Sustainability first

Smarter, fairer?

A discussion paper on cost-reflectivity and socialisation of costs in domestic electricity prices

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About Sustainability First

Sustainability First is small environment think-tank with a focus on practical policy development in the areas of sustainable energy, waste and water. We celebrated our fifteenth anniversary in 2015.

Our aim is to improve knowledge and understanding of complex multi-disciplinary issues in energy, water and waste. We develop implementable ideas which can make a difference for sustainability in these key policy areas – including the roles of economic and other regulators. We carry out research and analysis, publish papers and organise policy seminars. Our primary focus is on policy and solutions within the UK, but we draw on experience and initiatives both within and outside the UK.

Recent work on energy includes our major three-year (2011-14) multi-partner project **'GB Electricity demand – *realising the resource*'.** This involved a systematic look at the policies, regulatory approaches and commercial and consumer issues for development of an active demand-side in the GB electricity markets**.** All project papers have been published on the Sustainability First website. Together with our earlier studies on energy efficiency, household smart energy meters, and smart energy tariffs & demand response, we have brought significant practical insight to the development of policies and measures for smart sustainable energy.

In June 2015, we published a discussion paper to spell out suggested principles for government to adopt in the design of new low carbon interventions: '**Let's Get it Right: a suggested framework for improving Government low carbon interventions**'**.**

In July 2015, Sustainability First embarked on a major three-year multi-partner project, '**New-Pin' – New Energy and Water Public Interest Network.** Our aim is to establish a 'public interest voice' for the water and energy sectors. New-Pin brings together citizen, consumer, environment & investor interests around a table - together with a small group of energy and water companies – plus regulatory and government actors – to systematically explore some of the important long-term public interest issues for energy and water. These range from long-run affordability, stewardship, trust and confidence, standards for resilience and climate, and demand-side developments. Areas of commonality between the water and energy sectors will be explored as well as areas of agreement and disagreement among Network members. New-Pin also has two other work streams : in governance terms, to look at how the public interest is considered at water and energy company board-level ; and, thirdly, to develop some new thinking about capacity-building for public interest advocates in their interaction with the water and energy companies.

Our projects are funded via a group of partners. To date this has included funding from participating companies, regulators and consumer organisations. Aligned with our charitable objectives for environmental and sustainability education, we also undertake suitable project work which may be paid for by companies, by government and / or the economic regulators.

Sustainability First projects are developed and delivered by associates and trustees. Sustainability First Associates are Judith Ward (Director, part-time), Sharon Darcy, Gill Owen, Rebekah Phillips, Clare Dudeney and Jon Bird.

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Executive summary

Demand–side response (DSR), in its widest sense[1], has the potential to reduce costs across the energy sector in the transition to a low-carbon economy. Sustainability First's GB Electricity Demand Project[2] has extensively explored the potential for this and how this could be brought about. In order to keep customers' electricity bills as low as possible, customers need to be encouraged to use less electricity at times when it is expensive (and either use it at other times or reduce unnecessary use altogether). One way to encourage this is greater cost-reflectivity in pricing.

According to economic theory, cost-related pricing should have two related benefits: the removal of cross-subsidies in itself should improve overall system efficiency, and cost-related pricing should also encourage behaviour change. This paper examines these arguments in turn.

Theory argues that prices of goods and services should reflect the cost of providing them if the overall benefit to the economy is to be maximised. This is an important consideration in considering the structure of future electricity pricing, given the increased costs that will result from the move to a lower carbon electricity system. However, for various historical reasons, including the necessarily infrequent reading of domestic electricity meters, many of the costs that an electricity supplier faces that go to make up the domestic electricity bill have been averaged, or socialised, in different, and by no means consistent, ways.

The introduction of smart meters will make it easier to relate customers' usage to the actual wholesale cost of electricity at the time of usage and Ofgem's plans for half-hourly settlement for domestic customers[3] will encourage suppliers to make tariffs more cost-related. However, the wholesale price is currently only 37% of the retail customer's bill and is likely to decline further in future as a proportion of the end-bill. If more cost-related approaches to retail pricing were to be introduced in the future, several other changes may need to be made in addition to half-hourly settlement, for this to provide effective signals. For example, in order for electricity tariffs to be used to assist distribution network operators in dealing with local network constraints, distribution use of system charges for domestic customers could include a capacity element (price per kW) as well as an energy throughput element (price per kWh) (or be priced on a time-of-use basis) and/or become more location-specific.

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[1] Defined in 'Future Potential for DSR in GB, a report prepared for DECC by Frontier Economics with support from LCP and Sustainability First' as 'all actions that reduce demand from the transmission system at a particular time'.
[2] http://www.sustainabilityfirst.org.uk/gbelec.html
[3] See paragraphs 14-20 of https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/493713/Impact_Assessment_-_Draft_Measures_-_Fast_and_Reliable_Switching_and_Hal___.pdf for the latest position

However, moving towards greater cost-reflectivity in retail prices raises a number of issues:

- Greater cost-reflectivity, if reflected in retail tariffs may result in higher electricity costs for some customers who can ill afford it or who have limited ability to change behaviour. This can include fuel poor customers, those in rural locations and (in the non-domestic sector) heavy industrial users of electricity. Any move towards further cost reflectivity needs to be preceded by a full analysis of the impact of such a change on these very different groups.

- For proper cost-reflectivity, attention needs to be given to the basis on which industry charges are structured, i.e. which costs vary with peak load (kW) and which vary with consumption (kWh). This will become increasingly important for recovery of the industry's underlying costs with the increase in 'prosumers' who will generate more of their own electricity, but still need access to the network for emergencies or when their generation is not operational.

- While some costs and charges can be allocated in an unambiguous way against a customer's usage, there may be no unique way to do this for other charges. This applies to part at least of transmission and distribution network charges (the non-marginal cost element) and to Green Levy charges. If the totality of the electricity price is to provide an effective signal to end-customers, thought needs to be given to how best to allocate such costs.

- It is the electricity supplier who directly faces all of these different costs and charges. It is likely that the supplier will want to reflect these costs and charges, and the way they are structured, in the retail tariffs charged to customers. But, unless customers are to be charged actual costs, the tariffs will inevitably involve a degree of averaging (for example, peak/off-peak pricing rather than a different price for every half-hour). How suppliers are likely to approach greater cost-reflection in their retail tariffs will need further discussion with them.

On the other hand, retaining an element of cost-socialisation within the overall costs and charges payable by suppliers creates its own issues:

- Socialisation of charges is a blunt tool. While attempting to benefit the targeted group, it may provide unintended subsidy to a different or wider group, for instance, those with large discretionary usage at peak time. There may be better ways to provide targeted support.

- If a move to more cost-reflective retail pricing were purely voluntary, then distortions could arise which could affect the costs faced by retail customers. The paper explores examples from other industries that illustrate this, including the universal service obligation in mail and voluntary water metering. Two potential issues from the electricity sector would be:

- If half-hourly settlement were elective, then a supplier could offer a customer with a flatter than average usage profile a cheaper package based on elective half-hourly settlement and a ToU tariff. But unless this package resulted in the customer changing their behaviour, the cost of supplying all customers as a whole would not have reduced and so other customers as a whole would inevitably end up paying more.

- A similar situation would arise if half-hourly settlement were to be made mandatory and movement to a ToU tariff were voluntary for customers. In this case, customers with a more peaky profile would be inclined to stay on the flat tariff. With mandatory half-hourly settlement in place, electricity suppliers could lose money in supplying 'peaky' customers.

These issues suggest that the decision whether or not to continue to socialise aspects of the electricity cost-base needs considerable thought, particularly as we move to the likelihood of greater cost-reflectivity in electricity retail tariffs.

It is also important to examine the role of cost-related pricing to end-customers in encouraging behaviour change at day time peak. The simplest way to make domestic electricity prices more cost-reflective is through a retail tariff that charges different prices at different times of day (a time-of-use (ToU) tariff). There have been a number of recent trials of domestic electricity ToU tariffs which have shown a positive, albeit relatively small, customer response to cost-related pricing. However, more work is needed on the likely attitudes of customers more generally (as opposed to trial volunteers) to such tariffs, on the level of shifting that can be relied upon and on what are the effective means of encouraging flexible behaviour. One important feature from Northern Powergrid's Customer-Led Network Revolution (CLNR) project was that 40% of the participants would have lost money from a switch to ToU pricing had there not been a safety net in place.

A simple analysis carried out for this paper, using published data from the CLNR project about **average** annual consumption and the **average** proportion used at peak (16.00-20.00) by different demographic groups, would seem to suggest that in itself the introduction of a ToU tariff would have little financial disbenefit on average on any particular demographic group. Moreover, had every trial participant achieved the **average** reduction in peak-use seen in the trial of 55kWh, then everyone would have been better off. In other words, if everybody was 'average' (which of course they are not), everyone could gain from a switch to a ToU tariff[4].

[4] This finding appears somewhat at odds with the specific CLNR trial-finding that, in the absence of a safety net, 40% of trial participants would have been worse off on the ToU tariff.

On the other hand however, the individual consumption profiles published by the Low Carbon London project indicate **a wide variability in the levels of consumption and peak-use of individual customers**, and hence winners and losers from a transition to a ToU tariff. Putting together these two specific lessons from the CLNR and Low Carbon London trials, suggests that predicting the impact of ToU tariffs on individual customers **from looking solely at averages, even when differentiated by demographic group,** could be seriously misleading.

The CLNR project also published data on electricity-use by domestic users of low carbon technologies. EV and heat pump users may significantly add to peak load on the networks at a time when domestic demand is otherwise static or declining. For an EV user charging their car regularly at peak time, moving to a basic ToU tariff (peak price double the standard rate (assumed to be 15p/kWh) and off-peak tariff reduced to ensure neutrality for the average customer) would cost the user about £60 a year. If EV charging was moved to wholly off-peak times, there would instead be an annual saving of £60 compared with a flat tariff. Because of the amount of electricity consumed at off peak times, a heat pump user would save about £50 a year on the same ToU tariff compared with a flat tariff, even without behaviour change.

We conclude that domestic ToU tariffs could be economically beneficial for the electricity system as a whole and encourage some behaviour change in domestic customers. But the size of any potential incentive to change in behaviour may be small compared with the impact on some customers of the increase in their electricity cost resulting from the introduction of the new tariff itself. As a result, any behaviour change that occurred might well be limited. Furthermore, requiring all domestic customers to move to a ToU tariff could well be unpopular, particularly with those customers who would face increased bills and may therefore have limited economic benefit.

Further, if, as Ofgem currently envisage, HH settlement is eventually to be introduced for every customer, suppliers will in turn be under commercial pressure to make their domestic retail tariffs more cost-reflective if they are to avoid their lower cost-to-serve customers being ‘cherry-picked’ by their competitors. This ‘knock-on’ effect on suppliers could arguably have a similar result to introducing mandatory ToU tariffs. **The costs, risks, benefits and unintended effects of any move to individual HH settlement (both elective and mandatory) therefore need careful thought before any final decision is taken.**

A voluntary approach to ToU pricing, where those who wished would remain on a flat tariff, would be more attractive to the customer. But only those with a flatter profile than average would gain from, and therefore be inclined to shift to a ToU tariff, leaving those with a peakier profile than average on the flat rate with no incentive to change behaviour. Moreover, ahead of HH settlement for all domestic customers, the voluntary approach would only be attractive to electricity suppliers if the customers who chose a ToU tariff could be individually HH settled. Once full HH settlement was in place, suppliers are likely to want to encourage all their customers onto a more cost-related tariff, but risk succeeding only where they can match their customers' costs more closely with their own underlying costs and charges. This is most likely where customers already have a flatter than average profile. There would only be an overall beneficial economic effect if these customers *also* changed their behaviour to reduce their current peak consumption. For the future, it would also create a substantial subsidy to heavy peak users such as EV users who chose to remain on the standard tariff.

Other ways to encourage behaviour change could involve:

a) Better understanding of how to encourage behaviour change
More research is still needed to establish how people can be encouraged to shift their electricity usage away from high-cost periods and the scope for such peak-related behaviour change. There is clearly a role here for smart technology, automation and appliance control to assist in bringing that change about.

b) Protection for the vulnerable
Adequate financial protection and advice would need to be given to the fuel poor and vulnerable customers on the introduction of ToU tariffs, whether voluntary or mandatory. But the availability of smart meter data to suppliers and third-parties should make these vulnerable customers easier to identify and could be used to help identify those in need of help. Moreover, since a principal aim of targeting the fuel poor in energy efficiency schemes such as ECO is to reduce their energy bills, it would make sense to explicitly extend the scope of these schemes to install smart technology and appliances aimed at reducing peak energy use.

c) Target the atypical customer
Customers whose consumption patterns are close to the average are well modelled by the existing profile classes[5]. They could continue on a standard tariff.

It is, broadly speaking, only those *atypical* customers, whose very peaky consumption pattern makes it particularly advantageous to them to refuse a ToU tariff, where there would be a firm financial benefit for their supplier in getting them onto a ToU tariff, and an *overall system* benefit from either getting them to change behaviour or charging them the full economic cost of their behaviour.

Suppliers and third parties could take advantage of the availability of much better quality customer data as a result of the introduction of smart meters:

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[5] Load Profiles 1 & 3.

- The electricity supplier would identify from smart meter data households with *overall* consumption levels and *peak* consumption levels significantly higher than the norm.

- This data would be first used to identify whether the pattern of usage represented high deprivation or poor insulation. In this case social measures could be offered.

