Sustainability First

GB Electricity Demand Project – *realising the resource*

Paper 12

The household electricity demand-side & participation in the GB electricity markets

Sustainability First Authors :

Judith Ward & Sharon Darcy

July 2014

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Sponsored by : BEAMA ; British Gas ; Consumer Futures ; EDF Energy; Elexon ; Siemens ; E.ON UK ; National Grid ; Northern Powergrid ; Ofgem ; Scottish Power Energy Networks ; UK Power Networks ; Vodafone.

Smart Demand Forum Participants : Sponsor Group ; Energy Intensive Users' Group ; Consumer Futures ; Which ? ; National Energy Action ; Ofgem ; DECC ; Sustainability First.

Preface

Sustainability First

Sustainability First is a UK environment think-tank with a focus on practical policy development in the areas of sustainable energy, waste and water. Sustainability First undertakes research, publishes papers and organises policy seminars. It is a registered charity with independent trustees – www.sustainabilityfirst.org.uk.

Since 2006, Sustainability First has produced a series of major multi-sponsor studies on GB household smart energy meters and brings significant knowledge and insight in the fields of energy efficiency, smart metering, smart energy tariffs and demand response.[1]

The Sustainability First project '**GB Electricity Demand – *realising the resource*'** is a three-year multi-partner project (2011-2014) focusing on the potential resource which the electricity demand side (industrial, commercial and household customers) could bring to the GB electricity market, through both demand response and demand reduction.

Key themes for the project include:

- Customer Response and Consumer Issues.
- Commercial and Regulatory Issues.
- Public Policy Issues.

The project was supported in its first year under the Northern Powergrid Low Carbon Network Fund project - and thereafter for a further two years to 2014 via a multi-sponsor group.

Sponsors include : BEAMA ; British Gas ; Consumer Futures ; EDF Energy; Elexon; E.ON UK ; National Grid ; Northern Powergrid ; Ofgem ; Siemens ; Scottish Power Energy Networks ; UK Power Networks ; Vodafone.

Work is coordinated through a **Smart Demand Forum,** whose participants include the sponsor group together with Ofgem, DECC and key consumer bodies: Energy Intensive Users Group, Consumer Futures, Which? and National Energy Action.

1 Sustainability First published smart meter papers are available on the website – www.sustainabilityfirst.org.uk

The project is:

- Evaluating and understanding the potential GB electricity demand-side resource across all economic sectors (including the role of distributed generation and micro-generation) ;
- Developing a clearer understanding of the economic value of this resource to different market actors and to different customers over the next 10-15 years ;
- Evaluating the key customer, consumer, commercial, regulatory and policy issues and interactions.

The project is developing a substantive knowledge-base, and provides visibility and thought-leadership for GB electricity demand-side issues. The project is undertaking work relevant to:

- GB smart meter deployment.
- Low Carbon Network Fund and Network Innovation Competition projects – emerging lessons & insights.
- The DECC / Ofgem Smart Grid Forum & its workstreams.
- Plans for the electricity demand-side (DSR & electricity demand reduction) in Electricity Market Reform.

The work for the GB Electricity Demand project is delivered through the Smart Demand Forum, through wider stakeholder events, and through thirteen published papers.

The project also draws upon relevant information from demand side developments in other countries to inform its work (notably the EU, US and Australia).

Sustainability First

July 2014

www.sustainabilityfirst.org.uk

Contact us : info@sustainabilityfirst.org.uk

Sustainability First. Registered office. 6th Floor. 10 Dean Farrar Street. London SW1H 0DX

GB Electricity Demand Project papers – www.sustainabilityfirst.org.uk	
1	**GB Electricity Demand – context and 2010 baseline data**
2	**GB Electricity Demand 2010 and 2025 – Initial Brattle Demand-Side Model: scope for demand reduction and flexible response .**
3	**What demand-side services could customers offer ?** **Household customers .** **Industry customers.**
4	**What demand-side services can provide value to the electricity sector ?**
5	**The electricity demand-side & wider energy policy developments**
6	**What demand-side services does Distributed Generation bring to the electricity system ?**
7	**Evolution of commercial arrangements for more active customer & consumer involvement in the electricity demand-side.**
8	**Electricity demand and household consumer issues**
9	**GB Electricity Demand – 2012 and 2025. Impacts of demand reduction and demand shifting on wholesale prices and carbon emissions. Results of updated Brattle modelling.**
10	**The electricity demand-side & local energy : how does the electricity system treat 'local'?.**
11	**How could electricity demand-side innovation serve customers in the longer term ?** Joint paper with Frontier Economics.
12	**The household electricity demand-side & participation in the GB electricity markets.**
13	**Realising the Resource : GB Electricity Demand Project Overview.** Publication September 2014

Paper 12

The Household Electricity Demand-Side
&
Participation in the GB Electricity Markets

Paper 12 is in two parts as follows.

Part I : offers a high-level overview of the GB electricity markets & how far they are open to household demand-side participation.

Part II : discusses four areas of principle relating to the Smart Consumer.

Part II of Paper 12 follows a roundtable discussion at the Smart Demand Forum on 8 May 2014. That discussion focused on four major issues for household customers for future demand-side development : greater cost-reflection in retail tariffs ; how a DSR market can work in the interests of consumers in general ; empowering & protecting the individual consumer ; and, possible developments for regulation and consumer representation in a 'smart' world.

We are very grateful for the many helpful contributions to this paper from Smart Demand Forum members and others. Particular thanks to Gill Owen and Jon Bird of Sustainability First, and to Conrad Steel of Citizens Advice, for their inputs.

Responsibility for the paper and its conclusions rests with Sustainability First.

Paper 12

The household electricity demand-side & participation in the GB electricity markets

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Paper 12

Part I

The Household Electricity Demand-Side

&

Participation in the GB Electricity Markets

High Level Overview

Part I is organised as follows.

Annexes 1-5 : detailed material on which Part I draws.

Part I

High Level Overview :

The Household Electricity Demand-Side & Participation in the GB Electricity Markets

Chapter 1. Summary & conclusions

1.1 Electricity demand reduction

Electricity demand reduction – remains absolutely central to driving affordability for individual households : for the efficiency of the electricity system in general, for carbon reduction and to support electricity market reliability. The government attributes around **one-half** of the total estimated cost-savings from 'policy & measures' in future electricity bills to electricity demand reduction as a result of EU product policy and regulation (£167 less p.a. *per customer* by 2020). But, if these EU measures are not driven forward and implemented in the timescales expected, or, if appliance stock turnover is slower than estimated, the major upward cost pressures on electricity bills will remain (including from levies), but will not be 'offset' by the electricity efficiency savings as presently calculated by DECC. This could have substantial implications for electricity affordability, & also for capacity & carbon.

1.2 Household DSR participation in the electricity markets

Wholesale markets and household DSR : Our *working assumption* is that pre-2020 :

- Most **overall value** from the demand-side sits in the wholesale markets (as against other parts of the electricity markets) - and that -
- This value has yet to be unlocked to any worthwhile degree - and that -
- In practice, the wholesale markets are where most initial rapid progress could be made in developing household DSR, post-2016, once smart meters. This assumes that suppliers may wish to develop a range of basic ToU household tariffs **for peak-avoidance** to offer to household customers.

We assume that pre-2020, demand-side actions for peak-avoidance in the wholesale markets should support the greatest *overall* share of electricity market cost-savings (affordability) plus some carbon savings. However, peak avoidance in the wholesale markets may presently offer only modest cost-savings to an individual household (other than those with on-peak electric heat). This in turn, may potentially make it somewhat challenging for suppliers to produce interesting customer offers.

Post-2020, more substantial savings could become available from household DSR – both from peak-avoidance and from more general flexibility by shifting load to other times, including into the night if windy, and especially in summer. If suppliers make a start now with offering basic static ToU tariffs, this could help pave the way for greater customer acceptance of household DSR for the future.

Capacity markets – household DSR participation in the capacity markets will also help to realise affordability, carbon and reliability, but substantial household participation seems unlikely before 2020. Before this however, household peak-avoidance in the wholesale markets promoted via ToU tariffs offered by suppliers would very largely serve the same policy goal, and, the capacity market supplier charge arrangements should encourage this. After 2020, with widespread smart meters and potential half-hourly settlement, there may be more realistic opportunity to engage households directly in the capacity markets via dynamic and automated responses.

Balancing markets : there is realisable demand-side value to be obtained in the Balancing markets today – in particular for I&C customers, but potentially for households too if they can provide fairly instantaneous flexibility through automated switching of their appliances for frequency and / or fast reserve (e.g. via hot water tanks, storage heaters). Such demand-side actions can support overall system cost-efficiency, affordability and carbon to some degree.

Relative to the overall cost-saving potential available in the wholesale markets from household peak-avoidance, the overall savings to the electricity system from household DSR in the Balancing market is small (balancing costs presently represent ~1% of the end-bill). But, the potential value available to share *with an individual participating customer* for a particular demand-side balancing service may well exceed the DSR cost-savings currently available to an individual customer via the wholesale markets.

Network DSR : Households are participating in distribution network trials for household DSR (deferred or avoided investment from peak-avoidance, supports low-carbon). In practice, cost-savings available from DSR schemes in the networks are very location-specific : dictated by specific constraints at particular places. Even at these network 'hotspots' there may be relatively little value to share with an *individual* household. This modest value proposition is prompting the distribution networks to look at how best to combine their own needs for peak-avoidance with similar DSR needs of other market actors[2]. Beyond the early 2020's in a more smart grid world, the potential DSR cost-savings picture for individual households may change, but will always be locational and peak- or fault- related.

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2 Demand Side Response Shared Services Framework Concept Paper. ENA. April 2014 and DECC / Ofgem Smart Grid Forum Work Stream 6. Options Paper. April 2014.

As yet, households do not participate in TRIAD avoidance (potentially to avoid transmission charges), but this could come with smart meters and especially once half-hourly settlement.

1.3 Measures and policy for the household demand-side

The general direction of current measures and policy put in place by DECC and Ofgem - with the many practical implementation steps now in hand - will certainly offer the **technical means** to encourage the GB household demand-side. This is so for potential household participation in the wholesale markets - as well as in other parts of the electricity markets : capacity, balancing, distribution. Smart meters, auxiliary load control switches, CADS (consumer access devices) – plus half-hourly settlement - will each incrementally serve to provide greater and more sophisticated *technical means* for households to participate in the demand-side – initially largely via their electricity suppliers, but not just. Ensuring that these 'technical' conditions are met, is a fundamental 'enabler' for household customer demand-side participation.

However, in themselves, these measures will not solve four other important drivers of household DSR. Two of these drivers are 'commercial' and two are 'customer-led'.

