff for small scale electricity generation.²³

The figures on the current costs of distributed generation based local energy service companies are difficult to assess and several of the largest schemes currently operate at a loss or with significant amounts of up front subsidy towards their capital investment (see Kelly, 2008). The Ofgem/BERR review of DG raised concerns about whether increasing supplier exemption thresholds would unfairly favour currently uneconomic distributed generation and whether it might result in stifling retail competition in electricity and heat and locking in customers to unfair contract terms. However these concerns about the current prospects for local energy service companies based on distributed generation – when incentives are modest - are rather different from scenarios where carbon prices and policy targets imply large amounts of distributed generation are necessary. Hence DG incentives in the future may be much stronger than today. It is also the case that small DG schemes find it difficult to participate in the wholesale market due to the transaction costs of doing so (hence the Electricity Supply Order Exemption, under which they do not have to) meaning that they find it difficult to get competitive terms for their surplus/deficit power. This problem may only be one which exists at the current small scale of penetration of such DG. Over time more aggregators may emerge in the market than at present meaning that competitive intermediaries may offer reasonable terms to individual small schemes.

It is worth pointing out that telecoms contracts are themselves sometimes reasonably long-lived (often 18 months) and restrictive and often individuals voluntarily buy contracts which are not appropriate for them (i.e. include too much capacity). The bewildering range of tariff packages acts as a 'confusopoly'²⁴. What is true in telecoms is that long term contracts and pay-as-you-go packages exist alongside each other. One imagines that might continue to be the case with energy service companies. A significant number of customers would likely continue to be with national energy suppliers offering 'competitive' tariffs which could be used to benchmark or even to index longer-term contracts. Indeed the Woking ESCO currently offers tariffs which track a basket of 'competitive' national suppliers. Thus while 10-20 year customer contracts might seem to be necessary to finance ESCO investments in generation (given the asset lives) they might not actually be necessary. If local ESCOs were to be part of larger holding companies and/or to hold a balanced portfolio of assets then risks might be diversifiable in conventional ways.

A look at telecoms reform suggests three ideas worth considering for the future of regulation of electricity networks: facilities based competition, local wire (loop) unbundling and buyout of parts of the existing network.

Facilities based competition in telecoms takes the form of competition, between mobile, cable and fixed lines. It can also involve duplication, particularly, of trunk lines. In electricity facilities based

²³ See www.decc.gov.uk

²⁴ Originally coined by Scott Adams in his Dilbert cartoon, see Gans (2005) for application to telecoms. Ofcom are currently taking steps to address this.

competition might take several forms. First, local generation competes with a combination of central generation and transmission services, rendering transmission services competitive (similar to competition in trunk lines in telecoms). Second, for some energy users disconnection from the grid may become an option (echoing mobile technology making giving up fixed line connections an option). Third, DG based micro-grids could threaten to bypass incumbent networks, by building private wires, if they were not offered competitive terms. The combination of heat and power (and additional value added services) energy services strengthens the parallel with telecoms, suggesting that there may be drivers other than the demand for power that might spur facilities based entrants. Facilities based competition in electricity distribution is currently rare. India formally introduced the right to create multiple distribution licences in addition to the incumbent in the 2003 Electricity Act²⁵. This has led to the issuing of second licences in several areas, but to date there appears to be no actual direct competition between parallel distribution networks, as envisaged by the Act²⁶. Kwoka (1996) noted that there were a small number of places in the US where there was head-to-head competition between local distribution companies operating parallel networks (and that this was associated with statistically significantly lower electricity prices than elsewhere).

Local loop unbundling in telecoms does seem to have facilitated the take-off of broadband competition across fixed line networks. It has done this by allowing entrants to get access to the part of the network that is a genuine bottleneck while giving them the opportunity to add value by avoiding using the incumbent in other parts of the value chain. The issue for electricity is whether a similar local wire unbundling might facilitate energy service companies based around distributed generation or other value added services. The unswitched nature of electricity networks makes the parallel imprecise as one cannot physically reserve the access capacity to the unbundled electricity customer in the same way as in telecoms. However we might envisage a simple tariff regime (and hence lower transaction costs) for access to the network capacity required to serve a customer of a DG based scheme. The telecoms experience suggests that in order to make access provision genuinely non-discriminatory it may be necessary to create a local access company whose job it is to provide access on a non-discriminatory basis. Thus the creation of Openreach type arrangements from nodes in the electricity system deemed to be competitive might be something worth considering. This has some parallels with a policy of ownership unbundling of distribution networks from the rest of the electricity system.