- In the absence of such factors, ie if the high peak usage was seemingly largely discretionary, the household could be targeted to incentivise / encourage behaviour change. This could involve a range of actions from provision of information and advice through to higher charges (for example, the eventual introduction of household connection or capacity charges, or, a ToU tariff).

d) Target the LCT user

Arguably, 'fairness' could mean that customers who place an 'unusual' or a 'major' new demand on the electricity system should contribute towards meeting the associated extra costs. The same approach as for the atypical customer could therefore be used to encourage best practice in the use of low carbon technology, such as heat pump or electric vehicle charging. Encouraging off-peak electricity use from the outset would be a good way of reinforcing these practices. In particular, where customers receive a subsidy towards their low carbon technology, it would be possible to discourage discretionary use of peak-time electricity by the use of incentives or tariffs.

e) Introduce ToU tariffs by degrees

Moving directly from a flat rate tariff to a fully cost-related ToU tariff causes winners and losers. However, if this change were to be introduced over a period of, say, five years, the amount of change in any one year would be much reduced and might be more acceptably accommodated. Moreover, the evidence from the trials suggests that mere awareness of a price differential has some incentive effect, and so whatever behaviour change in terms of moving electricity usage away from peak times that does occur might happen earlier than would be expected from the purely economic level of incentive. Suppliers could therefore be encouraged to put a 'toe-in-the-water' in offering ToU retail tariffs to those customers likely to benefit.

f) Target change of occupancy

A further example from the water industry might also be considered. This is that metered water charging can be required on changes of occupancy. A house move is a good time to change energy use conventions and practices and so encouraging behaviour change. Customers moving house could be targeted with information and advice, encouraged to install a smart meter and offered a ToU tariff.

g) Combine any of the above with a voluntary approach
None of this need stand in the way of customers voluntarily choosing to accept a ToU tariff, particularly if this was part of a package including smarter control of household electricity load, which could be a way to increase the scope for reduction in demand at peak times.

h) Incentivise behaviour change directly
A ToU tariff rewards non-peaky behaviour rather than targets changes in behaviour as such. As a result it can have unintended consequences which could be larger than the change it is aimed at producing. The introduction of smart meters allows for a more sophisticated and bespoke approach to incentivise change in customer consumption behaviour at peak (or other high cost times):

- Everyone remains on their existing tariff or voluntarily moves to a ToU tariff.
- Through the use of smart meter data, their electricity supplier builds up for each customer a usage profile over time.
- Customers on the flat tariff who reduce the peakiness of their profile are rewarded through financial payments or other incentives.
- This could, if desired, be extended to create disincentives / 'penalties' for those who significantly add to their peak time load (including those who install new LCTs).

This paper does not consider the many complex customer and consumer protection issues which will arise in connection with a move at scale to time-varying tariffs for households. These issues, including next steps, were discussed at length in Sustainability First Papers 8 and 12[6].

Although this paper has focused on the impact of ToU tariffs, a number of lessons emerge of more general and wider application to any change in the structure of the way domestic customers pay for electricity:

- If cost-related retail pricing is to be used to encourage customer behaviour change, there first needs to be greater coherence in the current socialisation of charges faced by suppliers. There also needs to be a clearer understanding of whether - and how far

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[6] Sustainability First. GB Electricity Demand Project. **Paper 8 :'Electricity demand and household consumer issues' and Paper 12 : 'The household electricity demand-side & participation in the GB electricity markets'.**

See also : Citizens Advice : Take a walk on the demand side. Making electricity demand side response work for domestic and small business consumers. August 2014. Ofgem : Consumer Empowerment & Protection in Smarter Markets : Updated Work Programme (September 2014) – & follow-on smart meter papers. Plus the forthcoming paper by Work Stream 6 of the DECC / Ofgem Smart Grid Forum (Autumn 2015).

- suppliers might then reflect these more cost-reflective charges onwards to their domestic customers through retail prices.

- Domestic customers are very variable in their overall use and also in their peak time use of electricity. Any change to the structure of retail pricing will create winners and losers compared to the status quo, and the impact of this needs careful examination taking account of the variability of customers - as well as the impact on the average customer.
- A greater understanding is needed of the factors that can influence avoided consumption at peak times via behaviour change, particularly for those customers who contribute most to the peakiness of the electricity system – both those with significant flexible load and those who may have very little flexibility when electricity system costs are high. Care is needed to ensure that incentives put in place do not have unintended or perverse consequences.

Introduction

This paper is aimed at exploring in more detail some of the issues raised in Sustainability First's GB Electricity Demand Project (especially Paper 12)[7], and investigated in several of the Low Carbon Network Fund projects, about the use of cost-related pricing and domestic Time of Use (ToU) tariffs to encourage changes to the way customers use their electricity:

> '[Demand-side response (DSR)] has the potential to help reduce costs and emissions across the energy sector. By changing the profile of demand, and increasing the flexibility of the demand side, DSR can reduce the need for investment in generation and network capacity, and increase the utilisation of more efficient generating plant. The move to a low-carbon economy is likely to increase the demand for DSR, as generation from intermittent sources increases, and the electrification of heat and transport increases overall and, potentially, peak demand. At the same time, this growth of potentially flexible load and the roll out of smart meters may increase the supply of DSR, particularly in the household sector. DSR is therefore likely to have an increasingly significant part to play across the electricity system – and an increasingly significant role within DECC's models of that system.'[8]

Many commentators (including Sustainability First) have discussed the potential use of greater cost reflectivity in electricity prices as a way of encouraging DSR. Greater cost reflectivity could involve static or dynamic time of use tariffs and/or locational pricing. However, any change in the way customers are charged for their electricity raises a number of issues about acceptability and fairness.

Whilst greater cost reflectivity is widely recognised as an important tool if the electricity system is to be decarbonised, it is a very different approach from the current pricing paradigm of encouraging greater simplicity in tariffs in order to improve customers' understanding. Indeed, there are those who have argued for greater socialisation (EdF in relation to distribution network charges, the Scottish Government in relation to generator transmission charges) rather than greater cost reflectivity. Whilst the current approach lacks overall consistency and coherence, any change from it needs to be carefully considered and the implications properly understood.

This paper attempts to tease out some of the issues. Cost-related pricing should have two related benefits: the removal of cross-subsidies in itself should improve overall system efficiency, and cost-related pricing should also encourage behaviour change.

Part 1 considers the first of these issues. Section 1 explores the economic arguments for greater cost reflectivity in retail prices. Section 2 then examines the different costs faced by

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[7] See footnote 2
[8] Reference in footnote 1, section 1.1

electricity suppliers that go to make up the final electricity price to retail customers, exploring the rationale behind the degree and nature of socialisation in each case. Section 3 considers how this can affect the way customers are charged for their electricity. Section 4 describes issues that have arisen in other markets, such as the postal service and water, from the tensions between cost-reflectivity and socialisation. Section 5 draws some conclusions.

Part 2 looks at the issues that could arise if more cost-reflective retail pricing were used to encourage behaviour change at daytime peak. Section 6 recaps the arguments for demand side response. Later sections look specifically at time of use tariffs and the variability of their impact on domestic customers, drawing on material from two Low Carbon Network Fund projects. The final section considers options for other ways to encourage effective DSR and draws general lessons that apply to the consideration of any potential tariff change.

Part 1 – Cost-reflection v socialisation

Section 1 : The economics of cost-reflective electricity pricing

An economics-driven approach to pricing would argue that to encourage cost-effective behaviour change in electricity use we need to get the price right. This section explores the reasons behind this argument.

According to economic theory, allocative efficiency is maximised when goods and services are priced at the cost of production. (In fact, it is, strictly speaking, the marginal cost that is relevant. We deal with this further below.) If the price is set too high (too low), then less (more) of the product is used than would be optimal and this is inefficient and a waste of resources. Setting the price correctly means that valid and efficient choices can be made between the product and alternative ways of meeting the customer's needs. This is the case even if the customer is not able to change the amount of the product they use, since (in theory at least) it encourages efficient budgeting between different items of expenditure.

In markets that are competitive and not unduly subject to political intervention, cost-reflective pricing is expected to be the norm. This has the added advantage of encouraging productive efficiency since, in a competitive market, the only way a supplier can increase profit, short of innovating new products, is to reduce the cost of production. However, customers do not always act 'rationally' (ie take the most cost-effective option). There may often be very good reasons for this, such as aversion to risk or complexity, or to customers having other priorities. So suppliers may deviate from this norm in practice to take account of these behavioural factors. This may be for marketing reasons, such as special offers for new customers, or through exploiting the reluctance of customers to change supplier. In a properly competitive market with rational customers, opportunities for suppliers to do this are likely to be limited, which explains the importance of some of the issues currently being investigated by the Competition and Markets Authority in relation to domestic electricity and gas prices and 'sticky' customers.

In markets of particular political interest, such as the utilities, in addition to the possibility of suppliers exploiting behavioural factors, Governments and regulators, over a long period, have imposed a wide variety of different averaging methods to different elements of the input charges faced by electricity suppliers, in part in the interests of 'fairness'[9], to reduce prices below cost for certain special interest groups, such as those in remote rural areas or on low incomes, or large industrial energy users, with the additional costs being picked up by the remaining customer groups. As a result of the difference in approach adopted for different

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[9] Fairness is a flexible concept. See the Appendix where fairness has been used as a justification for promoting water metering, ie cost-related pricing.

cost input elements, there is a current lack of overall coherence in the effect of this so-called socialisation of pricing.

In the case of electricity, much of the averaging that has occurred historically has arisen because of the crudeness of electricity metering. When the only information available, both to customers and suppliers, about consumption levels is the total amount of electricity used between two six-monthly meter readings, there is little point in more complex time-of-use pricing[10]. The result has been that, in the domestic market at least, customers have been left with the impression that electricity is a single product with a single price regardless of when it is used. This is far from the case: the cost of producing and delivering electricity to the customer varies by time of day and time of year, as well as by location. Moreover, there are some costs that vary with the amount of electricity used (measured in kilowatt-hours), some which depend on the peak demand of the customer (measured in kilowatts) and some that vary only with the number of customers.

What's more, because the electricity industry is a highly capital intensive one, there is the question of how capital costs should be recovered and remunerated. Economic theory argues for marginal cost pricing, where prices are set at the cost of producing one extra unit of production. This can either be short-run, which is the cost of producing an extra unit in the absence of new capital investment, or long-run, which is the long-term increase in cost resulting from investing to meet the additional demand. Unless a business is in equilibrium, it is unlikely that marginal cost pricing will recover all the costs of operation, and so there remains the question of how to recover the remaining costs. Theory would suggest a fixed or daily charge.

[10] The one exception to this approach is Economy 7 tariffs, using a separate meter or meter register for off-peak consumption often with appliances (such as night storage electric heating) hard-wired into the off-peak meter circuit.

Section 2 : The costs an electricity supplier faces and the extent to which these are socialised

To understand more about how the costs of producing and delivering electricity are recovered in domestic electricity bills, we need to explore the different components that make up the bill and see how the costs are spread between different customers[11]. As it is the electricity supplier who aggregates each of these and then sets a tariff, we start with the costs faced by the supplier. According to Ofgem, an average domestic electricity bill for the financial year 2015-16 is estimated to break down as in Table 1[12].

Table 1 – Breakdown of an annual domestic electricity bill

Wholesale electricity costs	£223[13]	37%
Network costs	£146[14]	24%
Environmental and social costs	£71[15]	12%
Operating costs	£81	13%
VAT	£29	5%
Pre-tax margin	£52	9%
Total	£603	100%

(Source: https://www.ofgem.gov.uk/publications-and-updates/charts-outlook-costs-make-energy-bills)

We look at each of these in turn.

Wholesale costs

An energy supplier has to buy electricity so that it can supply it to customers. It may buy this on the wholesale market, or have a contract with an electricity generator. Some suppliers are also part of companies that generate their own energy. The wholesale market is a national one and so the wholesale cost of electricity does not depend on the location of the generator or the customer. However, the overall cost of generating electricity depends on the time of day and time of year because, as the level of demand increases, more expensive power stations need to be added to the operating mix to meet the extra demand. So the wholesale electricity costs a supplier faces will vary by hour and time of year.

The British electricity market works on the principle of bilateral trading between generators, suppliers and traders. So energy suppliers aim to match their contractual positions against the expected demand from their customers in each half hourly settlement period of the day. Imbalances are dealt with in two ways. First, any imbalance that a supplier faces in any half-

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[11] This analysis examines the costs that are currently faced by an electricity supplier. It does not consider the extent to which they reflect, or should reflect, an appropriate cost of carbon.
[12] https://www.ofgem.gov.uk/publications-and-updates/charts-outlook-costs-make-energy-bills
[13] Of which £1 is imbalance costs
[14] £39 transmission use of system, £101 distribution use of system, £6 balancing system use of system
[15] £48 Renewable Obligation, £17 Energy Companies Obligation, £11 Feed in Tariff, £7 Warm Homes Discount, less £12 Government-funded rebate

hour between its contracted position and its actual demand results in an additional payment to the supplier (at the System Sell Price) if it is over-contracted or a payment from the supplier (at the System Buy Price) if it is under-contracted. The net cost to a supplier is a result of its aggregate contractual position and therefore this cost cannot be directly attributed to individual customers, but it can be seen from footnote 13 that the cost is relatively small. Second, any overall imbalance on the system resulting from a mismatch between contracted positions and actual demand or from an unforeseen issue such as a generator trip is managed by the System Operator (National Grid) as balancer of last resort. The cost of this latter service is considered below under network costs.

One complication to this market arrangement has been caused by the decision of the Government to remunerate renewable generation and nuclear power by means of Feed-in Tariff Contracts for Difference (CFDs). Because the strike price in the CFDs does not vary between peak and off-peak periods, renewable generators do not face normal pricing signals and so will tend to run in 'must-run' mode, ie they do not generally[16] need to respond to signals from the system operator to reduce their output in response to lower electricity demand[17]. As a result, wholesale prices are likely in future to be comparatively low (or even negative) for substantial periods at times of high-wind and/or non-peak demand periods[18] – with higher, more volatile and unpredictable price patterns when fossil plant runs to provide flexibility, or at times of system 'stress' – i.e. at periods of low-wind output - which may or may not coincide with peak. The Renewable Obligation, which CFDs are planned to replace, suffered less from this problem, since it provided a top-up to the market price rather than an overall fixed price.

Suppliers need to know the amount of electricity their customers have used in order to know how much they need to pay generators. The process for comparing the amount suppliers have contracted for with actual metered consumption and reconciling any difference is called 'settlement'. This process is set out in the Balancing and Settlement Code (BSC) and is performed for every half-hour settlement period. Under the current arrangements set out in the BSC, consumers must be settled against their actual half-hourly (HH) consumption if their average maximum demand exceeds 100kW. A supplier can also elect to settle HH any consumer with an appropriate meter. However, in practice very few sites are voluntarily settled HH at present, because the benefits do not justify the additional costs.