1.4 Commercial drivers

Absence of a strong supplier driver / business case – at present supplier appetite for offering household DSR seems to be driven mostly by individual supplier thinking around 'market advantage'.

From 2016 onwards, smart meters will offer suppliers far better insight into and knowledge of their customers' electricity usage. This better insight also coincides with a period when suppliers will start to face new wholesale price uncertainty from :

- Increased output from wind (a more unpredictable mix of prolonged low-priced periods and volatile higher peak- and flexibility-related prices).
- Some significant regulatory changes. Both the electricity cash-out review of imbalance prices (EBSCR) and half-hourly settlement are likely to cause suppliers to seek more accurate half-hourly matching between their *actual* customer usage and their wholesale energy purchases. Also, as generation and supply arms become more separate, there may be greater savings available than now from greater variation of within-day prices (currently an average differential of ~20% [3]).

3 DECC Electricity Demand Reduction. Initial Impact Assessment. 29 November 2012. Annex A. Internal modelling of EDR impact on system costs. pp 33-34. Value of potential average savings modelled as between day-time : night-time.

Taken together, these different and uncertain factors could perhaps prompt suppliers to re-assess their present commercial thinking on household DSR as a way to smooth the overall daily 'shape' of their wholesale energy purchases. However, DSR would only benefit suppliers if it also *improves predictability* and does not make life more unpredictable and therefore more risky. In the early 2020's this points strongly towards suppliers seeking 'firm', automated DSR solutions from willing households. Together with other market actions, such as hedging wholesale purchases over different time-frames, *firm household DSR* could help suppliers to reduce their wholesale market risk.

In reality however, it is very hard to predict how this complex combination of smart meters, greater wholesale market uncertainty and new regulatory measures will shape suppliers commercial thinking regarding the benefits of household DSR.

Lack of cost-reflection in the cross-industry charges paid by suppliers : separate from the discussion above of wholesale market drivers on suppliers for household DSR, a different and separate question arises as to how far suppliers might also become more directly exposed than now to the underlying variability of *other* industry costs (network costs, levies).

Cross-industry charges are presently calculated and allocated in such a way that these are recoverable in full by suppliers from customers via a standardised average charge, on a per customer basis. Suppliers pass-through these charges to customers unseen (p/kWh or a fixed sum). These charges split between:

- **Network costs** (T&D) **& balancing** - currently ~23% of the end bill[4.]
- **Levies** (i.e. for RO, FITs CfDs, Capacity & some social obligations) – 14 % of the end-bill today. Estimated by DECC to amount to 33% of the end electricity bill by 2020 ; 41% by 2030.

These standardised charges represent **a growing share of the end-bill**. By 2020, they will comprise **over one-half of the end-electricity bill ; and two-thirds of the end-bill by 2030**. Arguably, this will become a very significant portion of the bill simply to pass through to each customer on a wholly flat p/kWh averaged-cost basis.

Reform of the way in which cross-industry charges are recovered from suppliers could be contentious, because this could also add to supplier risks if suppliers were unable to manage the impacts (including via household or other DSR). The thinking behind any such move

4 Network and balancing charges are already subject to efficiency pressures via price controls and incentives. But, in seeking greater cost-efficiency in network investment, industry bodies are already starting to consider introducing potential ToU bands, designed to send a signal to *suppliers* via their DUOS network charges (DUOS ToU bands already in place for half-hourly customers). In principle, once half-hourly settlement, network charges could potentially be allocated accurately *to suppliers* against each customer's usage in every half-hour (rather than the present standardised basis).

would be to expose suppliers more than they are now to peak-related variation in industry costs . In turn, this might start to incentivise suppliers to encourage peak avoidance by their customers. At least, more so than today.

Two further important questions therefore arise for market efficiency about present approaches to the transfer of cross-industry charges – especially the levies - between market actors :

- **Should suppliers become more exposed than today, via reform of cross-industry charges, to the underlying variability of certain industry costs** (network costs and / or levies) **– and if so to what extent ?**
- Might some form of **peak-related 'sculpting' of the combined envelope of cross-industry costs and charges** (for networks, levies), provide a clearer signal to suppliers about the generally higher costs associated with peak ?

A separate and equally important question then follows for consumers :

- If in the future, suppliers do become more exposed through their cross-industry charges to some of the industry's underlying true costs, **how far should some or all of those de-averaged costs then be more fully reflected through to end-customers?**

Our *basic working assumption*, notwithstanding any eventual new underlying cost-complexity faced by suppliers, **is that time- or price-related DSR retail tariffs offered to end-customers should build on RMR principles and be broadly simple and readily understood.** The potential distributional impacts of more cost-reflective retail tariffs also need to be understood.

In Part II we discuss the principle of introducing greater cost-reflection in retail tariffs for household customers.

1.5 Customer-led drivers

Household appetite for demand-side participation – electricity trial experience (EDF EDRP, Ireland, CLNR) shows that trial customers generally like basic static ToU tariffs and respond to these, even where the financial benefits to them may be relatively modest (with an average trial peak shift of ~7-10%). CLNR suggests that small households, renters, and households with young children already use less electricity at peak (so perhaps have less flexibility). Larger households either shifted load – or ended up paying more – both of which are perhaps 'rational' responses[5]. All of this suggests that suppliers could do more to offer basic ToU tariffs to their customers, as it seems that at least some customers may be content to engage, even if the bill benefits are relatively modest.

In Part II we discuss customer and consumer issues, including risks and benefits for customers who engage ; and risks for customers who cannot or do not wish to engage with ToU tariffs, including vulnerable customers.

Lack of flexible controllable household load at peak – GB policies and measures for household DSR remain based around expectation of a major household shift to electric heat and EVs, essentially to decarbonise - but also with the expected spin-off that automated electric heat & EVs may facilitate a household demand-side in the 2020's & 2030's. Smart wet appliances may have a role, but paper 11 suggests that this may perhaps be relatively modest. EVs may have some growing traction in the 2020's. However, there is little sign that a significant market for **controllable off-peak household electric hot-water and heat** will grow in the near term, unless there is near-term promotion of more electric thermal storage (hot water cylinders, storage heaters) and / or better incentives and / or long-term regulation designed to promote a wholesale shift to heat pumps – and this latter may not be popular. Above all, efforts to encourage sources of controllable and flexible household electrical load need to be realistic and give consumers what they want. Equally, without more forethought about what will drive new sources of controllable household load by say, the early 2020's, two linked problems could arise :

- There could be a lack of appliances in homes – readily switchable at scale via automated load-management schemes - to offset higher industry costs associated generally with low carbon and wind in particular.
- This may be particularly problematic for suppliers : who could find themselves facing a commercial environment with even more risk than noted in para 1.4 above – because in a heavy wind-system, by increasing unpredictability, *voluntary* static ToU tariffs may *increase* supplier risk.

5 Customer-Led Network Revolution. CLNR –LO52. Durham University. Social Science Research. 24 April 2014.

1.6 Market actors most likely to lead household demand-side participation

Suppliers have direct commercial exposure to the wholesale, capacity and balancing markets. They lead on smart meters. They also have initial exclusive switching control arrangements over those appliances most likely to be directly connected via smart meters and the auxiliary load control switches (e.g. hot-water, storage heaters, heat-pumps, EV chargers). Pre-2020, suppliers are therefore the actors who seem to have both the greatest commercial incentive - as well as the communications and technical controls most readily at their disposal - to be best-placed to deliver household demand-side peak-avoidance actions to produce cost-savings in the wholesale and capacity markets.

This is not to say that there is no place for other actors to engage households in demand-side activity in the wholesale markets - or in other parts of the electricity market. Aggregators, distribution networks, local authorities and other third parties clearly have a role – and we have looked at this in detail in our earlier papers. **But, clearer acknowledgement of this pivotal supplier-role in taking the lead in early-development of a GB household demand-side in the period to 2020 may bring some helpful clarity to regulatory and policy thinking around likely future routes to market for household DSR.**

Suppliers also need to cooperate actively with other actors to facilitate the demand-side in the Distribution DSR markets, and perhaps also for the Balancing markets : not least because of suppliers' lead via the smart metering arrangements and auxiliary load control switches in having a capability to switch their customers' load.

So, in working up their DSR Framework, Ofgem will particularly wish to consider the nature of suppliers' commercial and technical interactions with other market actors for household DSR. Ofgem will wish to consider how to ensure fair market access, via the DCC, smart meter arrangements, auxiliary load control switches and CADs (consumer access devices), for other actors who may wish to deliver household DSR with a view to creating electricity system cost savings (networks, system operator), or for third parties who may wish to facilitate household DSR on behalf of other actors (aggregators, others).

1.7 Local energy & demand-side

Present impetus, momentum and individual commitment to making the demand-side work, including the household demand-side, lies substantially at the community and local level.

However, local network-level household DSR may not necessarily be where most *overall* value lies in today's electricity system, although beyond the early 2020's this may start to change in a more smart grid world.

As noted, potential distribution network cost-saving / value available today from household DSR is likely to be very location specific : driven by specific constraints (or, by faults) on the lower voltage networks. These constraints may be rural, or, equally, city-centre. Development of low cost storage, including at a household level, will be central to unlocking the local demand-side.

Today, community-level energy schemes which incorporate DSR and / or storage are important test-beds, able to show-case how to make demand-side schemes work commercially and institutionally in reality, both for market actors and for customers. Current stimulus and innovation funding from government and others with a focus on local community energy schemes therefore makes a good deal of policy sense. However, the ability to successfully replicate community energy and demand-side schemes beyond trials and pilots will also require DECC and Ofgem to tackle in a systematic way some of the key administrative silos and the detail of distribution charging approaches, which we identified in paper 10 [6].

6 i.e to address : present silos between FIT administration & retail supply arrangements to enable suppliers to align their commercial incentives to create tariffs for 'prosumers' ; silos on data-sharing arrangements - to enable market actors to identify local demand-side solutions ; tying household FIT for PV to requirements for low-cost storage (thermal, battery); distribution charge reform (connection charges for PV <3.6 kW ; possible capacity charges for load ; better communication to communities about network 'hotspots' which might benefit from demand-side actions.

1.8 Household demand-side priorities from now to 2020

Our assessment of household participation in the GB electricity markets leads us to conclude that it will be important to identify a number of clear *electricity-focused* priorities from now to 2020, designed to deliver seven basic goals as follows :

- **Critical to affordability, a concerted drive to support those GB customers already dependent today on electricity for their main heating & hot-water.** These customers have the highest annual electricity bills & pick up a disproportionate share of the levies. Some of these customers may also live in poorly insulated homes, rented homes, be on lower incomes and / or be vulnerable. Thermal insulation measures should be targeted at electrically heated homes. Where desirable & feasible, encouragement for : on peak-electric heat to be replaced with off-peak ; and, old inefficient electric hot-water heaters and storage heaters replaced.