Buyouts of parts of existing telecoms networks are not strictly necessary in the presence of local loop unbundling and the possibility of facilities based competition. However it is possible that the current configurations of electricity networks are not optimal, based as they are on centralised generation and the process of consolidation that has taken place over decades as economies of scale at the plant level and then at the wholesale market level increased the optimal scale of regional networks. However it might be the case that smaller local companies, in order to optimally configure generation and distribution assets, might save transaction costs by owning some of the existing local distribution wires. One driver of the emergence of these sorts of companies would be ability of these companies to self-regulate distribution charges by exercising the right to buy distribution assets at

²⁵ See www.powermin.nic.in/indian_electricity_scenario/national_electricity_policy.htm.

²⁶ See Sachin Bhise, *op.cit.* It is worth noting that there is no regulatory impediment in Great Britain to an IDNO competing directly with a DNO to supply existing connected customers by building a parallel network (indeed existing distribution license holders – both DNOs and IDNOs - have the right to do this across Great Britain).

fair value in order to pass lower charges on to customers. This right to buy local electricity assets already exists in the US for local municipalities.²⁷ Such buyouts might be undertaken by customer cooperatives or local councils directly or private companies acting on their behalf, resulting in competition in ownership.²⁸ Arguably, Openreach is a reorganisation of asset ownership within BT that has facilitated more innovation for customers than the pre-existing ownership structure facilitated.

Each of these suggestions for the future of network regulation plays to the aims of RPI-X@20. They would make network companies more engaged with their direct and ultimate customers and they would facilitate the possible emergence of one potentially important aspect of the low carbon economy.

Section 5: Lessons for the regulation of Electricity networks from Telecoms

It was once thought that the fixed line telecoms network was a natural monopoly. It took many years for regulators to be convinced that it was not and that there could be competition for international and long distance calls and that price regulation was unnecessary (see Leighton, 2001). It is still thought that there is an access bottleneck in the local loop which requires price regulation. However this view is itself under threat from the emergence of facilities based competition and the challenge of next generation networks.

Currently we believe that local distribution networks are natural monopolies. However the electricity and heat sectors are about to go through a period of rapid technological change forced on them by the climate change agenda. Some of the scenarios that this gives rise to for the future involve significant amounts of DG and micro-grids. Keeping these scenario options open would seem to have significant option value at this stage. Hence it would seem to be important to have a regulatory system which is not biased against these scenarios emerging either at a significant national level or in particular locations.

The possibility of scenarios with significant amounts of DG and/or micro-grids suggests we would expect micro-grids and indeed own generation to be playing a similar role to competitive providers in the fixed line telecoms market. In telecoms there are two types of competition, one based on the construction of competing facilities which bypass the incumbent, the other involving access to the local loop owned by the incumbent. We would expect to see the same with competition based on

²⁷ See Hughes (2002).

²⁸ A potentially interesting form of this would be customer trust (such as exists in New Zealand for some local electricity distribution companies). Customer trusts are owned and governed by consumers. In New Zealand, they are exempt, from price control regulation on the assumption that consumer representatives on their boards will decide the optimal dividend/energy service price/reinvestment combination (see Commerce Commission, 2008). In India competitive tendering for the operation of distribution assets has been used with some success (see Sachin Bhise, 'All about deregulating the electricity distribution', *DNA Sunday*, 21 September 2008). This idea of customers or the government contracting out the operation but retaining the ownership of network assets has long been around in the UK since before privatisation in the UK water industry and formed the basis for the subsequent creation of Glas Cymru (a not for profit company which pays customer dividends).

distributed generation, i.e. competition based on threat of facilities based competition and competition based on easy rental of access to the local distribution system wires.

If we wish to see these two sorts of competition emerge the following suggestions for the regulation of distribution networks and distributed generation are worth pursuing:

First, we need to push through with the conclusions of the BERR/Ofgem review of distributed energy (2008a, 2009c) and the follow up action being proposed as part of DPCR5 (Ofgem 2008b) to reduce the transaction costs into the market for local energy provision. It is clearly the case that these costs continue to be a significant barrier to the potential entry of the sorts of companies envisaged in some of the LENS scenarios. Local loop unbundling in telecoms was a response to the slowness of the incumbent in offering access to new entrants, while regulated MPF and SMPF charges an attempt to arrive at a fair maximum price for access.