For customers whose consumption is not settled half-hourly (non-HH customers, which in practice currently include all domestic customers), Elexon, the company responsible for operating the BSC, creates a number of consumption profiles, each chosen as representing

[16] Even renewables generators may have to curtail their output if it exceeds the capacity of the transmission network locally to deliver it. But in this case, National Grid has to make constraint payments to the generator.
[17] An issue raised at Ofgem's Sustainable Development Advisory Group meeting in June 2015.
[18] Sustainability First, Paper 9. The Brattle modelling indicates negative prices for considerable periods by the early 2020's. Similarly, Poyry, Assessment of DSR Price Signals (2011), found potentially negative prices for up to half of the time by 2030.

large populations of similar customers, which provide a typical daily and yearly pattern of consumption. Suppliers then pay for their electricity on the assumption that, averaged over many thousands of similar customers, the total consumption in each half hour of their customers in each profile class will match the relevant profile. To allocate the right cost to each customer, meter readings of consumption are needed. But because non-half hourly meter readings are taken infrequently[19], with bills often relying on estimated readings, there is a lengthy process of reconciliation[20], taking up to 14 months, before settlement relating to a particular half hour is finalised.

The introduction of smart and advanced meters will simplify the position by creating data relating to customers' actual consumption in each half hour. Customers in Profile Classes 5-8 (typically the largest non-domestic customers currently settled using profiles) were required to have advanced meters installed by 6 April 2014 and all to be settled half-hourly from 1 April 2017.

Smart metering offers the opportunity of extending half-hourly settlement to all customers. In its paper 'Electricity settlement reform'[21], Ofgem said:

> With the roll-out of smart metering, it will be possible for the first time for suppliers to pay for the energy that their customers actually consume. This is because smart meters will record consumption for every half-hour period in the day. Settling consumers against their HH consumption data could also enable suppliers' network charges to better reflect the costs of transporting energy to their customers.
> Inaccuracy in the allocation of energy volumes affects the costs that suppliers incur in purchasing and transporting energy. Through imbalance charging, suppliers currently have incentives to contract with generators to meet the amount of energy they will be allocated through profiling rather than what their customers actually consume.
> We consider that, wherever possible, costs should be allocated to those responsible. More accurate allocation of energy and network costs will support the transition to smarter energy markets, to the benefit of consumers.

In summary, in any given half-hour, **suppliers face the *actual* wholesale energy costs of customers who are half-hourly settled, but only an *averaged profile cost* for those that are not.**

[19] Even half-hourly meters are not read more frequently than daily and so reconciliation is also needed here albeit on a much shorter timescale than for non-HH meters.
[20] The reconciliation also takes into account system losses, unmetered supplies and other abstractions of electricity.
[21] https://www.ofgem.gov.uk/publications-and-updates/electricity-settlement-%E2%80%93-moving-half-hourly-settlement. A useful update on the state of the proposal is provided in paragraphs 14-20 of https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/493713/Impact_Assessment_-_Draft_Measures_-_Fast_and_Reliable_Switching_and_Hal___.pdf

Network and balancing costs

Network costs are the charges made by the transmission and distribution operators for use of the network. These cover the cost of building, maintaining and operating the electricity network. Suppliers are charged for this, and pass on these costs to their customers. In principle at least, it is possible to identify the relevant charges and costs in respect of each customer and so exploring how cost-reflective these charges are, is a relevant issue.

Transmission Network Use of System (TNUoS) charges recover the cost of providing and maintaining shared (or potentially shared) electricity transmission assets, ie assets that cannot be solely attributed to a single user. TNUoS charges are recovered from all generation and demand users of Britain's electricity transmission system. These charges vary by geographical zone, reflecting the costs that users impose on the transmission network to transport their electricity. This zonal approach, which comprises a degree of cost-reflectivity, is unusual internationally, with most other European countries applying a 'postage stamp' approach or a single price per MW or MWh[22].

Generators are charged a price per kW connected, which in 2015-16[23] varied from £25.5/kW in North Scotland to -£5.8/kW in West Devon and Cornwall. The tariffs are a combination of a locational element that reflects the (long-term) cost of providing incremental capacity to generation on an area of the main integrated onshore transmission system, and a non-locational residual element which ensures that the appropriate amount of transmission revenue is recovered from generators. The negative values in the south of the country reflect the fact that extra generation there reduces the need for additional investment.

Very large users, and suppliers on behalf of other users, are also charged zonally, but by zone that relates to the distribution network operator for the location of the customer. Consumption charges in 2015-16 vary from a demand tariff of £23.5/kW and an energy consumption tariff of 3.4p/kWh in Northern Scotland to £46.2/kW and 6.0p/kWh, respectively, in London. The demand tariff, which is derived in the same way as the generation tariff, is calculated by reference to the user's average half-hourly demand in the three half hours in the year with the highest national demand (Triad periods). The charges relating to HH customers are based on their meter readings in the Triad periods. For non-HH customers, the charge which suppliers face is based on the deemed usage during peak periods using the relevant settlement profile.

Balancing Services Use of System (BSUoS) charges recover the costs of the day-to-day operation of the transmission system. These costs primarily relate to the real-time balancing of the electricity system. They include payments to generators either to increase or decrease

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[22] https://www.ofgem.gov.uk/ofgem-publications/54363/principlesandprioritiesfortxchargingreformoxera.pdf, page 1

[23] http://www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=40130

output, in some cases at very short notice, and, increasingly, to demand customers who are prepared to reduce their demand in response to a request from the System Operator. BSUoS charges are charged to both generators and suppliers on a per MWh basis for each half-hour.

Distribution Use of System (DUoS) charges recover the cost of providing and maintaining the distribution network in whose region the customer is located. Unless a specific connection agreement has been entered into between the customer and the DNO, the relationship is governed by the National Terms of Connection[24]. **For HH customers**, the agreement specifies the maximum import and export capacity (in kW) for the customer. **For non-HH customers**, no specific limit is placed on import or export capacity, although customers are required to notify the DNO 'if you propose to make any significant change to the connection or to the electric lines or electrical equipment at the premises, or if you propose to do anything else that could affect our network' (Section 2.2). Customers are also required to notify the DNO[25] if they install generating equipment with an output of less than 16 amps per phase (3.68 kW for a single phase supply) or to obtain the DNO's consent for a larger installation. It is highly unlikely that more than a small proportion of domestic customers are even aware of the National Terms of Connection. Moreover, comparisons that have been made between the number of feed in tariff applications for PV and notifications to DNOs suggest substantial under-reporting of PV installations to DNOs despite the fact that certified PV installers are aware of their legal obligations to inform DNOs[26].

For HH customers, DUoS charges include a daily charge, a capacity charge (based on the maximum capacity in the connection agreement) and a unit charge (per kWh). The unit charge has three time bands, weekday peak, weekday other day time, and all other times. **For non-HH customers**, there is simply a single unit charge. Although there are different prices for each DNO[27], there is no differentiation within a DNO region, despite the fact that it costs considerably more to maintain and operate the network to deliver to customers in remote rural areas than in urban areas. Industry working groups are discussing how to introduce greater cost-reflectivity in the way that *suppliers* are charged for the peak-related costs of the lower-voltage networks in anticipation of wider use of half-hourly settlement[28].

A strict cost-reflective approach would look at the level of spare capacity at each location (node) on the network and set prices according to the marginal cost of supplying additional load at that location (as happens with transmission charges). This would mean, for example, in areas where load was declining and reinforcement investment unlikely to be needed,

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[24] http://www.connectionterms.org.uk/
[25] G83 process
[26] DECC have proposed that this should be rectified: https://www.gov.uk/government/consultations/consultation-on-a-review-of-the-feed-in-tariff-scheme
[27] Ranging for a typical domestic consumer from around £66 a year in London to £122 in north Scotland. See https://www.ofgem.gov.uk/sites/default/files/docs/2015/10/reg_charges_final_master_version_23_october_2015.pdf where Ofgem also defends regional DUoS price variation.
[28] Sustainability First GB Electricity Demand Project, paper 12, section 5.4.2

charges would be lower. Instead however, prices are based on the long-run marginal cost of a hypothetical significant increase in load on the network[29]. The stated reason for this is that customers are benefiting from the maintenance of the electricity distribution network as a whole and charges are a system cost. This is despite the fact that about half the cost of running a distribution network is at low voltage and depends on local conditions. It is also at odds with the methodology for charging for a new generation or load connection to the network, where the charge is heavily dependent on whether or not there is spare local capacity and so whether new reinforcement investment is needed[30].

Two other factors are relevant for the future. First, since average domestic electricity usage is slowly declining (as is peak demand), low voltage reinforcement in predominantly domestic areas is likely only to be driven by the introduction of new low carbon technologies such as electric vehicles and heat pumps. Second, those involved in those community energy projects where the aim is to minimise their use of the wider electricity network are still paying the full network costs. It could be argued that only the net costs should be charged. More localised approaches to low voltage network charging would therefore be more cost reflective and is an area that could merit further study.

Environmental and social costs

These are the costs of government programmes to save energy, reduce emissions and encourage take up of renewable energy. They also include the cost of social programmes like the Warm Homes Discount. They are all charged to the supplier on a per kWh delivered basis. Table 2 below shows that the proportion of the electricity going to pay these ‘green levy’ costs is forecast to rise from around 10% of the domestic end-bill today to around 24% by 2020 and 32% by 2030. Assuming that network charges (around 21% of the bill) continue to be charged to domestic customers on a per kWh basis, around 46% of the bill in both 2020 and 2030 will continue to be charged to the customer on a flat per kWh basis[31].

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[29] Because prices derived from LRMC would not recover the whole of the DNO’s costs, the resulting prices are scaled up until they do so. This is not what economic theory would recommend.
[30] Although socialisation raises its head here too. Single G83 installations are not charged any related reinforcement costs (in practice, in the past at least, reinforcement has been unlikely to be necessary), although multiple G83 installations have been charged. For the ED1 period (2015-23), reinforcement costs associated with multiple G83 installations are to be socialised.
[31] DECC’s update (see footnote 32) in November 2014 has resulted in amendment of the figures in Sustainability First GB Electricity Demand Project, paper 12, section 1.4

Table 2 - Breakdown of estimated average impact of energy & climate change policies on household electricity bills (including VAT) for 2014, 2020 and 2030

Real 2014 £	2014	2020	2030
Estimated electricity bill	586	606	729
ECO support	15	23	-
Smart meters	1	1	-5
Small scale Feed in Tariffs	9	14	13
Renewables Obligation	36	48	30
Contracts for Difference	-	30	84
Capacity Market gross auction cost	-	12	14
EU Emissions Trading Scheme carbon cost	7	7	80
Carbon Price Floor carbon cost	16	30	
Other wholesale price effects	-5	-12	-17
Warm Home Discount support	6	6	5
Warm Home discount rebate	-13	-12	-11
Government Electricity Rebate	-12	-	-
Costs of energy and climate change policies as a percentage of average electricity bills	59(10%)	147 (24%)	192 (26%)
Extracted from Tables D1-3 of DECC, 'Estimated impacts of energy and climate change policies on energy prices and bills', November 2014[32]			

Green levy costs are charged within the electricity bill rather than being paid for through general taxation to avoid them counting as public expenditure. This approach began with the Fossil Fuel Levy introduced at the time of electricity privatisation, although the Fossil Fuel Levy was effectively a reallocation of costs rather than an addition. As green levy costs have risen as a proportion of the fuel bill, a range of issues relating to fairness arise:

- The beneficiaries of the green levy policies are either the nation as a whole in terms of lower carbon emissions, or those who benefit directly from insulation measures. Yet the costs of the green levies are spread in a highly regressive way between electricity

32 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384404/Prices__Bills_report_2014.pdf

users given that low-income consumers spend a much higher proportion of their income on energy than most affluent consumers[33].

- Because green levy costs are not charged on gas bills, they impact particularly hard on all-electric households, and increase the cost of electricity compared to fossil fuels such as gas, coal or oil[34].

Supplier costs and margin

These are the costs associated with running a retail energy business, including sales, metering and billing together with the supplier's profit. In the price they charge consumers, suppliers will seek to cover these costs and achieve a surplus, which is their profit margin (before they pay tax).

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[33] Successive Fuel Poverty Advisory Group annual reports. See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/405588/fpag_12th_annual_report_2013_2014.pdf, page 30

[34] http://www.eurelectric.org/media/189332/electrification_report_final-2015-030-0437-01-e.pdf

Summary

Table 3 below summarises this section’s discussion, demonstrating the range of ways in which the costs faced by an electricity supplier are presently socialised.

Table 3- Degree of current socialisation of different costs and charges faced by the electricity supplier

	Time of day unit (kWh)	Time of year unit (kWh)	Peak demand (kW)	Location
Wholesale electricity costs (HH settled)	Actual	Actual	Wholesale contracts and capacity market	National market
Wholesale electricity costs (non-HH settled)	Averaged by profile class	Averaged by profile class	No	National market
Imbalance costs	Supplier faces net imbalance costs and so not attributable to individual customers	-	-	-
Transmission network charges (HH settled)	Time banded	No	Yes	Zonal
Transmission network charges (non-HH settled)	Averaged by profile class	Averaged by profile class	No	Zonal
Balancing system charges (HH settled)	Time banded	No	No	No
Balancing system charges (non-HH settled)	Averaged by profile class	Averaged by profile class	No	No
Distribution network charges (HH settled)	Time banded	No	Yes	Zonal
Distribution network charges (non-HH settled)	Averaged by profile class	Averaged by profile class	No	Zonal
Environmental and social costs	Averaged	Averaged	No	No
Operating costs, VAT and margin	Supplier’s internal costs	-	-	-

(Source: Sustainability First)

Section 3 : How cost-reflective are retail domestic electricity prices?

The analysis of Section 2 describes the costs and charges faced by suppliers. It does not describe how these are passed on to the final customer or the extent to which the prices experienced by end users are cost-related or socialised. These prices are set by contract between the supplier and the customer or in supplier tariffs.

As far as it is possible to ascertain given the commercial nature of the contracts, HH customers' prices are related to the costs the supplier meets in supplying them. However, there is anecdotal evidence to suggest that, while some HH customers' bills separately identify network charges, the time-related nature of these charges is not always passed on to customers[35] and so customers may be unaware of the incentive effect of these ToU signals. This may be one reason why the CLNR study of the impact of the introduction of ToU DUoS charges for HH settled customers[36] found that there had been no significant change in customer behaviour.