- **Encouragement of 'early days' development of a voluntary GB household demand-side** - in tandem with smart meters - through supplier development of customer-friendly voluntary basic ToU offers.

- **Encouragement of a supply-chain and early development of a market in automatable, controllable load** – with a focus on giving customers the heating systems they may want / prefer.

- **Bring together in a far more coherent and concerted way than now those policies, measures and incentives which already exist - for electricity efficiency, thermal insulation and the household demand-side – so that the 'whole' becomes greater than the sum of its parts**.

- **Consideration of whether some present industry cost-allocations** (network charges, levies) **could be better 'shaped' than now** to encourage retail tariffs which are still clear, fair and simple – but which at the same time may also help to encourage household peak-avoidance.

- **Continued government, regulatory and market actor support for local energy schemes as an important show-case and test-bed** for the household demand-side.

- **Concerted push on electricity demand reduction through EU product policy.**

We therefore suggest that pre-2020 the following specific measures should be seen as a priority to support development of these goals.

Electricity demand reduction priorities for households pre-2020 – a concerted government and manufacturer drive on : household lighting efficiency schemes (CFLs (compact fluorescent), LED) ; replacement of older less efficient fridges and freezers.

Electricity demand-side priorities for households pre-2020

- **Basic static ToU tariffs** - suppliers to be encouraged to test household appetite with offers of voluntary ToU tariffs to interested customers. Ofgem to stress that RMR does not prevent this.

- **0.5 m 'on-peak' electrically heated customers :** improve their thermal insulation. If desired, feasible and practical, to consider whether 'off-peak' electric heat (hot water, storage heaters, heat pumps) might offer a more economical alternative.

- **Smarten existing Econ 7 customers** – some of these customers are anyway likely to be offered early smart meters (with integrated auxiliary load control switches) due to retirement of the radio-teleswitch. There is a need to understand more about the demographic of the ~3+ million Economy 7 customers today. This could pave the way for suppliers to develop appropriate offers for these customers for better home-insulation and, *where appropriate*, possible renewal of their hot-water tanks & storage heaters (ECO) – **brought together with developing attractive offers to participate in DSR schemes** (off-peak schemes, Balancing).

- **Smaller new-build homes** (flats) – developers (incl social landlords, but not just) to be far more actively encouraged to consider **off-peak heat & hot water options** together with good thermal insulation (instead of predominance of 'on-peak' electric heat, as now).

- **Househhold PV – FIT subsidy** : to explore the feasibility of making household FIT eligibility for PV conditional on installing measures for self-balancing at the household level such as immersion-heater divert switches and / or other low-cost storage (thermal heat, battery).

- **Development of new markets for 'smarter' off-peak hot-water, storage heaters, and heat-pumps** – development by suppliers and third parties (including appliance manufacturers) of 'appliance-led' customer offers for hot-water & electric-heat **combined with DSR propositions**. **Any such developments would need to be <u>appropriately marketed</u>** (see Part II) **& coupled with high levels of thermal insulation**.

- **Explore possible pros and cons of adopting a <u>combined</u> peak / capacity-based (kW) approach to household retail tariffs <u>coupled with</u> energy-charges (p/kWh).** In the longer term, such an approach may produce a better alignment of the growing fixed-cost element of retail customers bills with incentivising peak-avoidance (including critical peaks).

- **RHI, Green Deal, ECO etc** – consider how far these schemes already deliver on measures for increased electricity efficiency *in the round*, especially for low-income or vulnerable customers who are high electricity users. For low-income and vulnerable customers, consider how to extend existing incentives in such a way as to **bring together electricity efficiency schemes with incentives to fund the upfront costs associated with automated household DSR.**

Chapter 2. Household load : key characteristics

2.1 Introduction

In Paper 12 we focus on household load for two reasons :

- In Paper 11[7] we concluded that for the I&C sectors, both electricity demand reduction and electricity demand-side response are to some degree now 'taking off'. On the household side however : electricity demand reduction still lacks similar policy attention ; and, importantly, beyond the start of the smart meter roll-out, there has been little detailed thought about how the GB household electricity demand-side might develop in practice.

- Household load represents a disproportionate part of daily GB peak load – perhaps as much as one-half of daily evening peak albeit only around one-third of total annual electricity demand [8] . This means that successful peak-avoidance by households - whether by demand reduction or by load-shifting load – could help to support electricity system reliability, overall electricity system cost-efficiency (peak-related costs (short-run operational costs, long-run capital costs), and carbon reduction (where higher-carbon plant is operating at the margin). Most important, in a more cost-reflective world, peak household demand reduction and / or load-shifting could potentially help - at an individual customer-level - to support affordability.

2.2 What do we know about GB household load ?

There are ~27 million small & household GB electricity customers[9].

Annual household electricity consumption was ~115 TWh in 2012[10] – ~one-third of total annual consumption for all sectors of the economy. Since 2010, average annual household electricity consumption has reduced by ~5%[11], with a slight pick-up in 2012-13.

Average annual household electricity consumption is estimated at 3,800 kWh p.a, split fairly evenly between the six-months of summer and winter (~ 2,000 kWh is consumed from

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[7] Frontier Economics & Sustainability First. Paper 11 : 'How could electricity demand-side innovation serve customers in the longer term ?'

[8] Ofgem. DSR Discussion Paper 2010. Appendix 2 - & Sustainability First Paper 1.

[9] https://www.ofgem.gov.uk/ofgem-publications/89052/smimethodologyjuly2014.pdf

Assume : ~22 million Load Profile 1customers ; ~ 5 million Load Profile 2 (off-peak) customers. (Plus a further 2 million SME customers in Load Profiles 3 & 4).

[10] DECC. Energy Consumption in the UK . Chapter 3. Domestic Energy Consumption in the UK. (July 2013). UK annual household gas consumption is around 3-times more (339 TWh in 2012) - also on a declining trend.

[11] Ofgem. Supply Market Indicator. September 2013.

October – March (not Econ 7)). Electricity consumption is relatively non-dependent upon outdoor temperature (unlike gas) [12] [13].

Consumption of Economy 7 customers is on average ~5-6,000 kWh p.a., due to use of electric storage heating & electrically heated hot water[14] .

CSE recently updated an earlier study for Ofgem, 'Beyond Average Consumption', designed as a framework to help assess impacts of policy proposals on different customer groups. From their detailed modelling, CSE has identified twelve customer 'archetypes' to improve understanding of GB domestic gas and electricity consumption and the characteristics that drive variation in household usage[15]. This is a helpful tool to better inform and target policy and measures – including, potentially, for the household electricity demand-side.

Two household types identified by CSE are likely to be key customer-groups for targeting future initiatives on the electricity demand-side (both for reduction & demand response) :

- **Low Income Electrically Heated. Archetype 1** - 4% of GB households (881,000) are on low-income and heat with electricity. Typically single adults, retired or not working, in urban areas (esp south-east, south-west & Scotland). One third on pre-pay. Mean consumption : 5,130 kWh.

- **All Other Electrically Heated Households. Archetype 2** – 7% of GB households (1.69 m) are on middle-ranging incomes, couples (one-fifth w children), 25% below 35 years, just over half are owner-occupiers & one-quarter private-rented. Two or fewer bedrooms. Mean consumption 7,674 kWh (so the largest consumers by around 2,000 kWh p.a.).

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[12] Seasonal variations in electricity demand. DECC. Energy Trends. Special feature. March 2014.

Across all types of customer (I&C, household) 54% of annual electricity is consumed in the winter months (October to March) – and 46% consumed in the summer months (April – September). Electricity demand is typically 36 % higher on a winter's day than on a summer's day, with higher demand in each 48 half-hour periods in winter. Overnight, there is relatively little commercial or household demand.

[13] EU comparisons : Scandinavia : 15,000 kWh p.a.. Southern Europe - nearer 2,000 kWh p.a. [EU Task Force Smart Grids (EG3) draft 2 April 2014 – Annex].

[14] Possibly around 2-3 million customers.

[15] CSE (Centre for Sustainable Energy). Report for Ofgem 'Beyond Average Consumption'. Beyond average consumption. Development of a framework for assessing impact of policy proposals on different consumer groups. Updated report to Ofgem. March 2014.

http://www.cse.org.uk/downloads/file/beyond_average_consumption_update_2014.pdf

Brattle Group has developed an electricity end-use model for the GB Electricity Demand project[16] , which has informed Sustainability First thinking on the technical potential for flexibility.

A further welcome and recent source of empirically-based data about patterns of UK household electricity-use is a series of eleven papers for DECC & DEFRA which analyse in more detail the 2010-11 HEUS data (Household Electricity Usage Study)[17]. Some headline findings from the summary paper, material to discussion in later sections of this paper about how households may in due course participate in the GB electricity markets, are as follows :

- **Appliance size** : appliance efficiency is improving – but appliances are getting bigger.
- **Wet appliances** : 80% of washing cycles are already at low temperature (<40°C) – but the gain is somewhat offset by more frequent washes (especially by 'younger' households with newer appliances).
- **White goods** : appliance replacement and / or scrappage of white goods could save over one-fifth of the power which these appliances presently use (especially tumble-driers, but also cold appliances, washing machines & dish-washers). The *average* age of a fridge-freezer is 8.4 years
- **Lighting** : replacing old incandescent & halogen bulbs with low energy bulbs (CfLs, LEDs) could potentially save each household 230 kWh p.a. (say, £35 saving p.a – or a reduction of ~6% of annual average household load)[18]
- **Peak Load** : household peak occurs from 18.00h to 19.00h – at 720 watts per home on average. In cold weather, peak household load averages 1 kW.
- Some scope for load-shifting exists (wet appliances made up 9% of peak-load). But, steps to *increase the efficiency of other appliances* (fridge / freezers, efficient lighting, tumble driers) – *would make a bigger difference to reducing GB peak load*.
- Low-use households tend to be single people living in small dwellings and often retired. High-use households were in a higher socio-economic group, larger homes with three or more people, middle-aged, not working but not retired.[19]

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[16] Sustainability First. Paper 2. **'GB Electricity Demand 2010 & 2025 – Initial Brattle Demand Side Model : scope for demand reduction and flexible response'**.

Sustainability First. Paper 9. **'GB Electricity Demand – 2012 & 2025. Impacts of demand reduction and demand shifting on wholesale prices and carbon emissions. Results of updated Brattle modelling**'.

[17] Powering the Nation 2 : Electricity Use in Homes, and how to reduce it. A series of eleven papers produced for DECC & DEFRA, by Cambridge Architectural Research Ltd, Loughborough University, Element Energy & Cambridge Energy. April-June 2014.