Second, an essential part of any future pricing regime for distribution services is nodal pricing within the distribution system to encourage the efficient location of DG around the electricity system (see Pollitt and Bialek, 2008). Prices for access to the distribution system must reflect the system benefits/costs of new entry (recognised in Ofgem, 2009c). In telecoms appropriate cost allocation (which the creation of Openreach facilitated) was important in correctly incentivising lower cost entrants. In electricity entry could be more localised and prices will need to be more granular than in telecoms. As in telecoms interaction with the existing implicit cross subsidies within a distribution network operator's charges would need to be recognised to prevent significant cream-skimming.

Third, facilities based competition in electricity should not be dismissed. It was challenged for years in telecoms before it was allowed to take off, especially in trunk lines and across technology platforms. Encouraging small scale entry offers the prospect of significant amounts of facilities based competition in electricity. No doubt as in telecoms there will be a continuing need for regulation of monopoly bottlenecks but substantial areas of deregulated charges may be possible, as well as a much simpler process for regulating the overall revenue of incumbents.

Fourth, a comparison between local loop unbundling and local wire unbundling (LWU) can be made. Local wire unbundling may be a way of making it straightforward for energy service companies based on DG to get access to network services on a non-discriminatory basis. This could be trialled in a few areas initially as a way of proving whether a workable model is possible and then could be extended as more potential renters of local wires come forward.

Fifth, reconfiguration of the ownership of existing assets may be necessary in order to facilitate more distributed generation. This might follow the pattern in telecoms of creating a separate corporate vehicle for operating local wires following the Openreach model and paralleling the ownership unbundling in distribution which has come about by statute in The Netherlands and New Zealand and voluntarily in some areas in the UK (see Nillesen and Pollitt, 2008). It might however involve the introduction of rights to buy parts of the DNO network in order to optimally configure a micro-grid and/or local energy service company.²⁹

²⁹ There is an issue of compliance with EU electricity directives relating to access to networks. LWU would seem to comply with these, but local micro-grids or energy service companies based on bought out network assets might be required to provide access across their networks for other energy suppliers. This follows the

Sixth, complete deregulation of electricity network regulation could be envisaged in the longer term as a result of competition between incumbent wires, micro-grids and own generation. Thus we could offer the prospect of the removal of price controls on a DNO once competition from DG/own generation reaches a threshold level. The prospect of this might encourage investment in island generation. This is similar to the Weisman (2006) point made earlier with reference to telecoms that it is the contestability of the provision of network services that matters for effective deregulation rather than the loss of significant market share. A key to this would be the limitation of the ability of incumbent DNOs to price discriminate within their DNO area against 'captive' network customers who had no prospect of competition. This might involve significant market power (SMP) tests of identifiable sub-markets similar to those used in telecoms. In the meantime we can consider moving to a simpler and more permissive regulatory regime based on maximum prices for incumbents. This should be combined with stronger incentives to facilitate DG connection and to experiment with new business models (on the part of both the DNO and those of their customers).

Seventh, the radical changes envisaged above need to be experimented with in order to understand the value of changing existing regulation to facilitate scenarios which may never come about (even in the absence of the barriers to DG identified in Ofgem (2008a)). Electricity companies still invest very small amounts of their turnover in R&D, in spite of the Innovation Funding Incentive – IFI - (which allows for R&D expenditure of up to 0.5% of turnover for network companies). The Registered Power Zone (RPZ) incentive which allows DNOs to fund experiments such as local micro-grid arrangements has only been used by three companies for four projects since its inception (Ofgem, 2008b). In 2007-08 R&D investment of the largest UK electricity/gas/water/multi-utilities (by absolute R&D spend) was just 0.2% of sales³⁰. In fixed line telecoms (mainly BT) it was 6%.³¹ Interestingly the UK leads the world in terms of R&D spending/Sales ratio in fixed line telecoms³², but is below the global leaders in electricity/gas/water/multi-utilities R&D who spend 0.6% of sales.³³ Clearly if we are to experiment with larger scale trials involving the sorts of regulatory arrangements envisaged above more R&D type funding is likely to be needed.³⁴

Section 6: Concluding remarks

This paper has argued that any fundamental reform of RPI-X regulation which involves partial or complete removal of price control should pay attention to the progress of price regulation in the telecoms sector. Telecoms provides a vision of both the conditions under which network charges can be fully deregulated and some of the reasons for continuing with price controls even where substantial amounts of competition are possible. There is no doubt that the application of lessons

'Citiworks' case ruling in the European Court of Justice which effectively overturned the exemption from providing universal access which applies to small electricity systems in the European Electricity Directive 2003/54/EC (and which the UK's 2001 Electricity Supply Exemption Order complies with). See Ofgem (2009c, pp.11-12). This is not a theoretical problem but might pose additional transaction costs on small companies.