Supply licences incorporate standard conditions requiring suppliers to avoid 'unduly onerous terms' between their non-domestic and domestic customers[37] . In addition, because all parts of the market are open to retail competition, then at least in principle there should be no opportunity to load costs between different customer sectors (for instance, making use of excess profits from 'sticky' domestic customers to subsidise prices to commercial and industrial customers)[38]. We note that this issue is not included in the CMA terms of reference.

For non-HH customers, a supplier's costs are determined by the relevant settlement profiles together with the structure of the remaining customer-related costs. **This means that a supplier's costs per customer are identical for each customer within a single profile class and in a single DNO region**. This tends to lead to:

- A single unit price (or at most two unit prices) for electricity relating to the profile classes for unrestricted use and Economy 7 customers.

- A price which is different in each of the DNO regions because of the regional variation in network charges.

- A standing charge, which may be zero, in addition to a unit price.

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[35] Private communication
[36] http://www.networkrevolution.co.uk/project-library/april-2010-tariff-reform-analysis-introduction-common-distribution-charging-methodology-cdcm/, from a group of around 16,000 half-hourly settled customers.
[37] LC 7.3 & 7.4
[38] Because only part of the water market is being opened up to competition, this is currently a live issue for the water regulator, Ofwat.

Most domestic tariffs that have been on offer in the recent past have followed this structure, the differences being on whether a fixed price is offered for a fixed period and for how long, and the amount of extra-normal margin the supplier may be obtaining from 'sticky' customers[39]. As mentioned above, this latter point is currently being investigated by the CMA.

The question then arises as to what a supplier is likely to do if it faces a change in the structure of its costs and charges that differentiates between individual customers, such as the introduction of individual HH settlement. This would mean that retaining the existing tariff structure would lead to the cost of supplying some customers exceeding the income generated from them, and others becoming more profitable to supply. On the assumption that the CMA deals with the 'sticky' customer issue (by ending evergreen contracts or otherwise), suppliers may have a number of options, including:

- **Do nothing** If the cost differential is not large, and in particular if the cost to the supplier of changing tariffs or other customer interactions exceeds the benefit, this may be the best strategy. Otherwise, there is an opportunity for other suppliers to 'cherry pick' the more profitable customers. This would leave the supplier with the need to raise prices to its remaining customers if it were not to lose margin.[40].

- **Attempt cost recovery in flat bespoke tariffs** Assuming the 'four tariffs' constraint is lifted, the supplier could seek to recover its costs by setting a bespoke, individual flat tariff for each customer, or at least for those with atypical profiles. In order to set tariffs, suppliers would have to estimate customers' individual load profiles. This would be extremely administratively complex, would need constant adjustment to take account of forecasting error, and would in effect be a separate contract for each customer.

- **Retain uniform flat tariffs but concentrate marketing on profitable customers** Given the risk of 'cherry-picking' by competitors, a supplier is likely to devote more marketing and customer service attention to its more profitable customers, and less to its unprofitable customers. However, it would continue to make a loss on these latter customers and if it cannot get rid of them or persuade them to change their behaviour, its overall margins would fall.

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[39] See paragraph 26 of https://assets.digital.cabinet-office.gov.uk/media/53e38996e5274a261f000001/Stephen_Littlechild_et_al_submission_to_CMA_7_Aug_2014.pdf for examples of alternative social tariffs that were available before the Retail Market Review.

[40] There is an interesting parallel in the water industry, where there has been concern that introducing competition would lead to a de-averaging of prices between rural and urban household customers through the incentive for new entrants to 'cherry pick' those customers within an incumbent company's region that are the lowest cost to serve. Ofwat, rather unconvincingly, described this possibility as a 'myth'. http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenvfru/674/67402.htm, paragraphs 34-37.

- **Introduce more cost-reflective retail pricing** Some form of cost-reflective retail pricing would be a natural option to choose in order to retain the customers with a lower cost-to-serve. However, cost-reflective retail pricing would not be a popular choice with those customers with higher peak power usage whose end-bills might increase. A voluntary cost-reflective tariff would address cherry-picking, but at the risk of increasing prices to those remaining on a flat tariff. This is dealt with further below.

- **Use other approaches / incentives to change customer consumption at peak** A supplier might try to bring its costs and revenues more into line by changing customers' behaviour by means other than a cost-related tariff change alone. Marketing initiatives such as British Gas's Free Saturday trial or offering cheap, or free LED lights as a means of reducing peak usage, could be useful.

To conclude, if as a result of half-hourly settlement suppliers have an increasing exposure to more customer-specific costs, and the cost-differentials are sufficiently high, then it seems inevitable that suppliers would wish to act to bring their underlying costs and revenues more closely into line, to mitigate the problem. In practice however, it is only the last two options above that may result in behaviour change at peak times by customers.

Section 4 : Socialisation of retail prices in other markets

The debate between cost-reflection and socialisation is not restricted to the energy sector. Here are a number of examples from other sectors and the issues they have raised. They have relevance to the debate and some parallels on how far underlying costs and charges might be reflected through into electricity retail prices.

4.1 The universal postal service obligation

Ever since Sir Rowland Hill introduced the Uniform Penny Post in 1837, postal rates in the UK (and rapidly thereafter worldwide) have provided the ability for anyone in the UK to post letters and parcels to any other part of the country at the same affordable prices (the Universal Service Obligation). With the privatisation of Royal Mail and the introduction of greater competition, there have been concerns that the obligation was under threat.

In June 2014, Royal Mail argued to Ofcom that competition from Whistl posed a serious threat to its ability to provide the universal service. Royal Mail argued, amongst other things, that Whistl was unfairly cherry picking high-density, low-cost areas in which to provide end-to-end competition (such as London), leaving Royal Mail to deliver in the remaining unprofitable areas and unwinding the cross-subsidies needed to support the universal service. Royal Mail also argued that its universal service obligations put it at a competitive disadvantage relative to an entrant because it is required to deliver six days per week whereas an entrant faces no such requirement.

In light of Royal Mail's submission, Ofcom carried out a review of the position by reference to both Royal Mail's business plan and Whistl's latest business plans[41]. It concluded that entry on a selective geographic basis did not represent 'unfair competition' and did not undermine the cross-subsidies needed to finance the universal service. It considered Royal Mail's real concern appeared to be the loss of volumes, not the loss of cross-subsidies. Its delivery network was characterised by a significant proportion of fixed costs so the average cost of delivering universal service mail increases when volumes fall. This effect was not linked to selective geographic entry as it would occur even if entry was on a national basis. It did not mean that Ofcom would not intervene in the future, should it be necessary to do so in light of emerging evidence.

Ofcom considered that other issues, such as Royal Mail's own efficiency in providing the service and Royal Mail's performance in the parcels market in which it is facing increasing competition, could potentially significantly outweigh the current and likely future effects of end-to-end competition in bulk mail on Royal Mail's ability to provide the universal service.

[41] http://stakeholders.ofcom.org.uk/post/securing-universal-postal-service/

4.2 Insurance premiums

Private insurers will try to match the premium on a particular policy to the associated risk, and so will ask questions concerning lifestyle and pre-existing conditions on health insurance and previous accidents for car insurance. Governments, and the Courts, have promoted socialisation for a number of reasons:

- Following a European Court of Justice ruling in 2011, insurance premiums must now be ‘gender neutral’. This has meant that car insurance premiums for young women (considered to be less risky than young men) were expected to rise, while life and health insurance premiums for women were expected to decline. This is despite the fact that premiums are allowed to be cost-related on other factors, such as type of car or health factors.
- Following an increase in the number of major floods in the UK, it became clear that between 300,000 and 500,000 households would have difficulty in obtaining affordable flood protection insurance. The Association of British Insurers and the Government in 2013 announced a new not-for-profit re-insurance scheme, Flood Re, to allow flood insurance to remain widely affordable and available to end-customers, while allowing a sustainable transition to risk-reflective pricing over 25 years. It is due to be launched in April 2016.
- The National Health Service provides a universal service paid for by general taxation, regardless of the health of the individual. This avoids the situation where some high-risk individuals may be unable to afford insurance or medical treatment (although a debate is opening on whether certain ‘high-risk’ actions by patients care (obesity-, alcohol-, sports- related) should continue to permit them ‘equal access’ to health).

4.3 Water metering and charging

The debate over water metering and related customer charging over the last few years provides some interesting parallels to the issues of socialisation in electricity pricing and a number of useful lessons. Many of the questions dealt with in this paper first arose in the water industry. From the way they have been dealt with (or, in some cases, glossed over), it is clear that perceived public acceptability has been a key concern of successive governments and may have predominated over economic arguments. It is interesting, for instance, that Ofwat’s 2009 paper ‘Water today, water tomorrow – Ofwat and sustainability’, which remains Ofwat’s vision for sustainable water, does not mention metering at all.

The picture, as it has developed from the Walker report in 2011[42], through government White Paper and legislation and Select Committee scrutiny, to the present Government’s position

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[42] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69459/walker-review-final-report.pdf

set out in a consultation in July 2015, is important and relevant enough to be set out in detail in the Appendix to this paper. In summary:

- In substantial parts of the country, water resources are scarce and, with climate change, this is likely to get worse. Metering and associated pricing of water by volume are generally accepted as part of an appropriate response to water scarcity, just as more cost-related pricing is for future electricity demand. Metering is only needed in areas of water stress (which are designated by the Environment Agency). Metering is expected to rise from 48% currently to 61% by 2020 (and to 84% in England by 2034-35 according to the Walker Review[43]).

- The Government permits water companies to introduce compulsory metering in areas of water scarcity, although it is clearly sensitive to accusations that it is making water metering compulsory[44].

- The Walker Review used the concept of 'fairness' (ie you should pay for what you use) to justify greater use of metering, although the vagueness of the criteria could just as easily have justified a water poll tax or payment through general taxation. An additional, and more convincing, argument was that the current system of paying by relation to rateable value (RV) was clearly broken, with RVs not having been updated for many years and no clear correlation with either water usage or ability to pay.

- Where compulsory water metering has been introduced, some customers have benefited whereas others have had to pay more. In 2014, Southern Water calculated that 62% of households were better off with meters, saving £159 a year on average, while 38% are losing out, ending up £175 worse off on average[45]. (These figures indicate a wide variability in water usage per household, suggesting both the importance of considering such variability when setting or revising charges and the potential scope for financial savings for some households by reducing water use.)

- In areas where water metering is voluntary, the fact that only those who are likely to benefit have chosen to install meters has pushed up the cost of water charges overall for unmetered users.

- Regional pricing for water (although with some safeguards for the South West) has been widely supported on the grounds that costs are different in different parts of the country, but taking the argument further to justify cost-related pricing within a region (for instance, in relation to the distance from a water treatment plant) has been strongly resisted by all parties. This is starting to cause problems because, with the

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[43] Ref 26, paragraph 6.1.11
[44] https://www.gov.uk/government/news/water-metering-response-to-an-article-in-the-telegraph
[45] http://www.bbc.co.uk/news/business-28879168

introduction of competition for industrial customers in water supply, it becomes possible for new entrants to 'cherry pick' those I&C customers with below average costs of supply. The Select Committee was concerned about this but did not offer a solution.

- A water company can choose to install a meter at a domestic customer's property. However, it can only charge using the meter if the customer:
  - Uses an automatic watering device (such as a garden sprinkler)
  - Automatically fills a swimming pool
  - Has a power shower or extra-large bath
  - Uses a reverse osmosis water softening unit
  - Is the new occupier of a property (provided the water company has not already sent an unmetered bill)
  - Lives in a water stressed area where the Government has allowed compulsory metering as part of a plan to maintain secure water supplies

The examples outlined in this section from other sectors show that the questions and issues that result from moving from socialisation of costs to a more cost-reflective approach are not unique to the electricity sector. Some of these are:

- The importance of considering how the variability of customers will lead to winners and losers from any change to the approach to charging
- While changes may result in better economic signals to efficiency, customers may have differing ability to respond to the changes (eg existing homes on flood plains, people with high and inflexible water needs, people with chronic or addictive medical conditions)
- Lack of consistency in relation to socialisation of costs (gender neutrality for car insurance, regional pricing of water charges)

Some of the ways of dealing with these issues may be relevant for thinking about future approaches to greater cost-reflection for electricity customers.

Section 5 – Conclusions from Part 1

As we have seen, there are good arguments grounded in economic theory for facing customers with the full cost of the services they buy. This is as true in the case of electricity as the other goods and services we have considered. This is why Ofgem is exploring the case for individual half-hourly settlement, both elective and mandatory, for domestic customers. And it is likely that, if the cost-differentials are steep enough, suppliers will want to reflect these costs, and their structure, in their retail prices. However, moving towards greater cost-reflectivity raises a number of issues:

- Greater cost-reflectivity, if reflected in retail prices, may result in higher electricity costs for some customers who can ill afford it or who have limited ability to change behaviour. This can include fuel poor customers, those in rural locations and (in the non-domestic sector) heavy industrial users of electricity. Any move towards further cost reflectivity needs to be preceded by a full analysis of the impact of such a change on these very different groups.

- For proper cost-reflectivity, attention needs to be given to the structure of retail price charging, ie which underlying costs and charges vary with peak load (kW) and which vary with consumption (kWh). This will become increasingly important for recovery of the industry's underlying costs as 'prosumers' generate more of their own electricity, but still need access to the network for emergencies or when their generation is not operational.

- While some costs and charges can be allocated in an unambiguous way against a customer's usage, there may be no unique way to do this for other charges. This applies to part at least of network charges (the non-marginal cost element) and to Green Levy charges. If the totality of the electricity price is to provide the correct incentive, thought needs to be given to the best way to allocate these charges to customers (ie which customers should pay and whether the costs should be "sculpted" to align with the shape of the other costs, eg with a time of day element or whether by kW or kWh).

- It must be remembered that all these costs are the costs faced ***by the electricity supplier***. As we have seen, it is likely that the supplier will want to reflect these costs, and the way these costs are structured, in the tariffs charged to customers. But, unless customers are to be charged actual costs, the tariffs will inevitably involve a degree of averaging (for example, peak/off-peak pricing rather than a different price for every half-hour). How suppliers are likely to approach greater cost-reflection in their retail tariffs will need further discussion with them.