[18] Based on an assumption of installation of low energy lights from 30% now - to 80% by 2024, in line with Market Transformation Programme projections. Average annual household load – 3,800 kWh.

[19] Some caution needed on data in original study : small sample, mainly owner-occupiers & poor seasonal data.

Two additional observations on household peak shifting, which follow from the HEUS analysis :

- DECC electricity models *over-estimate* electricity-use by appliances by one-third & lighting by one-quarter (so, household load which technically may be shiftable or reducible is probably over-estimated in the models). Electricity use for cooking is *under-estimated* by one-third. Cooking presumably offers little potential to shift, given that some household peak-time electricity uses are more readily flexible than others[20].

- Given that the household peak would seem to (1) start later and (2) extend later into the evening than the national system peak (national : 16.30 – 18.00h ; household (say) 17.00h – 19.00h, this lack of peak 'coincidence' should start to inform market actor approaches to household DSR.

2.3 Possible future trends in GB household electricity demand growth.

Across their Future Energy Scenarios analysis, National Grid see annual residential power demand remaining relatively static and / or reducing until around 2020 (mainly due to lighting efficiency). Beyond this, under their four scenarios, the trend in annual electricity demand growth to 2030 is likely to be strongly dependent upon how far & how fast heat and transport electrify : the highest annual-growth rates for residential load being in the two greenest scenarios[21]. National Grid's analysis of the possible rate of growth of peak power demand for GB, from today's weather corrected system peak of around 55 GW, suggests a similar trend.

[20] Customer Led Network Revolution. LO-52. Social Science Report. Durham University. April 2014.

[21] UK Future Energy Scenarios. National Grid. July 2014. Section 4.1.1

Chapter 3. Household Electricity Demand Reduction : a central role

Household electricity demand reduction remains absolutely central to driving affordability for individual households : the efficiency of the electricity system in general, carbon reduction and to support electricity market reliability.

Key policies for delivery of household electricity efficiency and electricity demand reduction are a combination of :

- 2009 EU Framework Directive for the Eco-Design of Energy Related Products, Products Policy
- Support via the RHI, Green Deal & ECO for renewable heat and electricity efficient technologies & measures
- The Electricity Demand Reduction pilot via the Capacity Mechanism

3.1 Eco-Design Framework Directive - Implementation

The 2009 EU Framework Directive for the Eco-Design of Energy Related Products, Products Policy : includes legally binding EU minimum standards which raise the minimum level of efficiency of energy-using products available on the market. DECC notes that households & businesses effectively comply with these standards when they purchase products sold within the EU. For some products, the Energy-Labelling Directive also applies, and is expected to encourage consumers towards purchase of more efficient appliances.

The government attributes around one-half of the total estimated cost-savings from 'policy & measures' in future electricity bills to electricity demand reduction as a result of EU product policy and regulation (£167 less p.a. *per customer* by 2020). But, if these EU measures are not driven forward and implemented in the timescales expected - and/or if appliance stock turn-over is slower than estimated - the major upward cost pressures on household electricity bills will remain (including from levies), but may not be 'offset' by the electricity efficiency savings as presently calculated by DECC. This could have substantial implications for electricity affordability, & also for capacity & carbon.

Some EU 'implementing measures' (minimum standards & energy labels) have already been agreed and cover certain products used by both business & households : lighting, TVs, washing machines, dishwashers. There is also a 'second tranche' of measures – but the likely efficiency impacts are more uncertain because the exact shape, timing & stringency of these measures has yet to be finalised[22]. Impact assessments for the following household measures have been :

[22] DECC. Estimated impacts of energy & climate change policies on energy prices & bills. March 2013. p. 71

- Agreed : fans, tumble-driers, directional lighting, LEDS, air-conditioning, pumps.
- Await EU vote : boilers, water-heaters, computers, vacuum cleaners.

Others have yet to be produced

The rate of delivery of electricity demand reduction from product policy, depends not only on the implementation of measures by the EU and member states, but also, just as critically, upon the rate of customer appliance purchase and replacement. Analysis for the HEUS study[23] indicated the following estimated life-spans for key household appliances.

Appliance type	Mean appliance age (years)	Estimated lifespan (years)
Washing machine	5.7	11
Tumble dryer	6.7	13
Refrigerator	6.8	14
Freezer	6.8	14
Fridge-Freezer	8.4	17
Dishwasher	5.5	11
Microwave	6.2	12

If these estimated appliance life-spans are indeed a robust indicator of the likely national rate of appliance stock turnover, then it would seem that serious consideration should be given to scrappage & appliance replacement schemes as a way to reduce GB household electricity demand. This seems especially so for cold appliances which seem to have particularly long lives – and which would bring the added benefit of also reducing peak-load.

In Annex 4, Table 12, we show how around one-half of the total expected electricity bill benefit from all energy & climate policy measures to 2020 is attributed to EU product efficiency standards. **Product regulation and product efficiency would therefore seem to need far greater policy prominence and drive, given that this is one of the key planks identified by government for electricity saving and affordability** [24].

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[23] Powering the Nation 2 : Electricity Use in Homes, and how to reduce it. A series of eleven papers produced for DECC & DEFRA, by Cambridge Architectural Research Ltd, Loughborough University, Element Energy & Cambridge Energy. April-June 2014.

[24] Annex 4. Table 12 – shows how the government cost-calculations of electricity bill cost-savings to 2020 indicate that **~53% of the total expected electricity bill benefit from all measures to 2020 is attributed to EU product efficiency standards** (i.e. a £167 saving of a total £310 estimated benefit ; and around 65% of the expected bill saving from 2020 to 2030 (a £137 p.a. saving of a total expected estimated saving of £211 in 2030).

http://www.telegraph.co.uk/finance/personalfinance/consumertips/household-bills/10796946/Energy-bills-to-rise-twice-as-fast-as-expected-due-to-inefficient-products.html

3.2 RHI, Green Deal & ECO : electricity related measures supported under current mechanisms

Among the current low-carbon and efficiency support mechanisms (RHI, Green Deal, & ECO), a variety of electricity-related measures are supported.

Inter al, these schemes support electricity-specific measures for renewable electric heat and / or greater electricity efficiency - & we list these in Annex 5.

Looking ahead, consideration is needed as to what *further* measures might - in due course - be considered for possible future support to enable certain domestic electrical appliances & installations to be 'smartened' (for example, Green Deal eligibility for, say, auxiliary load control switches and / or smart communication systems (for remote switching of heat pumps, storage heaters, hot water cylinders), or for 'smart' electrical appliances (in particular storage heaters, hot-water cylinders and heat-pumps).

Taken together with the smart meter roll-out, one possible goal may be for future electricity-related support-mechanisms to start to factor in 'smart efficiency'. The aim would be to begin to *bring together in a systematic way* measures which can help to develop *smarter approaches to* household electricity demand-side reduction & management, electricity demand-response and electricity & energy efficiency. **Such combined 'smart efficiency' approaches will become increasingly important for all-electric households, and in particular for the vulnerable and those on low incomes.**

3.3 Electricity Demand Reduction via Capacity Mechanism Pilot

See Annex 1, Table 1 for a detailed description of the Electricity Demand Reduction Pilot in the Capacity Mechanism.

Capacity savings need to be 'demonstrably relevant to the peak period for electricity demand': 16.00h – 20.00h each winter weekday (November to February).

Given that households generally have proportionately 'peakier' load than other sectors, the EDR scheme should, in principle at least, be supportive of household demand reduction measures.

Households are not ruled out from scheme, but are also not necessarily the initial focus.

This may in part result from : the scheme requirements for 'additionality' - which rules out measures already covered by support schemes such as the Green Deal, ECO and RHI ; a need to focus on more costly measures (given a 2-year plus payback rule) ; and, the need for measures such as lighting to receive financial support only for the peak-related element of the saving.

3.4 Electricity demand reduction priorities

The HEUS analysis[25] points to two particular household appliance types which would bring *both* demand reduction *plus* avoided-peak benefits.

Indeed, according to the HEUS study, more electricity could be saved *at peak* by these kinds of step than by the alternative of load-shifting.

- **Energy efficient household lighting schemes :** a concerted push is needed on efficient household lighting schemes - especially given relatively poor up-take so far of energy efficient lighting, against the potentially significant benefit identified[26] . Lighting efficiency schemes do not at present seem to be 'eligible measures' under the Green Deal or the ECO. Moreover, only the 'peak-saving' element would qualify under the EDR auction rules ; and, the 2-year payback requirements may conceivably rule-out certain basic household lighting efficiency schemes from the EDR pilot.

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[25] Powering the Nation 2 : Electricity Use in Homes, and how to reduce it. A series of eleven papers produced for DECC & DEFRA, by Cambridge Architectural Research Ltd, Loughborough University, Element Energy & Cambridge Energy. April-June 2014.

[26] up to a 6 % saving per household on an average annual bill with an 80% installation rate against a 30% rate today

- **Cold appliance scrappage :** given the 100% household ownership of cold appliances ; the potential 20 % efficiency-gain of new appliances ; and the likely slow stock-turnover (14-17 years for many fridges & freezers), some active promotion and carefully targeted financial support for refrigerator scrappage would seem highly beneficial - both for overall electricity demand reduction and for reduction at peak.

Each of these measures could make a real difference to overall electricity demand reduction among GB households and with minimum inconvenience to them. Importantly, these measures would also reduce peak load. They could be supported under the EDR Pilot in the capacity mechanism, under mechanisms such as the Green Deal and the ECO, or indeed by market actors (for example, DNOs who seek peak-reductions at network 'hot-spots').

Chapter 4. Technical Conditions for Household DSR

Creating the *technical* 'enabling conditions' for household DSR has been a strong focus of GB smart meter policy, driven by a wish to obtain additional and longer-term benefits from GB's mandated smart meter investment. Technical considerations for DSR have also been one part of the focus of Ofgem's Smarter Markets Programme.

As a result of this GB policy push and the associated measures, in both the near-to-medium-term - & beyond 2020 - DSR participation by households in GB electricity markets should become *technically feasible* – at least to some extent. This does not necessarily mean that the *commercial* arrangements are established. Nor that there is presently a market actor business case for household DSR. We discuss these issues below in section 5.

4.1 Technical 'enablers' of household DSR

There seem to be five main 'technical enablers' of note for future household DSR :

- **Smart meters** (SMETS 1 & 2) **with two way communications into the home** are a key DSR enabler. Inter al, GB smart meters are designed to allow the following tools for DSR [27] :

  Consumption recorded in half-hourly blocks (48 registers per meter).