³⁰ See DIUS (2009a, p.10, 16), sectors 8 and 16.

³¹ See DIUS (2009b, p.6).

³² See DIUS (2009b, p.6).

³³ See DIUS (2009a, p.116, 126), sectors 8 and 16.

³⁴ Ofgem (2008b) discusses the issues around increasing the IFI under DPCR5.

from telecoms to energy networks is conditioned on the currently less innovative nature of the electricity and gas sectors, particularly as regards to final customer demand for innovation. It is also the case that telecoms itself still has some debates major raging about how best to regulate / deregulate the sector and how to incentivise next generation networks.

The major lesson for energy networks from telecoms is that competition and innovation should go hand in hand in network industries. Where major innovation is possible and desirable, price regulation of incumbent monopolies is likely to be a barrier to new entry. If we are to take some of the more radical LENS scenarios for the future of the electricity (and heat) sectors seriously, there is no doubt that major innovation both in terms of the application of technology and in terms of the organisation of the energy sector is essential. It is here above all that the lessons from telecoms are salient.

If a world of micro-grids and energy service companies (and actively managed DNOs) is to emerge it will have to do so in a way which challenges the current business model of distribution network operators. No doubt innovative DNOs will be able to adapt to such a world, but all will have to face the threat of intensifying competition for the provision of network services and / or further unbundling and erosion of their natural monopoly. Telecoms provides two clear models of how this might proceed: via facilities based competition (based on actual or potential bypass of incumbent networks) or unbundled local access (via local loop unbundling). Telecoms experience also strongly suggests the link between effective competition and the improvement in performance of the incumbent, who may retain a significant market share but only at the cost of substantial innovation, implying that there are substantial net benefits from apparently inefficient network asset duplication.

There would appear to be no obvious technical barriers to this happening over time in electricity: only economic and regulatory barriers (which may be quite rational). What society should strive for is a situation where fundamental economics determines whether or not these radical electricity futures emerge and not the inertia of incumbents or the existing regulatory system. Telecoms in the UK provides a case history of the resistance of the incumbent to change in face of what would seem be greater technological barriers than in electricity and heat. There would also seem to be lessons about the role of the regulator in deciding what form deregulation should take and the speed at which it should proceed.

The lessons from telecoms remain tempered by the fact that electricity and heat networks develop more slowly than those in telecoms and the assets are longer lived. The role of climate change targets and incentives are also crucial in underpinning any future evolution of the energy sector. Information about how localised energy network competition based on new entrants might work has a high value in the near term. What would be sensible are some major experiments in promoting energy service companies and micro-grids to assess their ability to deliver climate change targets and their cost effectiveness. This might involve experimentation with fuller network charge deregulation/reregulation along the lines suggested above in particular localities. It also remains important to ensure that regulation does not close off more radical future network scenarios too early before they have the chance to be examined.

In closing, we suggest a number of factors that would bring a world of deregulated energy network charges closer:

1. **Reduced share of distribution charges in total energy bills.** Rising wholesale energy prices (due to a combination of high commodity prices, high carbon prices and high transmission/balancing services costs), would reduce the distribution network component of final energy prices, making network charge regulation less material and hence the threat of facilities based competition in networks more credible.
2. **Technological innovation which engages final customers.** Technological innovation on both the generation and demand side would facilitate the growth of direct sales to final customers of energy saving equipment and/or the emergence of energy service companies, micro-grids or more active distribution network operators.
3. **More local responsibility for climate change targets.** A move to delegate responsibility for meeting climate change targets to local authorities possibly via local carbon reduction targets, would result in the need for much more active engagement with final customers and pressure for the emergence of innovative local solutions.
4. **New forms of energy asset ownership.** The emergence of innovative forms of ownership of electricity assets such as via local public-private partnerships or customer trusts (possibly facilitated by new types of energy company licenses), based on carve-outs of local distribution assets and private wires, would reduce the need to regulate wholly-privately owned network monopolies and mitigate the need to regulate long term contracts for locally produced electricity and heat services.

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