On the other hand, retaining an element of socialisation within the costs and charges faced by electricity suppliers creates its own issues. On the assumption, as above, that suppliers will aim to reflect the structure of costs and charges they face in the retail prices they charge, these include:

- Socialisation of costs is a blunt tool. While attempting to benefit the targeted group, it may provide unintended subsidy to a different or wider group. For instance, retaining a flat-rate tariff provides an unintended benefit to those with large discretionary usage at peak time as well as those without the ability to shift their usage away from peak. There may be better ways than cost-socialisation to provide targeted support.

- If a move to cost-reflective charges were purely voluntary, then distortions could arise which could affect the prices paid by retail customers. We have seen in section 4 examples from other industries that illustrate this, including the universal service obligation in mail and voluntary water metering. Two potential issues for the electricity sector would be:

    - If half-hourly settlement were elective, then a supplier could offer a customer with a flatter than average usage profile a cheaper package based on elective half-hourly settlement and a ToU tariff. But unless this package resulted in the customer changing their behaviour, the cost of supplying all customers as a whole would not have reduced and so other customers would end up paying more.

    - A similar situation would arise if half-hourly settlement were mandatory and movement to a ToU tariff were voluntary. In this case, customers with a more peaky profile would be inclined to stay on the flat tariff. With mandatory half-hourly settlement in place, electricity suppliers could lose money in supplying these customers.

These examples are explored further in Section 9.

These issues suggest that the decision whether or not to socialise aspects of the electricity cost base needs considerable thought, particularly as we move to a regime of greater cost-reflectivity in electricity pricing.

We now turn to the second purpose of cost-reflectivity: to encourage customer behaviour change.

Part 2 – Cost-reflection as a means of encouraging customer behaviour change

Section 6 : Why consider a move to more cost-reflective retail pricing now?

To summarise the discussion of Part 1, the current position is that over many years a range of different averaging approaches have been applied to different components of the electricity price for a range of different reasons[46] and these costs have generally been passed through unseen to the final customer.

For a number of years, there has been a general consensus amongst energy policy specialists and industry professionals that demand-side response (DSR) has an important role to play if in the smarter, low-carbon world electricity prices are to be kept as low as possible. More cost-reflective pricing of electricity has generally been assumed to be a key way of achieving that. As long ago as 2009, DECC said, in 'Smarter Grids: the opportunity':

> [Smart meters will] make it possible for energy supply companies to offer their customers varying tariffs through the day that reflect the overall pressures on the system … This should mean lower costs for consumers than would be the case without smarter grids… The demand management that smart meters make possible should mean that we save money and cut carbon emissions due to reduced reliance on expensive peaking plants, reduced need for new generation capacity, and a lower requirement for reinforcement of electricity networks.[47]

There are two main reasons and one new enabler for a change of approach now. The first reason is that much low carbon generation is less operationally flexible than the generating plant it is replacing, and so the customer needs to become more flexible if costs are to be kept down. The second reason is that electricity demand, particularly at peak time, is expected to grow significantly with the forecast need for electrification of heating and transport[48]. The enabler is the ability through the use of smart meters and smarter networks to assist the customer to become more flexible.

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[46] And in some cases with, perhaps, unintended consequences. For instance, it could be argued that it is not equitable for the fuel poor to be paying an ever-increasing proportion of their electricity bill to subsidise the installation of domestic solar panels though the feed-in tariff to generally better-off householders. Or for those without south-facing roofs to subsidise those who have them?

[47] http://webarchive.nationalarchives.gov.uk/20100512190105/http://man270109a.decc.gov.uk/media/viewfile.ashx?filepath=what%20we%20do/uk%20energy%20supply/futureelectricitynetworks/1_20091203163757_e_@@_smartergridsopportunity.pdf&filetype=4

[48] 10 million electric vehicles charging at early evening peak would more than double today's network capacity requirement, not to mention the amount of additional generation needed.

This, indeed, has been much of what Sustainability First's GB Electricity Demand Project explored. However, as Paper 12 points out, with today's underlying electricity charging structure, there is little incentive on suppliers to offer to domestic customers tariffs that are more reflective of the underlying costs. It is always possible to offer incentives outside the existing tariff structure (indeed the demand-side management trials carried out under LCNF projects with industrial and commercial customers operated in this way). But, if tariffs are to be used to meet these objectives, the costs and charges as seen by electricity suppliers would need to be more reflective of the industry's actual underlying costs, and, in particular, those elements that can affect national peak demand and local network peak demand:

- **National peak demand** If domestic customers were half-hourly settled, then suppliers would face the actual wholesale price of providing their electricity needs during each half-hour and the relevant element of the transmission and distribution charges. This would be possible once smart meters have been widely installed.

  Green levy charges additionally distort the picture. Either, as Paper 12 suggests, green levy charges could be sculpted so that higher charges applied at peak times[49], or paid for in some other way that is fairer and less distortionary.
  However, this is only half of the equation. As mentioned above, part of the problem arises from the single strike price being offered under FIT CfDs. This ignores the time-value of the subsidised generation. A future solution could be for strike prices, around which CfD long-term contracts are written, to be sculpted to offer a higher price at times of winter peak demand and lower prices at times of low demand[50].

- **Local network peak demand** If distribution network charges were to be used to incentivise domestic customer demand-side behaviour, the basis of charging on the low voltage networks would need to change from long-run pricing to short-run pricing, including a per kW charge as well as a per kWh charge (or be priced on a time-of-use basis) and / or become more location-specific.

These changes would encourage electricity suppliers to charge customers on a more genuinely cost-reflective basis and could therefore seem to aid the effectiveness of the implementation of demand-side management. However, although this approach is broadly supported by policy makers[51] and other energy experts, it does not take into account a number of factors to which insufficient attention has yet been given. These include the fact that

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[49] Just as the Capacity Market Supplier Charge, which is a sculpted 4-7 pm winter peak-time p/kWh levy

[50] But this could impact pay-backs for those projects. Or, alternatively as has been suggested by Dieter Helm on a number of occasions, set a price for carbon and let the generators compete in the market.

[51] It is generally recognised that there is a disconnect between the current policy of greater simplification and improving customer understanding of electricity pricing, and the need for more cost-reflective pricing. Creating the political momentum for this change in direction will be an interesting problem.

policy makers have a range of objectives to balance, not just overall efficiency, and that customers are not always 'rational' nor are they all average. The rest of this paper explores these issues in more detail.

Paper 12 of Sustainability First's GB Electricity Demand project concluded that, at least up to 2020, the focus for domestic DSR should be on reducing the early evening peak and that static ToU tariffs could be an important means of affecting customer behaviour. After that, DSR could provide benefits both from early evening peak avoidance but also from more general flexibility by shifting loads to other times, particularly when wind or solar power is driving prices down. More use of automation, including more dynamic pricing signals, might then be needed to unlock the DSR potential.

Cost-reflective pricing and many of the issues discussed below are equally relevant to this later period beyond 2020. But, in order to simplify the analysis in this paper and make use of research results from the trialling of ToU tariffs, the rest of the paper focuses on the use of static ToU tariffs in the domestic sector.

Section 7 – Does cost-reflective retail electricity pricing achieve customer behaviour change?

Several recent trials of ToU tariffs with domestic customers suggest that this form of pricing can be effective in moving customers' electricity load away from peak times.

7.1 The Irish Commission for Energy Regulation

The Irish Commission for Energy Regulation (CER) carried out a smart meter and related ToU tariff trial in 2009 and 2010[52]. The tariff trial was undertaken with a large, representative sample of domestic electricity and gas customers in Ireland. For electricity, a tariff structure was used which had different unit rates at night, during the day and at the peak daytime hours of 17:00 to 19:00. Various tariffs conforming to this structure were trialled to test customer price-elasticity, together with other sources of information on electricity use and cost (such as more detailed and frequent billing, fridge magnets and an in-home display). The trial found that providing customers with additional information together with a TOU tariff made a significant difference to when, and how much, electricity they consumed, although the actual differences between peak and off-peak tariff ratios made relatively little difference overall. This was in comparison with a sample of customers who did not change tariff or receive any additional information. The sample of electricity customers with additional information and a TOU tariff used, on average, 2.5% less electricity overall and 8.8% less electricity at peak times. As a result, Ireland plans to roll out smart meters to all domestic customers and, additionally, to mandate ToU tariffs, including setting an end date by which suppliers must have removed tariffs other than ToU tariffs from the market[53].

7.2 EDF Energy's EDRP trial

EDF Energy's EDRP trial[54] found that:

- There was a statistically significant overall reduction in the percentage of consumption that occurred in the peak period of 7-10% but this did not persist beyond the first year.

- There was a small but statistically significant difference in electricity consumption between the trial group and the control group, and a reduction, but not a

[52] http://www.cer.ie/docs/000117/Appendix%20B%20-%20Time%20of%20Use%20Tariffs%20(CER13286B).pdf
[53] http://www.cer.ie/docs/001021/CER15270%20Time%20of%20Use%20Tariffs.pdf
[54] A fuller summary can be found in Annex 2 of Paper 7 of the GB Electricity Demand Project

statistically significant one, compared with baseline (ie consumption before the state of the trial).

- A fridge magnet displaying the time-blocks relevant to the tariff comparatively had more effect in influencing peak-shifting behaviour than an in-home display.

7.3 Northern Powergrid's Customer –Led Network Revolution project[55]

In the CLNR smart grid project, around 600 customers completed a trial of a ToU tariff. The peak ToU rate was 99% higher, the day rate 4% lower and the off-peak rate 31% lower than British Gas' standard flat rate tariff at that time. For smart meter customers with a ToU tariff, the average peak-power demand during the 4-8 pm period (i.e. the average across the year for each customer *of the highest half-hour demand each day* within the period 4-8 pm) was lower on average, by 96 W or 8% (from 1.219 kW to 1.123 kW), than for the comparable 'control-group' customers who had a smart meter but no ToU tariff [56]. The difference in average peak power demand for the trial-group was statistically significant for the 2012/13 winter period in the trial. Compared to smart meter customers without the ToU tariff, annual energy consumption during the peak period was lower by 55 kWh or 6% (from 861.6 kWh to 806.6 kWh), with the difference focused on weekdays. There was also a small but not statistically significant difference in total annual electricity consumption (on average, about 3,500 kWh) between the ToU customers and control-group customers (with just a smart meter alone). The majority of those on a ToU tariff who were surveyed said they would change the timing of appliance use in response to the ToU tariff. Most also believed that they used less energy overall while on the ToU tariff.
Trial participants were told from the outset that there was a safety net and that therefore they would not lose money from the use of ToU tariffs. It is not clear what effect this had on behaviour. Trial participants were given no feedback on whether they were saving or losing money under the ToU tariff until the end of the trial. Some 40% of participants would have ended up with electricity bills higher than under a flat-rate (had they not been guaranteed that they would not lose money). Because an average customer making no changes to their behaviour would have neither gained nor lost from the ToU tariff, those who would have lost money were those whose monitored usage during the trial had a higher than average proportion at peak times. They may or may not have changed their behaviour in response to the trial.

[55] http://www.networkrevolution.co.uk/wp-content/uploads/2015/04/Domestic-SME-Final.pdf

[56] i.e. the wider control group. Because of the length of time needed to recruit customers, it was not possible to test whether ToU trial customers had actually reduced their own individual consumption pre- and post-trial.

7.4 Low Carbon London

In UK Power Networks' Low Carbon London LCNF project[57], residential customers, facilitated through smart meters installed by project partner EDF Energy, were offered a first of a kind **dynamic Time-of-Use (dToU)** tariff, not previously trialled in Great Britain. Half hourly (HH) measurements available from smart meters allowed the project to offer a three-tier price tariff to over 1,100 electricity customers. The dToU tariff contained three different price bands, deliberately chosen to have a strong high to low price ratio, though still designed so that a consumer would be revenue-neutral should they remain on a typical residential demand profile. The values of the price bands were: High price: 67.20 pence/kWh; Mid-price: 11.76 pence/kWh; and Low price: 3.99 pence/kWh. The middle price point was used as a baseline tariff and the high and low price points were used to generate trial events of two distinct types, adapted to specific use cases:

- Network Constraint Management (CM): These events aimed to measure the potential for dToU demand response to relieve constraints on the distribution network; and

- Supply Following (SF): These events probed the response of households to simple high or low price signals of varying duration.

The objective of these events was to quantify the potential of dToU demand response to aid in energy balancing. Consumers were incentivised to change their electricity consumption in reaction to changes in the electricity tariff. Over the trial year, 95% of households saved money relative to what they would have spent had they been on the standard flat tariff of the non-ToU group.

The results showed a large variance across the group, but the key outcome was that the high price response available from residential households was an average of 56W of load reduction available during winter and 34W during summer. In addition to the HH data analysis, survey data was collected from the majority of these households and 37 semi-structured in-depth interviews were carried out. There was both a very positive customer reaction and strong acceptance of the dToU tariff: a high rate of endorsement (91% of those interviewed) and agreement that dToU 'should be the standard tariff for everyone' (81%).

Taken together, the evidence from these different trials would suggest that ToU tariffs can be effective in changing behaviour, but:

[57] http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/

- Those taking part in the trials were, inevitably, volunteers and were therefore likely to be pre-disposed towards reacting positively.

- Several of the trials had either a safety net or other inducements to positive behaviour.

- The amount of average movement, although it varied from trial to trial, was fairly small, and so the amount of money to be saved would also have been small: for example, a consistent 100W **reduction** in load sustained across the *whole* of a 4 hour peak period on every week day in the year would save just over 100kWh or, say, around £30 a year at a peak-tariff rate. This saving would of course be less if the load was simply shifted to another time of day. Currently, many customers on flat-rate tariffs, could achieve significantly higher bill savings than this from switching supplier, but so-called 'sticky customers' are failing to respond to this, despite the cash-savings available to them being much higher.

- Because the CLNR project did not analyse whether individual consumers had actually reduced their peak electricity use against their pre-trial use, it has not been possible to assess the **range** of responses to a static ToU tariff (Low Carbon London's tariff was of a different sort). A reasonable assumption would be that those who had a higher level of discretionary demand during peak time had the higher **scope** for behaviour change, but no conclusion can be drawn from the CLNR trial on their likely response to a ToU tariff. This needs further research, perhaps using the CLNR data which is now available for researchers.