  - Tariffs : Time-of-use (ToU) ; Block. Rising or falling. (Up to 32 registers : potentially up to 4 blocks, in 8 different time bands).
  - Load limiting : capability to : switch off ; or, to count number of times a pre-set threshold 'crossed'.
  - Maximum demand registers (records highest demand in *any* half-hour ; *plus* records maximum demand in any pre-configured peak period – e.g. winter evening). (SMETS 2 only – DNO can read as well).
  - Randomisation (for staggered load-switching – *including for* non-automated ToU tariffs).
  - Export register (single register).

27 DECC slides to Ofgem Smart Grid Forum. Workstream 6. 18 March 2014. Ofgem website.

https://www.ofgem.gov.uk/ofgem-publications/87092/deccsmartmeteringslide.pdf

- **Scope to automate control of load and home appliances** – either via arrangements for Auxiliary Load Control Switches & / or CADS (consumer access devices) – discussed at length in Sustainability First Paper [1128].

- **Data access (with customer consent) : access for both suppliers and third-parties to both price-information plus consumption data via the smart meter arrangements.** Via CADS, consumption data will also be available at up to ten-second resolution.

- **Supplier billing capability –** a supplier needs compatible billing software for any of the tariffs they might offer their customers (ToU, Critical Peak etc), so that a customer bill can be constructed from multiple meter registers.

- **Half-hourly settlement** – (Strictly speaking a commercial step – but assumed here to be an IT-enabled project). Ofgem April 2014 document[29] indicates that Ofgem's long-term thinking is to expose suppliers to the *actual* costs in every half-hour of both purchasing and transporting energy for their customers. This will be instead of the half-hourly estimated 'profiled' consumption basis for every half-hourly settlement period, as now. Universal half-hourly settlement would open the door to reform of the present 'back-office' arrangements - by which half-hourly industry costs are allocated to each supplier on an estimated basis in every half-hour (for imbalance, balancing, transmission, and distribution) – and thereafter recovered from suppliers. In effect, recovery of the industry's 'upstream' costs from suppliers could move away from being an estimated *average* for every LP 1-4 customer in every half hour[30] to being attributed accurately to each customer's actual use in every half-hour[31.] **Such reform does not automatically mean that suppliers would directly expose their customers to these more accurately-based half-hourly cross-industry charges.** But, one benefit of half-hourly settlement could be to enable suppliers to **offer either 'more complex' ToU tariffs and / or dynamic automated price-led tariffs, to their customers**. In turn, this may allow suppliers to unlock more value of DSR, and so pass greater cost-savings to those individual participating customers.

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28 Sustainability First & Frontier Economics. 'How could electricity demand-side innovation serve the electricity customer in the longer term?'. April 2014.

29 Ofgem. Electricity settlement reform – moving to half-hourly settlement. April 2014.

30 ~29 million customers.

31 LP 5-8 customers (160,000) will move to half-hourly settlement in 2016, following Ofgem's recent determination of BSC modification P272.

4.2 What household DSR might these 'technical' steps enable by when ?

The steps noted in 4.1 above – either separately or eventually in combination – potentially seem *technically* to enable household DSR developments over the following time-scales as follows.

From today onwards :

- **Time-related or capacity-related DSR tariffs** : in principle, if commercially attractive to a supplier, with a SMETS 1 or 2 meter, a supplier could offer a customer basic static ToU tariffs and also other DSR tariffs or services noted under Smart Meters at 4.1 above *today* - **provided these can be settled to the supplier's satisfaction within an adjusted Load Profile 1**[32].

- **Automated control** : via meters with integrated switches[33] for existing Economy 7 / 10 customers ; via auxiliary load-control switches (relays) installed for specific appliances after a smart meter has been installed – controlled by supplier instigated 'critical commands' ; for control of appliances via CADS by third parties – in principle, this could include any DSR service which needs consumption data at *less than 10-second resolution* for DSR validation purposes [34.] (So, in principle, this could potentially include some Balancing services e.g. fast response provided the system operator was content with the basis by which those services were validated).

Following half-hourly settlement : (assume from ~2020 onwards) :

- **Complex dynamic and / or price-led tariffs** – probably linked to automated DSR (but could be non-automated).

In discussion about this paper, one persistent question was how far full half-hourly settlement might be a pre-requisite - or not - for suppliers to crystallise any value that they might derive in either the wholesale or capacity markets by offering *dynamic* tariffs (or price-led tariffs) to households.

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32 It is feasible for a supplier to make an adjustment within the present LP1 settlement arrangements, to allow them to settle against a load-curve which *varies* from the standard distribution (SSC) of the Load Profile 1. Sustainability First. Paper 7. '**Evolution of commercial arrangements for more active customer and consumer involvement in the electricity demand-side**'. P. 58

For a more detailed discussion of the potential to adjust the Standard Settlement Configuration, see also :

Elexon Paper. Settlement of Dynamically Switched Meters. PSRG Consultation. PSRG 31/01. 2 June 2014.

33 HCALCS – Home Area Network-Connected Auxiliary Load Control Switches

34 See Sustainability First Paper 11 **'How could electricity demand-side innovation serve customers in the longer-term?'** for a detailed description of future arrangements for home automation.

On the basis of a recent Elexon consultation on dynamically switched tariffs[35] (and following a bilateral conversation with Elexon), our initial conclusion is that the meter registers in SMETS 1 & 2 meters allow considerable variation in the kinds of DSR actions which can be metered / recorded - **and then settled via an adjustment to the Standard Settlement Configuration in Load Profile 1**. This suggests that some relatively straight-forward dynamic tariffs *could* in principle be offered without full half-hourly settlement. For example, a basic household critical-peak tariff with limited 'calls' each winter. Similarly, by use of specified registers in the meter (e.g. up to eight half-hour registers 16.00h – 20.00h November to February), it may also be feasible to demonstrate firm household demand reduction for purposes of the capacity market - even where that response was called on a dynamic basis - and potentially to settle via an adjustment to Load Profile 1[36].

In discussion, the general view was that the more complex and the more dynamic the household tariff being offered (for example dynamic price-led 'wind-matching'), then the more likely it was that individual half-hourly settlement would be needed in order for suppliers to crystallise the benefit in the market from the DSR response, especially where such tariffs were on offer at scale. Half-hourly settlement could either be universal, or, in principle at least, only for particular customers at a supplier's request. Possible costs of this latter approach however, may currently make this a less attractive proposition from a supplier & customer viewpoint.

The question of how far full half-hourly settlement might be a pre-requisite - or not - for suppliers to crystallise any DSR value in either the wholesale or capacity markets by offering *dynamic* tariffs to households is an important area which will benefit from clarification by Ofgem, Elexon and suppliers. Not least, the supply chain and consumer bodies will wish to understand more clearly about the time-frames in which, realistically, the markets for certain kinds of dynamic household DSR actions might develop.

4.3 Technical Conditions for Household DSR - Conclusion

Due to forward-thinking by DECC & Ofgem, many *technical* conditions for eventual household participation in the GB electricity markets are in development. To some extent this thinking reflects an expectation for household DSR participation in the GB electricity markets. However, as noted in Paper 11, there is still a lack of a rounded 'forward view' on household demand-side participation beyond the start of the smart meter roll-out, though Ofgem's Smarter Markets Programme & SGF WS6 are starting to map-out a better forward view.

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35 Elexon Paper. Settlement of Dynamically Switched Meters. PSRG Consultation. PSRG 31/01. 2 June 2014.

36 Dynamic DSR actions for a stress event in the capacity market could in principle be enabled via auxiliary load control switches and / or the load-limiting capability and / or measured via the maximum demand registers – and communicated either via the DCC or by broadband communications.

Chapter 5. Commercial Conditions for Household DSR

By contrast to the technical conditions for household DSR, the commercial conditions are substantially less developed.

5.1 How far can households participate in GB electricity demand-side markets ?

Scope for household participation in the GB electricity demand-side markets is summarised in the chart overleaf.

In practice, households could participate today in the wholesale markets. In principle, household load could also be aggregated today to participate in certain activity in the Balancing markets. Household customers have also directly participated in distribution network DSR trials.

In Annex 1, Tables 2-8 look in turn at each of the main GB electricity markets where the household demand-side could, in principle, participate : Wholesale markets ; Demand-Side Balancing Reserve (DSBR) : Capacity Market ; Balancing ; Avoided Transmission (TRIADs) ; Distribution Constraint Management ; Distribution Emergency Support. The aim is to consider, at a very high level, for each part of the electricity market, on what basis households might at some point participate.

On the basis of this detailed examination in Annex 1, on the next page there is a **summary Table to illustrate how far each market may be open to households pre-2020 and post-2020.**

Working assumption on settlement : as noted in section 4.2 above, our working assumption is that half-hourly settlement would facilitate more complex dynamic services (and tariffs). Nevertheless, basic household DSR services, *including some limited dynamic services* (e.g. a limited household critical peak service) could in practice be metered, recorded, validated and settled in the market with a SMETS 1 or 2 meter *plus* an appropriate settlement adjustment to current Load Profile 1.

Table 1. Summary Table. GB electricity demand-side markets and possible household participation. Pre & Post 2020.

Source: Sustainability First.

Principal actor	Market Schemes	Demand-side activity	Open to household participation ? **Aggregaton** : may be needed. **Settlement** : basic static ToU tariffs & *simple* dynamic tariffs will need a settlement adjustment to Load Profile 1. Dynamic & complex tariffs will need half-hourly settlement (or more frequent interval for Balancing).	
			Pre-2020 ?	**Post-2020 ?**
Suppliers	Wholesale markets	Offer flexibility services – day-in-day-out peak-avoidance : critical-peak avoidance ; time-varying & price-driven DSR (turn-down, turn-up services).	Yes – Economy 7/10 ; other ToU trials & tariffs. Simple critical peak	Yes
System operator	Balancing : Frequency Control & Reserve Services	Fast, responsive services for Balancing	Yes	Yes
	Demand-Side Balancing Reserve (DSBR)	Critical peak avoidance	No (I&C only)	See capacity market
Transmission network	TRIAD critical peak-avoidance to avoid TNUOS charges	Critical peak avoidance	Half-hourly I&C customers only. Households : not yet – but feasible.	No reason why not. More likely w individual half-hourly settlement.
Distribution networks	Load management for constraint management (deferred/ avoided network reinforcement) and for improved fault management	Low Carbon Network Fund innovation trials. Bi-lateral peak avoidance agreements. Distribution Use of System (DUOS) time/price banding for low voltage (being discussed).	Potentially in ED1 – but depends local circumstance	More likely in ED2
Capacity Market **(Market for capacity adequacy in stress conditions. Administered by System Operator)**	**Electricity demand reduction pilot** (administered by DECC).	Permanent demand reduction to reduce the need for peak capacity	Aimed at I&C – but h/hlds not ruled out.	Yes
	Demand-side response in the capacity market	Ensuring sufficient capacity to meet forecast future demand.	Initially no – but not inconceivable once smart meters & ALCS. Not ruled out	Yes. More likely w settlement.