- The evidence, particularly from the Irish trial, (that simply being on a ToU tariff may be sufficient to prompt a peak-shift) suggests that of itself the size of the financial incentive (both in the ToU tariff and in the amount displayed in the in-home device) makes relatively little difference to the size of response. Simple memory-joggers such as fridge magnets, better information and bills, and efficiency 'tips', or the existence of an IHD, are also effective. Anecdotal evidence from the CLNR project was that a flagging response was re-energised when a reminder letter about the trial was received.

These arguments would suggest that more evidence is needed on the attitudes of customers more generally (as opposed to trial volunteers) - in particular on their attitude to complexity, inconvenience and risk - on the level and range of shifting that can be relied upon and on what might be truly effective means of encouraging flexible behaviour, before it would be feasible to conclude, as the Irish have, that universal ToU pricing should be mandated in this country. This is particularly the case given the finding in the CLNR trial that 40% of customers would have been worse off under ToU tariffs. This demonstrates the need to explore the impact on the broad range of customers, not just to rely on averages[58]. We therefore turn next to the evidence from the published data from the trials to demonstrate that it is important to look beyond **average** consumption patterns at peak to understand the possible impacts.

[58] The dangers of basing policies on averages beset many government energy schemes. Programmes of subsidy for domestic energy efficiency measures are designed to improve the average level of domestic energy consumption but only benefit those who get the subsidy, which is paid for by everyone else, including those, such as private renters who may also continue to face higher energy bills because their landlords have not taken advantage of the subsidy.

Section 8 – Evidence from the Low Carbon Network Fund trials about Time of Use tariffs and resulting behaviour change

In 2014, the Centre for Sustainable Energy was commissioned by Ofgem to use the EDRP dataset to assess the potential impact of ToU tariffs on domestic electricity customers[59]. The report clearly showed that there would be both winners and losers from the introduction of ToU tariffs, but because of the limitations of the data, including the lack of demographic information, the paper had to be aimed more at establishing a methodology than reaching firm conclusions.

Data available from recent trials now permit better analysis. This section therefore uses published data, including demographics, from the Customer-Led Network Revolution and the Low Carbon London project websites **to explore the variability in customers' daily electricity use and the benefit they would get from the introduction of a ToU tariff.** The conclusions we draw are tentative and would benefit from a more detailed rigorous analysis, perhaps using the CSE methodology.

The **CLNR** project website makes available half-hourly consumption data derived from 8,000 UK electricity customers with smart meters in a number of spreadsheets.[60] The data includes seasonal breakdowns and demographic analysis by Mosaic group and the project's own demographic analysis.

The project's headline conclusions (that, for those on the ToU trial, peak power demand was lower, on average, by 96 W compared with the control group, and annual energy consumption during the peak period was lower, on average, by 55 kWh) were focused on **averages**. For the purpose of this paper, we want to look at **customer variability**. Ideally, we would like to look at individual demand profiles to see how the proportion of peak-time use varies throughout the population and therefore to assess the impact of the introduction of a ToU tariff and see how many winners and losers would result and to what extent they would win or lose. This is not possible from the CLNR published data. A number of interesting points nevertheless emerge from the data for customers who had a smart meter but no change to their tariff:

- From the CLNR spreadsheet 'Power consumption by time period', we see that for the group of customers as a whole, the standard deviation of the range of demands in any one half-hour is generally about the same or a little larger than the actual demand in that half-hour. We also see that the median demand (or the level where there are equal numbers of customers above and below) is between half and two thirds of the

[59] https://www.cse.org.uk/projects/view/1238
[60] http://www.networkrevolution.co.uk/project-library/dataset-tc1a-basic-profiling-domestic-smart-meter-customers/

average. This implies a lengthy 'tail' with significant numbers of customers consuming well above the average and at least half the customers consuming well below the average in each half hour[61]. This does not necessarily mean, taking the 4 hour peak period as a whole, that there was a similar variation in overall peak consumption: some customers may have high usage during a part of the four-hour peak period and a low usage in other parts, but there is a clear suggestion that some of the difference will be due to customers with a significantly different daily profile of use from the average. Only a detailed analysis of individual profiles would elucidate this.

- This conclusion is supported by the CLNR spreadsheet 'Power consumption by tariff band' which shows the massive variation in daily and peak consumption within the group overall. For instance, in January 2012, when average daily consumption was 4.5kWh, the heaviest user consumed 42.8kWh and the lightest 0.02kWh. And whilst the average proportion of electricity used at peak time varied from 27.7% in November 2011 to 22.2% in August 2012, **typical very large** and **typical very small** users generally (with one exception) **used less peak time electricity than the overall average**.

- The CLNR spread-sheet 'Power consumption by customer type' analyses half-hourly and seasonal variation in demand by different demographic groups. Using this data and applying a simple ToU tariff, Table 4 shows the average proportion of power consumed in the course of a year in the period 16.00-20.00 for **each** of the demographic groups studied in CLNR and the gain or loss that would occur by a change to a ToU tariff if they were not to change their behaviour. Bearing in mind that these are averages for each group – and we have seen that there can be considerable variability within averages (as the CLNR project itself concluded) - the proportion of electricity consumed at peak times on average by the members of each demographic group is remarkably consistent. Based solely on the averages for each demographic group, therefore, one might conclude that the amount of customer loss or gain from the introduction of ToU tariffs would be small.

61 For instance, in the half-hour beginning at 18.00, average demand is 0.66kW with a median of 0.42kW, and a standard deviation of 0.7kW. This implies that, in this half-hour, half of the customers had a demand of 0.42kW or less, around 20% consumed between 0.42kW and 1kW, around 25% had a demand between 1kW and 2.1kW and 5% had a demand above 2.1kW. **Note that very few customers were close to 'average'.**

Table 4 - Impact of the introduction of a ToU tariff to the average users according to the CLNR demographic classification

CLNR classification	Average annual consumption (kWh)	Proportion used at peak	Annual gain/loss from changing to a ToU tariff without behaviour change[62]
£14,999 or under	2928	24.3%	+£2.94
£15,000-£29,999	3573	24.9%	-£0.94
Over £29,999	4227	25.0%	-£1.24
High thermal efficiency	3479	25.1%	-£1.85
Low thermal efficiency	3640	24.3%	+£3.36
Medium thermal efficiency	3509	24.8%	+£0.30
Non-renter	3717	25.0%	-£1.63
Renter	3185	24.1%	+£4.20
Rural	3731	24.8%	+£0.25
Rural off-gas	5266	25.2%	-£4.75
Suburban	3588	25.1%	-£2.07
Urban	3451	24.6%	+£1.46
With <5 or >65	3206	24.2%	+£3.67
Without <5 or >65	3825	25.1%	-£2.55

(Source: Sustainability First, using data from CLNR: http://www.networkrevolution.co.uk/project-library/dataset-tc1a-basic-profiling-domestic-smart-meter-customers/)

If the introduction of a ToU tariff led *every* customer to reduce annual consumption at peak times by the average 55kWh seen in the CLNR trial, then the benefit in terms of reduced peak tariff charges of, say 30p/kWh, would be £16.50 a year in all cases[63]. This would significantly exceed any gain or loss indicated by Table 4 from simply switching from a flat tariff to the corresponding ToU tariff. In other words, *if everyone was average*, everyone could gain from a switch to a ToU tariff, if they changed their consumption behaviour in line with the average seen in the trial[64].

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[62] Using the CLNR ToU tariffs with this data would result typically in a 10% increase in all groups' bills. Since the tariffs were designed to be revenue-neutral, the reason for this is not clear. Instead, this table and all subsequent analysis in this paper uses a peak price double the standard rate (assumed to be 15p/kWh) and reduces the off-peak tariff to ensure neutrality for the average customer.

[63] Assuming that overall consumption was reduced by this amount. If load was simply shifted to an off-peak period, the saving would be half this.

[64] Although it must be said that the amount that could be saved is considerably less than 'sticky' customers could save, and don't, by switching their supplier.

It is difficult to reconcile this finding to that in the CLNR project that 40% of those on the ToU trial would have been worse off on the ToU tariff had there not been a safety net[65]. There seem to be three possible alternative explanations:

- The set of ToU tariffs resulted in an increase in the average customer's bills. This would fit with the finding in footnote 62, but seems unlikely given the care taken to devise the set of tariffs[66].

- Few of those who would have lost money with a ToU tariff changed their behaviour. This seems inconsistent with the trial survey[67]which suggested that the majority of those on the ToU trial claimed to have changed the timing of appliance use. Even allowing for interviewee bias (in providing an answer they thought was wanted), from the figures in Table 4 only a small change in behaviour would seem necessary to produce a saving.

- **The average figures hide a wide range in demand profiles, both peakier and less peaky than the average**. For example, a customer who consumed 30% of their electricity at peak times rather than the average figure of about 25% would see a 7% increase in their bill (around £37 a year), and even if they reduced their peak time consumption by the typical amount of 55 kWh annually, they would still be £20 a year worse off. Similarly, a customer who only consumed 20% of their electricity at peak times would see a reduction of over 6% a year in their bill **without the need for any behaviour change**.

Turning to the **Low Carbon London** project, the massive amount of data made available[68] gives half hourly consumption readings for over 5500 London households over a period between November 2011 and February 2014. This provides us with the breakdown we need. The data would warrant detailed analysis of demand profiles, which is beyond the scope of this paper. **However, to illustrate the point, an examination of eight example demand profiles, selected from the LCL data suggests that there could be a considerable variation between individual customers in the proportion of electricity used at peak time.** Table 5 gives the annual consumption, the proportion consumed between 16.00 and 20.00 and the potential annual financial gain or loss from the introduction of a ToU tariff **for eight households from a data set of over 5,000**. These examples illustrate both the wide variation in the proportion of electricity consumed at peak and also the wide variation in

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[65] Interestingly, this figure is very similar to the proportion of customers who were worse off from the installation of a water meter (see Section 5 above).
[66] http://www.networkrevolution.co.uk/project-library/domestic-sme-tariff-development-customer-led-network-revolution/
[67] See reference in footnote 55, section 9.1.
[68] http://data.london.gov.uk/dataset/smartmeter-energy-use-data-in-london-households

annual consumption of electricity by those taking part (another finding that is not obvious from the average figures).

These examples illustrate the possible range of winners and losers compared with the status quo. It would be wrong to suggest that they are necessarily representative of either the sample population of the LCL trial, or of the different demographic types in the population at large. Only a more detailed analysis could investigate this. But they point to the importance of considering the impact of a tariff change across the range and type of customer affected.

Table 5 –Proportion of electricity used at peak time by eight households taking part in the Low Carbon London trial

Identification no.	Acorn demographic type	Annual consumption	Proportion of peak time use	Annual gain/loss from changing to a ToU tariff without behaviour change
MAC005566	Career climber	3818kWh	20.0%	+£36.65
MAC005567	Difficult circumstances	951kWh	20.5%	+£8.18
MAC005562	Countryside communities	2019kWh	24.7%	+£0.45
MAC000019	Student life	1117kWh	24.4%	+£0.92
MAC000026	City sophisticate	2261kWh	17.3%	+£33.88
MAC000020	Starting out	1111kWh	27.7%	-£6.40
MAC000674	Striving family	2742kWh	26.5%	-£9.23
MAC000664	Student life	2993kWh	28.1%	-£19.63

(Source: Sustainability First, using data from LCL: http://data.london.gov.uk/dataset/smartmeter-energy-use-data-in-london-households)

The published analysis of ToU data carried out by both the CLNR and Low Carbon London projects was aimed at identifying the impact of customers' **collective action** on local network peak-load. So, it is perhaps not surprising that **both projects focused on average figures rather than the variability, or "peakiness", of individual customer daily demand profiles. But, the discussion above makes clear that this analysis is crucial to an understanding of the impact of ToU tariffs on the broad range of domestic customers. There is an urgent need for more studies to investigate these issues to inform debate. This should include additional analysis of published data-sets from the customer-funded Low Carbon Network Fund trials.**

Users of low carbon technology

The CLNR project also monitored electricity usage by customers who were using different low carbon technologies (electric vehicles, heat pumps, micro-CHP and solar panels). We can use this data to assess the impact of the introduction of a ToU tariff on these customers.

For **electric vehicles**, the typical additional consumption was about 4kWh daily[69] about half of which occurred in the peak 16.00-20.00 period and half in the two hours or so after. Consumption was lower in the summer and at weekends. If we assume additional annual electricity consumption of 1200 kWh with half of this in the peak period, this would result in a typical total annual consumption of about 4500kWh of which nearly 1500kWh would be in the four-hour evening peak period. If there was no change in EV charging behaviour, moving to a basic ToU tariff (peak price double the standard rate (assumed to be 15p/kWh) and off-peak tariff reduced to ensure neutrality for the average customer) would cost the user about £60 a year. If EV charging was moved to wholly off-peak times, there would instead be an annual saving of £60 compared with a flat tariff.

For **heat pumps**, the additional annual load was around 2900 kWh[70], concentrated largely in winter and with a peak in the early morning and early evening. During the winter period, electricity consumption by the heat pump was comparable to the demand for the rest of the household at 3.1 kWh or say 465kWh peak time use annually. Because of the flatter profile of heat pump electricity usage, moving to the basic ToU tariff would save the customer about £50 a year compared to a flat tariff. (This is without the benefit of additional heat storage, which was also trialled, but is not suitable for all properties.)

For **micro-CHP**[71], the results of the limited number of trial participants were very varied, but typically led to a peak time reduction in demand of ‘a few hundred watts’. However, overall the conclusion from the trial was that, given the cost of the micro-CHP plant, it was not an economically viable option at present and the impact of the introduction of a ToU tariff would be a relatively minor consideration.

Solar panels[72] may generate some of their output during the peak period (particularly if south or west-facing) and so reduce net peak consumption. In addition, there was some evidence from the trial that customers changed their habits at home to use more of the electricity generated by the panels rather than export it. Although it is not possible from the published material to make quantitative estimates, it would seem that owners of PV could therefore benefit from the introduction of a ToU retail tariff (e.g. a ‘sunshine’ tariff).