5.2 Initial discussion of possible DSR value issues

Individual household demand-side actions need to deliver sufficient benefit to make the transaction worthwhile, both for the market actor(s) and for the individual household – and also, ultimately, for customers in general.

Some DSR activities may potentially offer a higher value in one or other sectors of the electricity market (for example if they are 'firm' by being automated), but this may also entail upfront investment above and beyond a smart meter (e.g. control equipment, IT, communications, smart appliances) [37]. In these cases, market actors are very likely to want to identify a clear and predictable cost-saving (or revenue stream) from DSR actions, so as to cover the costs of set-up plus any transaction and on-going operational costs.

Early on in the project, we took an initial look at where potential value might sit from the cost-savings from customers who provide demand-side services, including households, to the GB electricity markets. The picture we put together at the time was inevitably patchy, but we concluded that, in principle at least, the greatest long-run overall value from cost-savings from DSR, including from households, was likely to lie in savings in the wholesale markets[38.] Not least, due to two factors: wholesale costs represent ~40-50% of the end bill[39] : and also that GB household load is disproportionately 'peaky' (~one-third of total annual consumption, but ~ half of annual peak hours [40)].

In considering the potential cost-savings which household demand-side actions could offer to different parts of the electricity market, it is perhaps also worth making a basic distinction between :

- Those parts of the GB electricity markets where the greatest *overall* value / benefit[41] may sit from demand-side cost-savings – and -
- Those parts of the market where DSR providers (including households), may be able to realise 'pockets' of available value (either for £/kW or £/kWh saved) (e.g. frequency, fast reserve, capacity, avoided distribution investment) - and share that

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37 See SF Papers 8 & 11.

38 Sustainability First. Paper 4. 'What demand-side services can provide value to the electricity sector'. April 2012.

39 See Annex 4. Table 1. 37% of the end bill in 2012 real money.

40 Sustainability First. Paper 1 : 'GB Electricity Demand – context and 2010 baseline data'.

& Ofgem. Demand Side Response. A Discussion paper. Appendix 2. Table A2.1. p.50 July 2010.

https://www.ofgem.gov.uk/ofgem-publications/57026/dsr-150710.pdf- & Sustainability First Paper 1.

41 i.e. on a resource-cost basis.

value with individual customers. The overall cost-savings *to the market & to consumers in general* may be however less than in the wholesale markets – but offer greater value to the individual DSR customer than DSR actions in the wholesale markets.

Elexon recently asked Frontier Economics to consider cross-party impacts and DSR values in the GB electricity markets[42.] Based on this and other available information we have pulled together for Annex 3, our working assumption is as follows[43.]

Working assumption
Presently, the end-electricity bill is made up as follows[44] :

- Wholesale energy costs - 37% ;
- Network costs – ~23 % of which ~4% is transmission and ~1% is Balancing
- Supplier costs margin - ~21% ;
- Energy & climate policies – 14% (includes EU ETS & CPF);
- VAT – 5%

In line with our Papers 4 and 9, and in light of the Frontier Economics analysis of DSR values, our basic working assumption here on potential demand-side cost-savings from household demand-side actions is that most *overall* DSR value – including the DSR value which households could contribute - is likely for the foreseeable future to sit within the wholesale energy markets.

42 Cross-party impacts of DSR actions. Frontier Economics. A report prepared for Elexon. May 2014.

43 DECC / Ofgem Smart Grid Forum. A sub-group of Work Stream 6 is also presently considering 'Distribution of DSR Value'.

44 See Annex 4. Table 11.

5.3 Initial discussion of possible *relative* DSR values in different parts of the electricity market

Based on Tables 2-8 in Annex 1 and our earlier Papers 4 & 9, we put forward some initial thinking here as a 'strawman' for discussion as to where relative DSR value may eventually lie for households in the GB electricity markets.

As noted, we start with a *working assumption* that pre-2020 :

- Most **overall value** from the demand-side sits in the wholesale markets (as against other parts of the electricity markets) - and that -
- This value has yet to be unlocked to any worthwhile degree - and that -
- **In practice, the wholesale markets are where most initial rapid progress could be made in developing household DSR, post-2016, once smart meters.** This assumes that suppliers may wish to develop a range of basic ToU household tariffs **for day-in-day-out peak-avoidance** to offer to household customers.

Wholesale markets - We assume that pre-2020, demand-side actions for day-in-day-out peak-avoidance in the wholesale markets should support the greatest *overall* share of electricity market cost-savings (affordability) plus some carbon savings. However, peak avoidance in the wholesale markets may presently offer only modest cost-savings to an individual household (other than those with on-peak electric heat). This in turn, may potentially make it somewhat challenging for suppliers to produce interesting customer offers.

Post-2020, more substantial savings could become available from household DSR – both from peak-avoidance and from more general flexibility by shifting load to other times, including into the night if windy, especially in summer. **If suppliers make a start with offering basic static ToU tariffs now, this could help pave the way for greater customer acceptance of household DSR for the future.**

Capacity markets – household DSR participation in the capacity markets will also help to realise affordability, carbon and reliability, but substantial household participation seems unlikely before 2020. Before this however, household peak-avoidance in the wholesale markets promoted via ToU tariffs offered by suppliers would very largely serve the same policy goal – and the capacity market supplier charge arrangements should encourage this. After 2020, with widespread smart meters and potential half-hourly settlement, there may be more realistic opportunity to engage households directly in the capacity markets via dynamic and automated responses.

Balancing markets : there is realisable demand-side value to be obtained in the Balancing markets today – in particular for I&C customers, but potentially for households too if they can provide fairly instantaneous flexibility through automated switching of their appliances (e.g. via hot water tanks, storage heaters). Such demand-side actions can support overall system cost-efficiency, affordability and carbon to some degree.

Relative to the overall cost-saving potential available in the wholesale markets from household peak-avoidance, the overall savings to the electricity system from household DSR in the Balancing market is small (balancing costs presently represent ~1% of the end-bill). However, the potential value available to share *with an individual participating customer* for a particular demand-side balancing service may well exceed the DSR cost-savings currently available to an individual customer via the wholesale markets.

Network DSR : Households are participating in distribution network trials for household DSR (deferred or avoided investment from peak-avoidance, supports low-carbon). In practice, cost-savings available from DSR schemes in the networks are very location-specific: dictated by specific constraints at particular places. Even at these network 'hotspots' there may be relatively little value to share with an individual household. This modest value proposition is prompting the distribution networks to look at how best to combine their own needs for peak-avoidance with similar DSR needs of other market actors[45]. Beyond the early 2020's in a more smart grid world, the potential DSR cost-savings picture for individual households may change, but will always be locational and peak-related.

As yet, households do not participate in TRIAD avoidance potentially to avoid transmission charges, but this could come with smart meters and especially once half-hourly settlement.

Annex 3 expands this initial discussion of possible relative DSR values potentially available to share with households in different parts of the electricity market.

45 Demand Side Response Shared Services Framework Concept Paper. ENA. April 2014 and DECC / Ofgem Smart Grid Forum Work Stream 6. Options Paper. April 2014.

5.4 Wholesale Markets, Network Costs, & Levies : how do these give price signals to encourage DSR from household customers ?

5.4.1 Signals from wholesale costs & prices

The GB wholesale markets are already characterised by 'base-load' prices and 'peak / flexibility' prices – Ofgem estimates the present split roughly to be 70 % to 30 % [46]. For the future, wholesale prices may increasingly tend towards short run marginal prices and not reflect the full long-run underlying costs of supply due to the subsidy arrangements put in place to support EMR & the capacity market[47]. Wholesale prices may be comparatively low for substantial periods at times of high-wind and / or non-peak demand periods[48] – 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.

This begs a question as to how best to reflect these two increasingly divergent price-characteristics of the wholesale markets to household customers (even if EMR & the capacity mechanism are designed to suppress extreme volatility in wholesale prices).

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46 Ofgem Supplier Market Indicators. March 2014.

47 Sustainability First. Paper 9. GB Electricity Demand – 2012 and 2025. Impacts of demand reduction and demand shifting on wholesale prices and carbon emissions. Results of updated Brattle modelling.

48 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.

5.4.2 Network Costs & Levies : lack of cost-reflection in the cross-industry charges paid by suppliers

Separate from the discussion above of wholesale market signals on suppliers for household DSR, a different and separate question arises for the future as to **how far suppliers might also become more directly exposed than now to the underlying variability of *other* industry costs (network costs, levies).**

Cross-industry charges are presently calculated and allocated in such a way that these charges are recoverable in full by suppliers from customers via a standardised average charge, on a per customer basis. Suppliers re-coup / pass-through these charges to customers unseen (p/kWh or a fixed sum). These standardised charges split between:

- **Network costs** (T&D) **& balancing** - currently ~23% of the end bill.
- **Levies** (i.e. for RO, FITs CfDs, Capacity & some social obligations) – 14 % of the end-bill today. Estimated by DECC to amount to 33% of the end electricity bill by 2020 ; 41% by 2030.

Standardised approaches to the allocation of supplier charges – in particular for the levies, but also for network costs – represent **a growing share of the end-bill**. By 2020, taken together, these charges will comprise **over one-half of the end-electricity bill ; and two-thirds of the end-bill by 2030**. Arguably, if one is looking to incentivise household DSR through greater cost-reflection, this will become a very significant portion of the end-bill simply to 'pass-through' in the first instance to suppliers - and thereafter by suppliers to their customers - on a wholly averaged-price p/kWh or fixed sum basis.

Network charges & cost-reflection[49] : there is already some cost-reflection in the underlying structure of the network charges paid by suppliers. In addition, industry working groups are discussing how to introduce greater cost-reflection in the way that suppliers are charged for the peak-related costs of the lower-voltage networks[50]. This is with the aim of better 'sensitising' suppliers to the underlying costs of peak-related provision at low voltage. The thinking is that this, in turn, may better incentivise suppliers to encourage actions among their end-customers to avoid peak-usage. From the early 2020's, with the potential for universal half-hourly settlement, greater accuracy and therefore greater cost-reflection would be possible (in principle, at least) in terms of how network charges are allocated to each supplier, including with respect to the peak-related usage of their customers[51.]

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49 Network charges for larger half-hourly I&C customers are already charged cost-reflectively - and suppliers simply 'pass-through' these charges to their I&C customers : TNUOS (capacity based charges ; zonal charges) ; DUOS (capacity-based charges, ToU charges).

50 e.g. by introducing a ToU charge and / or a capacity charge into charges payable *by suppliers* for the lower voltage networks.

51 In settlement, a total for aggregate customer consumption (kWh) is allocated to each supplier for every half-hour. Inter al, this half-hourly kWh aggregate figure (supplier volume allocation) is then used to calculate the network charges owed by each supplier (TNUOS, DUOS, Balancing). Historically, without smart meters, the

Levies & cost-reflection : Annex 4 looks in detail at the composition of the end electricity bill & in particular at the role of the levies**.** In practice, levy costs are recovered from customers, via their suppliers, either as a p/kWh charge, or, as fixed charge per customer. One notable and interesting exception, is the way in which DECC has recently chosen to implement the supplier charge for the capacity mechanism : this will be structured around forecast share of each suppliers' aggregate load at evening peak in the winter months. In turn, the hope is that this may start to incentivise suppliers a little more than now to encourage their customers to shift their usage away from winter evening peak hours.[52]

5.4.3 Should there be further cost-reflection in how cross-industry charges are recovered from suppliers ?

As noted, the way in which network charges may in the future be charged *to suppliers* looks set, over time, to become more cost-reflective. A more radical or wholesale shift to cost-reflection in terms of how cross-industry charges are presently recovered from suppliers – most notably the levies – could perhaps be contentious : because this could add to supplier risk should suppliers be unable to manage / offset the impacts (including via household or other DSR). The general thinking behind any move to more cost-reflection in these cross-industry charges would be to expose suppliers more than at present **to peak-related variation in industry costs**. **In turn, this might start to incentivise suppliers to encourage peak avoidance by their end-customers. At least, more so than today.**

Two important questions therefore arise for market efficiency about present approaches to the transfer of cross-industry charges between market actors :

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half-hourly allocation for virtually all 29 million electricity customers (large I&C customers excepted), has been derived from a set of eight statistically-derived normal distributions / customer profiles (Load Profiles 1-8. Of which, ~27 million households form Load Profiles 1 & 2)). So, in calculating the supplier volume allocation for every half-hour for settlement purposes, each customer *within* a load profile is assumed to have a *common consumption pattern in every half-hour*, even though in practice, within each profile, there is variation at the level of the individual customer, including with regard to their peak-consumption. Once smart meters are fully rolled out, Ofgem indicates that they anticipate a move to universal half-hourly settlement. This will allow *actual* half-hourly usage data from every individual customer to be used to inform the aggregate half-hourly kWh supplier volume allocation for settlement. In turn, this would enable the calculation of a particular supplier's network charges to be more accurately allocated and charged in every half-hour according to their customers' *actual* individual usage, including, importantly, at peak.

52 Suppliers' annual share of total costs of capacity support will be payable monthly. Supplier share will be calculated each year on the basis of their total forecast market share (kWh) over four winter months between peak hours 16.00h – 19.00h. This has been expressly designed to give suppliers an indirect incentive to reduce the winter peak load of their total customer base.

- **Should suppliers become more exposed than today, via reform of cross-industry charges, to the underlying variability of certain industry costs** (network charges[53], environmental and social levies) **– and if so to what extent ?**

- Might some form of **peak-related 'sculpting' of the combined envelope of cross-industry costs and charges** (for networks, for levies), provide a clearer signal to suppliers about the generally higher costs associated with peak ?

A separate and equally important question would then follow <u>for consumers</u> :

- If in the future, suppliers do become more exposed through their cross-industry charges to some of the industry's underlying true costs, **how far should some or all of those de-averaged costs then become more fully reflected through to end-customers via retail tariffs ?**

Notwithstanding any new underlying cost-complexity which *suppliers* may eventually face, our *basic working assumption* here **is that time- and / or price-led DSR retail tariffs offered to end-customers at scale would most likely build on RMR principles and be broadly simple and readily understood.** Potentially this could extend to automated approaches such as direct load control tariffs. However, the potential distributional impacts of more cost-reflective retail tariffs will need to be understood. We discuss this question in detail in Part II of this paper.

5.4.4 How suppliers presently pass through costs to customers in retail tariffs - & what this may mean for price-incentives for household DSR

Suppliers recover their own underlying costs – *plus the costs of other market actors* – through the retail prices they charge to end-customers.

Most GB suppliers today, choose to offer their customers a single averaged p/kWh retail price[54].

Each supplier assesses all its 'unique' costs (wholesale prices, network & balancing charges, cost of subsidies & levies, own-costs & margin, VAT etc) and then bundles these together into a single flat p/kWh price, perhaps differentiated slightly (1) to attract new customers or to retain old ones, and (2) to reflect customer payment-method (on-line, direct debit, credit, pre-pay etc).

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53 As noted, to some extent this may happen with Network charges, once half-hourly settlement.

54 other than for the ~ 3 million Economy 7 & 10 customers. i.e virtually all GB end-customers are charged a 'bundled' p/kWh (volumetric) charge. 'Retail Electricity Prices : It's time to unbundle the package'. Rocky Mountain Instititute. 12 June 2013.

http://blog.rmi.org/blog_06_12_2013_retail_electricity_prices_its_time_to_unbundle_the_package

We concluded in our earlier project papers[55], that for the long-run, and RMR notwithstanding, it seems desirable **for suppliers to start to develop some basic time-related and even capacity-related price-signals** to offer to their end-customers via retail tariffs, with the aim of starting to encourage demand-side actions among retail customers. The general aim of any such change would be to help to support general underlying cost-efficiency and affordability in a low-carbon electricity system.

We also noted in our earlier papers how in a competitive retail market, voluntary time-related tariffs may tend to attract customers who have *least need* to change their behaviour to benefit. Interestingly, in a world where *suppliers* may face more by way of underlying peak cost-reflection, suppliers may also find it attractive to have customers who are in general not high-peak users. Mandated ToU tariffs however are not likely to be the answer. These would most likely hit hardest at high peak users, least able to be flexible - & this could well include more vulnerable customer groups. Mandated time-related tariffs would anyway signify re-regulation of GB retail prices.

For inflexible customer groups in particular, lighting efficiency schemes, product efficiency standards, and investment in schemes to shift the 0.5 million customers who today heat their homes with 'peak' electric heat to off-peak heating with good levels of thermal insulation, will be especially important before any widespread moves to more time-related retail pricing are envisaged[56].

Part II of paper 12 discusses the principle of introducing greater cost-reflection in retail tariffs from a customer viewpoint.

55 Sustainability First. GB Electricity Demand project Papers 7 & 10

56 Sustainability First. GB Electricity Demand project. Paper 8.

5.5 What are supplier drivers for household DSR services (i.e for peak avoidance, flexibility)?

What might tip the balance for suppliers in starting to offer voluntary ToU and other household DSR tariffs – and from when ?

From 2016 onwards, smart meters will offer suppliers far better insight into and knowledge of their customers' electricity usage.

This better insight also coincides with a period when suppliers will start to face new wholesale price uncertainty from :

- **Increased output from wind** (as noted, a more unpredictable mix of prolonged low-priced periods and volatile higher peak- and flexibility-related prices).
- **Some significant regulatory changes**. Both the electricity cash-out review of imbalance prices (EBSCR) and half-hourly settlement are likely to cause suppliers to seek more accurate half-hourly matching between their *actual* customer usage and their wholesale energy purchases. Also, as generation and supply arms become more separate, there may be greater variation of within-day prices than now (currently on average ~20%[57]).

Taken together, these different and uncertain factors could perhaps prompt suppliers to re-assess their present commercial thinking on household DSR as a way to smooth the overall daily 'shape' of their wholesale energy purchases. However, DSR would only benefit suppliers if it also *improves predictability* and does not make life more unpredictable and thus more risky. In the early 2020's this points strongly towards suppliers seeking 'firm', automated DSR solutions from willing households. Together with other market actions, such as hedging wholesale purchases over different time-frames, ***firm*** automated household DSR could help suppliers to reduce their wholesale market risk.

In reality however, it is very hard to predict how this complex mix of smart meters, greater wholesale market uncertainty and new regulatory measures will shape suppliers commercial thinking regarding the benefits of household DSR.

57 average wholesale prices - day-time : night-time. DECC EDR Initial Impact Assessment. op cit.

Tables 9 & 10 in Annex 2 explore some of the possible market drivers for suppliers (or other market actors) to seek to promote either peak-avoidance or price-led flexibility from households, both before 2020 and afterwards. We tentatively conclude that :

- **Pre-2020** : there are an increasing number of market changes which could prompt market actors to wish to procure DSR services from households **which encourage peak-avoidance.**
- **Post-2020** : greatest cost-savings from households in the wholesale markets and in other demand-side markets (capacity, networks) **may well still be associated with shifting household load away from the morning and evening peak periods, especially in winter.** In addition, market actors may also seek **price-led flexibility services from households too, via automation**.

Cost-savings from household demand-side actions may perhaps increasingly be available to those customers prepared to shift available flexible household load *into the night-time* (on a staggered basis to avoid creating new night-time peaks) : because at night, demand may be low and, when windy, wind may otherwise need to be constrained off (especially on summer nights). Goran Strbac suggests an average night-time 'flexibility value' today per customer of £3, rising potentially to over £100 per participating customer in 2025. His assumption is that if half of all household customers take part, and half do not, there could be 1 : 3 difference in their respective end-bills [58] [59]. In their high demand / high electrification scenario, Redpoint modelling estimated a £90 p.a. saving per participating customer in 2030 via their most 'dynamic' option for direct load control[60.]

58 Sustainability First. Paper 9. GB Electricity Demand – 2012 and 2025. Impacts of demand reduction and demand shifting on wholesale prices and carbon emissions. Results of updated Brattle modelling.

59 SUPERGEN HiDef Dissemination Event. 29 April 2014.Goran Strbac. Imperial College. Slides on GB 'flexibility value' (& material not yet published). NB - This calculation seemed to include some distribution and other system operation savings too.

60 But much less when modelled as a benefit to all households. Report for DECC. Redpoint, Baringa & Element Energy. Electricity Systems Analysis. Future System Benefits from Selected DSR Scenarios. August 2012.

5.6 Market actors most likely to lead household demand-side participation ?

5.6.1 Suppliers have a pivotal role in delivery of household DSR

Annexes 1-3 strongly point towards electricity suppliers having a key role going forwards in taking the lead in development of GB household DSR. Suppliers have direct commercial exposure to the wholesale, capacity and balancing markets. They lead on smart meters. They also have initial exclusive switching control arrangements over those appliances most likely to be directly connected via smart meters and the auxiliary load control switches (e.g. hot-water, storage heaters, heat-pumps, EV chargers). Pre-2020, suppliers are therefore the actors who seem to have both the greatest commercial incentive - as well as two-way meter communications and technical switching controls via the meter readily at their disposal - to be best-placed to deliver household demand-side peak-avoidance actions to produce cost-savings in the wholesale and capacity markets.