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[69] http://www.networkrevolution.co.uk/wp-content/uploads/2015/01/CLNR-L092-Electric-Vehicle-Insight-Report-RW.pdf
[70] http://www.networkrevolution.co.uk/wp-content/uploads/2015/01/CLNR-L091-Insight-Report-Domestic-Heat-Pumps.pdf
[71] http://www.networkrevolution.co.uk/wp-content/uploads/2014/11/CLNRL086-Micro-CHP-Report.pdf
[72] http://www.networkrevolution.co.uk/wp-content/uploads/2015/01/CLNR-L090-Insight-Report-Domestic-Solar-PV.pdf

Conclusion

Recent LCNF trials demonstrate that there is a wide variability in customers' overall electricity consumption and in their daily profiles of use. It could therefore be misleading to draw conclusions based solely on average consumption data / figures. If more cost-reflective retail pricing were to be introduced, it would be important first to examine the likely impact across the range of customers[73]. For the rest of this paper, we start from the finding that there would be winners and losers from a change to a more cost-reflective electricity retail price.

[73] See also Citizens Advice review of LCNF projects, https://www.citizensadvice.org.uk/Global/CitizensAdvice/essential%20services%20publications/LCNFpolicypaper.pdf

Section 9 – How far should cost-reflective retail pricing be encouraged and what are the alternatives?

Our conclusions so far are that:

- More cost-reflective pricing would be economically beneficial and efficient for the electricity system as a whole and would keep down the overall cost of moving to a lower carbon energy system.
- Trials conducted to date have successfully changed some customers' behaviour, although not by a large amount, and have been popular with those taking part.
- More work is, however, needed on the likely reaction of typical (ie non-trial) customers and the most effective ways to encourage behaviour change.
- On **average**, the impact of changing to more cost-reflective pricing would be small and, if accompanied by behaviour change, all would benefit, albeit to a small amount.
- However, averaging conceals **wide variations** in individual customers' annual and daily electricity use. The introduction of more cost-reflective retail pricing would therefore result in winners and losers compared with the status quo.

The change in size of a customer's electricity bill resulting from the introduction of the new tariff itself could well dwarf any potential benefit from a change in customer behaviour. As a result, any behaviour change that occurred might well be limited. Furthermore, compulsorily requiring all domestic customers to move to a ToU tariff would almost certainly prove unpopular, particularly with those customers who would face increased bills, and as a result may therefore have limited economic benefit.

Moreover, if, as Ofgem currently envisage, HH settlement is eventually to be introduced for every customer, suppliers will in turn be under increasing commercial pressure to make their domestic retail tariffs more cost-reflective if they are to avoid their lower cost-to-serve customers being 'cherry-picked' by their competitors. This 'knock-on' effect on suppliers could arguably have a similar result to introducing mandatory ToU tariffs. **The costs, risks, benefits and unintended effects of any move to individual HH settlement therefore need careful thought before any final decision is taken.**

In this context, it is worth considering a salutary example from Australia. In Victoria, the Victorian Department of Environment and Primary Industries (DEPI) decided in 2007 to roll out smart meters and mandatory ToU tariffs to all customers by the end of 2013. There was considerable consumer backlash to smart meters in general and the impact of ToU tariffs on customer bills, in particular following research that indicated that vulnerable consumers such as the elderly, long-term unemployed and people with disabilities would be disproportionately disadvantaged by the new pricing plan due to potential difficulties in shifting their energy use to off-peak periods. As a result, the Victorian government announced in March 2010 a moratorium on mandatory TOU tariffs[74].

Although it is outside the scope of this paper, it is worth noting that the CLNR project also investigated the electricity usage of over 1500 small and medium-sized companies (SMEs)[75], which showed a much wider variation in use profiles even than domestic customers. This would suggest that the introduction of individual settlement to customers with advanced meters and in due course those SMEs with smart meters, if it results in suppliers seeking to transfer these customers onto a ToU tariff, is likely to result in some SME customers facing considerably higher electricity costs than at present and some (with flatter daily profiles) gaining reductions.

A voluntary approach?

If mandatory ToU tariffs were judged unacceptable in principle, would a voluntary approach work? This needs looking at in two stages.

First, if settlement of domestic customers remains based on standardised profile classes, then, as we have seen, there is little new incentive on electricity suppliers to offer ToU tariffs. If such a ToU tariff was available, only those customers who could see a potential financial benefit would be likely to choose it. But, if these customers continued to be settled by relation to their profile class, the supplier would lose money to the same extent that the customer gained. If a supplier were in some way required to offer a ToU tariff, it would therefore wish these customers to be individually settled. There would also be a knock-on impact on the flat tariff rate offered to other customers, but with little enthusiasm on all sides the impact is likely to be small.

Second, if individual HH settlement is adopted for *every* customer, the incentives on the electricity supplier change:

- **Customers with a less peaky profile than average:** the supplier would probably want to encourage those customers with a less peaky profile than average onto a ToU tariff, because otherwise, as argued above, the customer could well switch to another supplier who offers such a tariff and which would be cheaper for that type of customer[76]. Moreover, it is customers with a less peaky profile who would see a

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[74] See the following references, https://theconversation.com/choosing-the-power-price-you-pay-voluntary-time-of-use-tariffs-18243
http://www.cer.ie/docs/001021/CER15053e%20Electric%20Ireland%20Response%20to%20CER15053.PDF
https://www.wec-policies.enerdata.eu/Documents/cases-studies/smart-meters.pdf page 9
http://aglblog.com.au/wp-content/uploads/2014/07/No.41-On-the-inequity-of-tariffs.pdf
[75] http://www.networkrevolution.co.uk/project-library/test-cell-report-baseline-sme-profiles-sme-customer-sub-group-analysis/
[76] This assumes that the CMA and Ofgem between them solve the problem of ‘sticky’ customers.

potential financial benefit from a ToU tariff. **However, there would only be a wider beneficial economic effect if these customers also changed their behaviour to reduce their usage at peak**. But since these are customers who use less electricity at peak time they are likely to have less scope for making further reductions than those using more electricity then. Furthermore, assuming customers left on the flat tariff used more peak-time electricity, then their prices would in the end have to rise to compensate for their suppliers' loss of revenue[77].

- **Customers with a more peaky profile than average:** the supplier would also probably want to encourage those customers with a more peaky profile onto a ToU tariff as the supplier would start to lose money on those customers. But, for the same reason, these customers would probably choose to remain on the standard tariff, unless they were able and willing to change their behaviour to the extent that they saved money. If they remained on the flat tariff, they would then have no incentive to switch their electricity usage away from peak time. High peak time usage is, in effect, already being subsidised by the other users and this subsidy would increase with universal HH settlement for small customers. For someone with a very heavy peak time use, such as an electric vehicle user who insists on using peak time electricity for charging their car, the implied subsidy could be large.

A simple voluntary ToU regime would therefore in itself do little to promote customer behaviour change. In this sense, voluntary ToU may at best be a stop-gap, rather than a long-term solution to encourage genuine and widespread behaviour change. Moreover, the introduction of individual HH settlement would create significant financial incentives on suppliers to introduce ToU tariffs with the potential for conflict with customers with a more peaky profile than average.

We therefore turn to other possible ways of encouraging DSR and behaviour change without mandatory ToU tariffs.

a) Better understanding of how to encourage behaviour change

As we have seen, customers do not always respond to price signals as economic theory expects or would wish. Since the principal aim of making retail prices more cost-reflective would be behaviour change to reduce peak use (initially at least), more research is still needed to establish how people can be encouraged to change behaviour at daytime peak and the scope for such behaviour change[78]. There is clearly a role here for smart technology,

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[77] Sustainability First Paper 8. 'Electricity demand and household consumer issues'. See Part 2 – 'Who wins who loses from DSR' for a worked example of possible impact of a voluntary ToU tariff on a supplier (p.33).

[78] Paper 12 identified the need for a better understanding of the value customers place on using electricity when they wish, and the trade-offs they would make to pay less, and the customer appetite for cost-reflective tariffs.

automation and appliance control to assist in bringing that change about. If successful, this could provide a longer-term alternative, or a supplement, to ToU tariffs for most customers[79].

b) Protection for the vulnerable

Adequate financial protection and significant advice would be needed for fuel poor and vulnerable customers on the introduction of ToU tariffs, whether voluntary or mandatory. Although in some cases the change to ToU pricing could be beneficial – those who are at home all day are likely to have a flatter daily profile than average – those who are out all day and those relying on direct electrical heating are likely to have a peakier profile than average and would therefore lose out from a change. But the availability of smart meter data to suppliers and third parties should make these vulnerable customers easier to identify and could be used to help identify those in need of help. Moreover, since a principal aim of targeting the fuel poor in energy efficiency schemes such as ECO is to reduce their energy bills, it would make sense to explicitly extend the scope of these schemes to install smart technology and appliances aimed at reducing their peak energy use.

c) Target the atypical customer

Another approach would be for suppliers to take advantage of the availability of much better quality customer data as a result of the introduction of smart meters. Customers whose consumption patterns are close to the average are well-modelled by the existing profile classes (Load Profiles 1 & 3). Suppliers would gain or lose little from seeking to encourage 'average' customers to take up ToU tariffs - and similarly 'average' customers themselves would face limited financial benefits or incentives from the change. And the ToU trials have demonstrated that 'average customers' have only limited discretionary load to shift in any case. They could continue on a standard tariff.

It is only for those **atypical** customers, with a very peaky consumption pattern in the evening, who would find it particularly advantageous to refuse a ToU tariff, where there would be a firm financial benefit for their supplier in encouraging them onto a ToU tariff, and an *overall system* benefit from either encouraging them to change behaviour or charging them the full economic cost of their behaviour.

As we have seen, households with high discretionary use of water can be required to have a water meter and be charged by usage. These households clearly make a particular and unusual demand on the water system and 'fairness' requires that they therefore should be

[79] Sustainability First. GB Electricity Demand Project. Paper 11: 'How could electricity demand-side innovation serve customers in the longer-term?' looked at length at what may be needed to bring about eventual widespread household automation for GB. (Joint paper with Frontier Economics).

charged for the privilege. The availability of smart meter data to suppliers or others would potentially allow a similar approach to be adopted for electricity:

- The electricity supplier would identify from smart meter data households with overall consumption levels and peak consumption levels significantly higher than the norm[80].

- This data would be first used to identify whether the pattern of usage represented high deprivation or poor insulation. In this case social measures could be offered.

- In the absence of such factors, ie if the high peak usage is seemingly largely discretionary, the household could be targeted to incentivise / encourage behaviour change. This could involve a range of actions from provision of information and advice through to higher charges (for example, the eventual introduction of household connection or capacity charges, or, a ToU tariff).

d) Target the LCT user

The same approach as for the atypical customer could be used to encourage best practice in the use of low carbon technology, such as heat pump or electric vehicle charging. Energy use is broadly driven by conventions and practices[81] and so encouraging off-peak electricity use from the outset would be a good way of reinforcing these practices. In particular, where customers receive a subsidy towards their low carbon technology, it would be possible to discourage discretionary use of peak-time electricity by the use of incentives or tariffs. Arguably, future thinking on 'fairness' may encompass a view that customers who place an 'unusual' or a 'major' new demand on the electricity system should contribute towards meeting the associated extra costs.

e) Introduce ToU tariffs by degrees

Moving directly from a flat rate tariff to a fully cost-related ToU tariff causes winners and losers, as we have seen. However, if this change were to be introduced over a period of, say, five years, the amount of change in any one year would be much reduced and might be more acceptably accommodated. Moreover, the evidence from the trials suggests that mere awareness of a price differential has some incentive effect, and so any behaviour change in terms of moving electricity usage away from peak times that does occur might happen earlier than would be expected from the purely economic level of incentive. Suppliers could

[80] Recollecting that the norm is represented by the median level of demand. The 'average', or mean, is skewed by the consumption of heavy users.
[81] See for instance http://www.networkrevolution.co.uk/project-library/key-social-science-findings-domestic-sme-customers-2/

therefore be encouraged to put a 'toe-in-the-water' in offering ToU retail tariffs to those customers likely to benefit.

f) Target change of occupancy

A further example from the water industry could also prove useful. This is that metered water charging can be required on changes of occupancy. A house move is a good time to change energy use conventions and practices and so encouraging behaviour change. Customers moving house could be targeted with information and advice, encouraged to install a smart meter and offered a ToU tariff.

g) Combine any of the above with a voluntary approach

None of this need stand in the way of customers voluntarily choosing to accept a ToU tariff, particularly if this was part of a package including smarter control of household electricity load, which could be a way to increase the scope for reduction in demand at peak times[82].

h) Incentivise behaviour change directly

A ToU tariff rewards non-peaky behaviour rather than targeting changes in behaviour as such. As a result it can have unintended consequences which could be larger than the change it is aimed at producing. The introduction of smart meters allows for a more sophisticated and bespoke approach to incentivise change in customer consumption behaviour at peak (or other high-cost times):

- Everyone remains on their existing tariff or voluntarily moves to a ToU tariff.
- Through the use of smart meter data, their electricity supplier builds up for each customer a usage profile over time.
- Customers on the flat tariff who reduce the peakiness of their profile are rewarded through financial payments or other incentives.
- This could, if desired, be extended to create disincentives / 'penalties' for those who significantly add to their peak time load (including those who install new LCTs).

[82] See Sustainability First. GB Electricity Demand Project. Papers 11 & 12.

Conclusion and next steps

The analysis in this paper, together with the experience from Australia, shows that the use of ToU tariffs, whether mandatory or voluntary, may have unintended consequences which may limit their practical utility as a way of encouraging behaviour change in domestic electricity users. There are a number of different approaches, **together with ToU tariffs**, that could be used to encourage DSR. More research, including trials, is needed to establish how effective some of these could be, what are the unintended consequences of each and what might be their impact on particular groups of customers and other distributional effects. And, bearing in mind that home owners and others might need to invest capital to maximise the benefit from the intervention, any large scale introduction of any of these options would also need to conform to the Sustainability First low-carbon intervention principles.[83]

Clear implications arise both for the impact assessment of the benefits of installing smart meters and also for the desire on the part of government and the regulator to encourage individual half-hourly settlement. In particular, more work is needed to understand how suppliers might respond in practice to changes in their underlying cost-allocations which could result from the introduction of universal half-hourly settlement.

This paper has not discussed the many complex customer and consumer protection issues which will arise in connection with a move at scale to time-varying tariffs for households. These issues were considered at length in Sustainability First Papers 8 and 12[84], in which we also identified a number of next steps for Ofgem, DECC, energy companies and the consumer bodies to consider.

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[83] Sustainability First. '**Let's get it right – a suggested framework for low carbon interventions**'. June 2015 http://www.sustainabilityfirst.org.uk/publications.htm

[84] Sustainability First. GB Electricity Demand Project. **Paper 8 :'Electricity demand and household consumer issues' and Paper 12 : 'The household electricity demand-side & participation in the GB electricity markets'.**

See also :

Citizens Advice : Take a walk on the demand side. Making electricity demand side response work for domestic and small business consumers. August 2014.

Ofgem : Consumer Empowerment & Protection in Smarter Markets : Updated Work Programme (September 2014) – & follow-on smart meter papers. https://www.ofgem.gov.uk/gas/retail-market/market-review-and-reform/smarter-markets-programme/consumer-empowerment-and-protection.

Plus the paper by Work Stream 6 of the DECC / Ofgem Smart Grid Forum (Autumn 2015).

Although this paper has focused on the impact of ToU tariffs, a number of lessons emerge of more general and wider application to any change in the structure of the way domestic customers pay for electricity:

- If cost-related retail pricing is to be used to encourage customer behaviour change, there first needs to be greater coherence in the current socialisation of charges faced by suppliers. There also needs to be a clearer understanding of whether - and how far - suppliers might then reflect these more cost-reflective charges onwards to their domestic customers through retail prices.

- Domestic customers are very variable in their overall use and also in their peak time use of electricity. Any change to the structure of retail pricing will create winners and losers, and the impact of this needs careful examination taking account of the variability of customers - as well as the impact on the average customer.

- A greater understanding is needed of the factors that can influence avoided consumption at peak via genuine behaviour change, particularly for those customers who contribute most to the peakiness of the electricity system – both those with significant flexible load and those who may have very little flexibility when electricity system costs are high. Care is needed to ensure that incentives put in place do not have unintended or perverse consequences.

Appendix - Water charges and metering

1.1 Introduction

About 48% of domestic water customers in England and Wales had a water meter in 2014 (although this is targeted to rise to 61% by 2020). Those households which are not metered are charged a flat rate for their water and sewerage charges based on the rateable value (RV) of their property. For these customers, there is no direct connection between the amount of water that they use and the size of their water bill.

The Government has allowed water companies in areas of England that the Environment Agency considers to be short of water (or 'water-stressed') to compulsorily meter their customers if they can demonstrate that this is the most efficient way to secure water supplies now and in the future[85].

In other areas, customers can ask to have a water meter installed free of charge. Bills based on water meter readings include a fixed charge and a charge per cubic metre of water used. Both fixed and variable charges cover both provision of clean water and disposal of waste water. Customers can change back to the unmetered charge within 12 months of the installation of the meter, unless they live in an area of compulsory metering. Once a meter has been installed, any new occupier of the property must pay the metered charge.
Every company offers the 'WaterSure' tariff. This caps the bills for certain metered household customers at the average household bill for their area. WaterSure is the name given to the vulnerable groups tariff, which was introduced in England by Government regulations in April 2000. The companies operating in Wales offer similar tariffs on a voluntary basis. It applies to metered customers who receive specified benefits and:

- have three or more dependent children living with them; or
- suffer from (or have someone living with them who suffers from) a medical condition that involves using large volumes of water.

1.2 The Walker Report

In August 2008, Anna Walker CB was asked to conduct a review into charging for household water and sewerage services. The aim of the review was to:

[85] The previous government claimed (rather disingenuously) that 'no water company is required to introduce compulsory metering, even if it is in an area of severe water stress', despite the fact that it permits the water companies to do so.

- Examine the current system of charging households for water and sewerage services; and assess the effectiveness and fairness of current and alternative methods of charging including the issue of affordability;
- Consider social, economic and environmental concerns; and
- Make recommendations on any action that should be taken to ensure that England and Wales have a sustainable and fair system of charging in place. This could include changes to current legislation and guidance.

The Final Report of the review[86] was published in December 2011. Against the background of increasing pressure on water resources both now and longer term, in part due to climate change, it identified two broad messages:

- It is very important that the charging system should incentivise the efficient use of water to ensure we have a sustainable water supply.
- Water, as an essential of life, also needs to be affordable, particularly to those on low incomes.

Although fairness is a matter of judgement, some generally agreed principles of what constituted a fair charging system emerged from the consultation. These were that fair charges should:

- incentivise the efficient use of water and therefore a sustainable supply of water;
- charge according to the use made of the system;
- apply the 'polluter pays' principle wherever possible;
- be affordable to those on low income;
- be fair to companies;
- be simple and transparent for customers and involve them in decisions on prices;
- not be too expensive to administer; and
- be fair to future generations.

The recommendations in the report sought to apply these principles.

[86] https://www.gov.uk/government/publications/the-independent-review-of-charging-for-household-water-and-sewerage-services-walker-review

Regional charging

Concerns had been expressed to the review at the differential pricing of water across the country. But the review concluded that there are real underlying regional differences in water costs and that local ownership of these costs encouraged greater efficiency. Water prices should therefore continue to be regionally based and averaged at an appropriate geographic scale within a company area recognising that the level of averaging may change over time. The review recognised that the cost of serving individual customers depended to a large extent on their distance from treatment works or other facilities. These costs were currently averaged between customers within company boundaries. The review recognised that although this could be considered a form of cross-subsidy, any charging system inevitably contained some element of averaging between customers, as individual pricing was too complex and expensive.

Water metering

The review highlighted concerns over the current mixed (rateable value and metering) charging system, since the RV system was out of date and did not target efficiently those who needed help with their bills. Although rateable value based charging had been thought to be a progressive system, allowing low-income customers to pay less for their water services than high-income ones, there was little correlation between rateable value and income.
It had been argued to the review that water and sewerage services should be paid for on a progressive basis, either nationally (via the taxpayer) or locally (via council tax). This was because, on equity grounds, the costs of the service should be distributed according to the customer's ability to pay. However, this approach to charging did not incentivise more efficient use of water.

The report concluded that charging by volume of water used (which requires meters to be installed) was the fairest approach to charging, since it incentivised more efficient use of water. However, installing meters incurs costs. The current largely optant system is a very expensive way to install meters. The report concluded that there is a strong case for metering:

- Where water is scarce and the benefits therefore outweigh the costs;
- For high discretionary users (who may not be paying for what they use at the moment); and
- On change of occupancy.

The case for metering was less compelling where water is not in short supply. With metering becoming more widespread, there was a transition from one charging system to another already under way. The report suggests that if these recommendations were adopted, about

80 per cent of households in England will be metered by 2020 (it will be much lower in Wales because they have more available water).

The report recognised that affordability was already a real issue for some groups of customers and in high cost areas such as the South West. It therefore recommended help with bills for customers with low incomes.

Unmetered bills were rising at a faster rate than metered bills, as people who could save from metering were doing so, leaving the cost of larger users to be spread across the unmetered customer base. Those opting for a metered supply tended to be households with low consumption (including single-person households and second homes) and/or those who live in higher rateable value properties. Those not opting for meters tend to be households using a lot of water (including those with large gardens, which they water) and those living in low rateable value properties. Individuals making the switch would save, while those remaining on the rateable value linked charges would see their bills rise so that companies could recover their costs.

Households with high discretionary use of water could provide the highest impact from metering in terms of reduced water use, as they had more scope to save water. They were also likely to be paying (often significantly) less than they would with a volumetric rate, and were therefore not paying their fair share of the costs of the system. But they were unlikely voluntarily to opt to change to a metered supply.

Allowing people to opt for meters also increased the fairness of the charging system, as it allowed those who use less water than average to reduce their bills. This included some low-income households.

Meters charges tariff design The review contained a long discussion on tariff design which effectively boiled down to the question on the balance between standing and volumetric charges. It concluded that the volumetric element of the tariff should normally be set at, or above, a level that covers the long-term costs of expanding supply or meeting increased demand for water, unless this would result in the company being overcompensated for its total costs.

1.3 Water for Life White Paper

Water metering was clearly a sensitive political topic as the 'Water for Life' White Paper[87], in responding to the Walker Review, had only this to say on water metering:

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[87] https://www.gov.uk/government/publications/water-for-life

> The costs and benefits of increasing levels of water metering to help reduce demand will vary from region to region depending on the level of water stress. Because of these complexities we will not impose a blanket approach to metering across the country. We believe water companies are best placed to find the appropriate local solution in discussion with their customers. As the climate changes and the population grows, the case for universal metering may change but will do so at different times for different areas.

1.4 Efra Committee

The Efra Select Committee then took up the challenge. In its 2012 report on the White Paper[88], the Efra Committee pointed to the persuasive evidence about the role that metering plays in reducing demand, and recommended that the Government set a clear and ambitious objective to increase levels of metering, taking account of Anna Walker's recommendation that metering penetration reach 80% by 2020.

In its subsequent report on the draft Water Bill[89], it tackled de-averaging of prices. It noted that water and sewerage customers usually pay the same prices within a given company's area, even if the costs of serving those customers vary because the costs of building and maintaining the infrastructure are averaged out across the company's customer base. So, for example, the distance that a customer is from a treatment works, or the additional cost of the infrastructure required to provide a water supply to a remote household, is not routinely taken into account when calculating individual bills.

The potential for de-averaging of prices would come about because of the incentive for new entrants to 'cherry pick' those customers within an incumbent company's region that are the lowest cost to serve. Ofwat told the Committee that it was a 'myth' to say that upstream reforms would lead to a de-averaging of prices between rural and urban household customers. However, they appeared to accept the prospect of some element of de-averaging in the non-household sector, saying that there was 'clearly an argument for giving non-household customers, particularly heavy users of water and sewerage services, cost-reflective price signals, so that they make efficient decisions—for example, on where to locate.' The Minister told the Committee that he would 'hold Ofwat to their duty to make sure that we are not penalising customers who live in rural areas because it is more expensive to provide water to them' and that 'we think it continues to be a very clear duty on the regulator to make sure that prices are averaged in the right way.' The Committee recommended that Defra make a clear commitment in the Water Bill that the reforms would not lead to any further de-averaging of prices.

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88 http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenvfru/374/37402.htm
89 http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenvfru/674/67402.htm

1.5 Defra charging guidance consultation

Bringing the story up to date, in July 2015, Defra issued a consultation on the Government's Charging Guidance that it would be issuing to Ofwat[90]. As it illustrates the Government's nervousness about socialisation and de-averaging in the water sector, it is worth citing at length:

> '2.4 …..In setting their Charging Rules Ofwat must have regard to their particular duties under the Water Industry Act 1991 to protect certain groups of customers including:
>
> - Individuals who are disabled or chronically sick;
> - Individuals of pensionable age;
> - Individuals with low incomes;
> - Individuals residing in rural areas.
>
> 2.5 ……Ofwat also has duties to secure that there is no undue discrimination and that no undue preference is shown in the setting of charges. Ofwat's duties are to further the interests of both current and future customers. The Water Act 2014 reinforced this responsibility to future customers by adding a further statutory duty to the Water Act 1991 to secure long-term resilience.
>
> 2.8 ……There are substantial cross-subsidies inherent in the water sector, due to the reliance of all customers on sufficient resources and a resilient network. In many cases unwinding these cross subsidies will be of little practical benefit and may lead to bill instability; creating winners and losers without delivering any measurable policy benefit. However, in some cases it may be beneficial to use targeted price signals to improve recognition of environmental costs. For example, if a very large water user is making a decision about where to locate new premises, it would make sense for them to consider the benefits associated with areas where water is plentiful. Currently, such incentives are minimal. However, such tools must be used appropriately to avoid the creation of perverse incentives and to ensure that any change is in the overall interest of customers and the environment.
>
> 2.9 In this context, the Government recognises that innovative tariff structures can send positive price signals and improve economic and environmental efficiency. This might involve pricing to reflect seasonal peaks or incentivise collection and use at times of lower demand. Rising block tariffs can also have a role in encouraging customers to consider their use of water. However, as above, the introduction of such tools needs to be properly evaluated, especially where costs would be incurred as part of implementation. Well-designed small-scale tariff trials can provide important

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[90] https://www.gov.uk/government/consultations/water-industry-charging-guidance-to-ofwat

evidence to guide decisions on tariff design. A balance will need always to be struck with the principles of fairness and affordability and stability and transparency.

4.6 ……In setting charging rules, Ofwat should recognise the role that volumetric charging can play in influencing consumer behaviour. However, because circumstances are very different in different regions and because the responsiveness of demand to changes in price for some types of customer can be very limited, the Government does not take a blanket approach to metering policy. The Government's policy in relation to volumetric charging is to encourage water companies to do more to promote metering to those who would benefit, whilst bearing in mind the potential impact on some struggling customers with high water use. Charges schemes should always make clear the circumstances in which companies will require measured charges to be applied.

4.8 In setting charging rules, Ofwat should always seek to ensure that any transition to metering by a company is handled with care; recognising that water bills may rise for some customers who move to a meter. It should make sure that, wherever appropriate, measures, such as transitional tariffs are put in place by the companies to support customers through this change and to protect them from sharp price rises. These should also be combined with social tariffs where appropriate. The Government's view is that any undertaker that chooses to introduce a universal metering programme across all or part of its operating area should seriously consider including a company social tariff in its charges scheme. This would address long-term affordability issues that may arise from the unwinding of the cross-subsidies inherent in charging for water according to the rateable value of a property.

6.14 The regulator will need to use the tools at its disposal to ensure that any moves towards greater cost reflectivity of retail charges are introduced in a measured fashion and are to the overall benefit of all customers. The regulator should also limit the extent and impact of de-averaging on retail charges on particular groups such as rural customers. The Government is clear that no particular category of customer should be unfairly disadvantaged by the extension of competition into the non-household market.

7.7 Some concerns have been raised in respect of the scope for 'cherry-picking' of lower cost to serve customers in the upstream markets leading to a de-averaging of costs. It should be noted that the averaging of charges is common practice in sectors that have much greater scope for contestability than the water sector. There may also be some opportunities for innovation to reduce costs for customers with a higher than average cost to serve – with potential benefits to customers as a whole. Ofwat has a number of tools to limit the effect of de-averaging on customer charges. In developing the wider implementation framework and issuing any future Charges Rules in respect of these markets Ofwat will need to carefully consider how best to use these tools in order to ensure that any marginal changes are introduced in a measured fashion and, above all, that they are in the overall interests of consumers as well as specific groups of customers'.

Extracts taken from : Defra Charging Guidance Consultation

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