This is not to say that other actors do not wish to engage households in demand-side activity in the wholesale markets - or in other parts of the electricity market. Aggregators, distribution networks, local authorities and other third parties clearly have a role. **But, acknowledgement of this pivotal supplier-role in taking the lead in early-development of a GB household demand-side in the period to 2020 may bring some helpful clarity to regulatory and policy thinking around likely future routes to market for household DSR.**

Different actors may have a potential interest in facilitating household DSR in different parts of the electricity market as follows :

- **Suppliers** (once smart meters, auxiliary load control switches) : wholesale markets ; capacity markets ; TRIAD avoidance.
- **Distribution Networks**[61] : at specific network hotspots to resolve constraints and / or manage faults. Local and / or community initiatives (see para 5.6.2 below).
- **Aggregators** (via consumer access devices (CADS)) : Balancing markets ; Capacity markets; Distribution constraints & fault managmenet ; TRIAD avoidance.

61 DECC / Ofgem Smart Grid Forum. Work Stream 6 & its Sub-Groups are doing a great deal of work in this area. https://www.ofgem.gov.uk/electricity/distribution-networks/forums-seminars-and-working-groups/decc-ofgem-smart-grid-forum/work-stream-six

5.6.2 Nature of agreements or contracts among market actors for household DSR ?

Suppliers will need to actively cooperate with other actors to facilitate the demand-side, including, potentially, for Distribution-led DSR, and perhaps also for the Balancing markets : given suppliers' lead role via the smart metering arrangements and auxiliary load control switches in being able to switch their customers' load.

However, depending on the DSR driver, actors other than the supplier may however wish or need to take a lead.

For example, where a DNO seeks a DSR solution at a particular network 'hot-spot' (for example, to resolve a constraint or to manage a fault), then a supplier-led approach may not necessarily be a way forward. Not least, multiple suppliers may be active on that part of the network – potentially each already with their own existing DSR offers to their end-customers – and perhaps none of which might resolve the DNO's particular problem. This means that an entirely supplier-led approach could leave a DNO with a challenge in seeking to solve a particular locational problem via DSR. DNOs will therefore wish to continue to explore the alternative of bi-lateral arrangements for DSR with local communities and / or end-customers, including households, perhaps by use of an aggregator, to procure their required DSR service. In practice, half-hourly settlement, and a modification to the Smart Energy Code, may also support DNO DSR activity with households, possibly from around the early 2020's (and, realistically, this is when DNOs may need support from household DSR at scale).

DECC / Ofgem Workstream 6 is helpfully exploring these matters. The ENA DSR Framework also starts to consider these issues, largely from the view-point of a *technical* hierarchy[62,] from a network point-of-view (distribution, transmission, system operator) – but not , so far, from a supplier view-point. Suppliers will certainly wish to engage in such discussion, not least given the risks to them of imbalance which third-party enabled DSR could perhaps cause at scale.

So, in developing their forthcoming DSR Framework, Ofgem will particularly wish to consider the nature not only of supplier technical interactions, but also suppliers' *commercial* interactions with *other* market actors for household DSR[63.] Ofgem will wish to consider how to ensure fair market access *for other actors* who may wish to deliver household DSR with a view to creating electricity system cost savings (networks, system operator), or for third parties who may wish to facilitate household DSR on behalf of other actors (aggregators, others). Arguably, from a customer viewpoint, there may ultimately be better overall value from the smart meter communication arrangements, if the smart meter appliance controls can be shared successfully with other actors, as well as suppliers.

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62 ENA. Electricity Demand Side Response Working Group. Demand Side Response Shared Services Framework Concept Consultation Paper. April 2014.

63 SGF **Work Stream 6 Options Paper**. April 2014 tackles this issue from the viewpoint of the distribution networks.

Separately, under the Consumer Empowerment & Protection arrangements, Ofgem will wish to consider the nature of agreements which **customers** may enter into with their suppliers and / or third parties (eg DNOs and / or aggregators) for load management services. This could become an issue if a customer has a supply agreement with one actor and a load-management agreement with another. **We consider the customer implications of such arrangements in Part II of this paper. In particular in Table 4, we map-out a number of possible retail market models as a straw-man to start a discussion about how routes to market for household DSR may eventually begin to develop.**

5.6.3 How to share household DSR Benefits : among market actors, with households & with customers in general ?

Others are working on these issues (Ofgem DSR Framework ; Work Stream 6 Sub-Group on Distribution of Value ; Frontier Economics paper for Elexon[64]). For delivery of household DSR in the wholesale and capacity markets, suppliers seemingly are not dependent on other parties - because suppliers have smart meters and direct access to auxiliary load control switches. So, suppliers can simply share the available cost-saving in an appropriate way with their customers.

For other actors, **& in particular the distribution networks**, the challenge seems greater because the DNOs may need to share a relatively modest overall cost-saving with several parties in order for the DNO to secure the DSR benefit. For DNOs (and the system operator), the chain of 'shared benefits' for delivering household DSR may broadly be described as follows.

(1) The cost-savings available (total avoided costs) to the market actor from a customer's demand-side actions will need to exceed the costs of delivering the DSR (this includes the costs of : any up-front spend on DSR equipment ; any 'reward' needed to incentivise each actor to participate in the DSR delivery-chain (aggregator, customer)).

(2) The first market actor may need to share any DSR cost-saving with another actor (aggregator or other third party) who obtains the DSR service on their behalf.

(3) The market actor (or second actor) **shares some of the cost-saving with the individual householder** who provides the DSR service. The DSR benefit 'split' is a commercial matter between the market actor and the customer (but would hopefully be transparent to the customer).

(4) **Consumers in general** may also eventually benefit from the cost-saving via lower costs in the electricity system than otherwise (i.e. due to lower wholesale and capacity-related costs ; lower DUOS, TNUOS or Balancing costs). However, other than short-run benefits (i.e. other than short-run operational or energy cost-savings), many of these benefits will only flow slowly to customers in general. For example, from one network price control period to the next (8 years); or, from avoided capital spend on new peaking plant.

In Annex 3, we discuss questions of how the benefits of DSR may fall, to whom and in what time frame.

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64 Cross-party impacts of DSR actions. Frontier Economics. A report prepared for Elexon. May 2014.

Chapter 6. Household Customers & DSR

6.1 What is the customer appetite for household DSR ?

Electricity trial experience (EDF EDRP, Ireland, CLNR) shows that trial customers generally like basic static ToU tariffs and respond to these, even where the financial benefits to them appear relatively modest (with an average trial peak shift of ~7-10%). CLNR suggests that small households, renters, and households with young children already use less electricity at peak (so perhaps have less flexibility). Larger households either shifted load – or ended up paying more – both of which are perhaps 'rational' responses[65.] **All of this suggests that suppliers could do more to explore offers of basic ToU tariffs to their customers,** as it seems that at least some customers may be content to engage, even if the bill benefits are relatively modest.

In Part II we discuss issues for customers and consumers, including risks and benefits for customers who take-up ToU and DSR retail tariffs, as well as the risks for those customers who cannot or who may not wish to engage with ToU tariffs, including vulnerable customers.

6.2 How do household-customer load characteristics match with market actor needs for DSR?

6.2.1 Current match : customer-load and DSR markets ?

Annexes 1-3 of this paper look at how household demand reduction and household DSR might at some point participate in GB electricity markets.

Overleaf, we attempt a list of how some types of flexible household load could serve to provide DSR into these different demand-side markets.

This takes no account of customer willingness to engage in DSR - either voluntarily or with automation. In Paper 11 we explored what is known about GB customer attitudes today to appliance automation [66.]

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65 Customer-Led Network Revolution. CLNR –LO52. Durham University. Social Science Research. 24 April 2014.

66 Sustainability First. Paper 11 : 'How could electricity demand-side innovation serve customers in the longer-term?'. Pp 108-113.

Table 2 . Flexible Household Load : Potential match with the GB Demand-Side Electricity Markets?

Source : Sustainability First

Pre-2020			
Household Appliance Type (i.e. appliance-use most likely to offer a good 'match' for market actor DSR 'needs').	**'Voluntary' Customer Response to an incentive (eg ToU)**	**Firm / Automated Customer Load Management Response***	**Potential Match w DSR Market ?**
Lighting efficiency schemes (CfLs, LEDs). **Refrigerator scrappage**	-	-	Capacity Market – Electricity Demand Reduction. Distribution (constraint & fault management) TRIAD management
Wet appliances (CLNR research). **Turn-off lights**	√		Wholesale Markets (day-in-day out peak avoidance ; critical peak avoidance).
Thermal hot water storage. (Nines project). **Storage heaters. (Nines project).** **Heat pumps (CLNR)**	-	√	Wholesale Markets (peak avoidance & load 'turn-up'). Balancing (Frequency, Fast Response). Capacity Markets (possibly if a measurable turn-down at system stress). Distribution (potential constraint & fault management). PV 'buffer'
Post-2020 : assuming half-hourly settlement plus automation - so that more complex 'dynamic' load-control tariffs are feasible.			
Thermal hot water storage. **Storage heaters.** **Heat pumps** **EVs.** **Refrigeration** **Batteries**	Once half-hourly settlement, 'voluntary' response - potentially increases supplier risk	√	Wholesale Markets (both peak avoidance & critical peak avoidance ; load 'turn-up' - & dynamic price-matching). Balancing (Frequency, Fast Response). Capacity Markets (need measurable & potentially prolonged turn-down for system stress events). Distribution : constraint & fault management (including PV 'buffer').
***NB. The additional cost of equipment necessary to fully automate / control the response of household appliances, would need to be offset by greater overall cost-savings in the DSR markets.**			

As well as a broad match with both customer appliance ownership and with day-to-day patterns of customer usage of those appliances, there are also significant underlying *technical* parameters which would also need to be met before households could be expected to participate

These technical requirements would not be a matter for end-consumers as such. They would be handled by the market actors. Beyond 2020, this would most likely increasingly be via automated services in order to guarantee a firm response of the technical nature required to the market actor concerned.

The Table below, taken from the recent ENA Consultation on a DSR Framework, is included here simply to illustrate some of the many technical requirements which market actors will need to take account of, when considering whether or how they might make use of household DSR.

Table 3. Characteristics Which T&D Networks & System Operator Require from Customers (I&C & households). ENA DSR FrameworkConsultation. Table 2 [67.]

Table 2: DSR service requirements Energy Trading / Portfolio balancing	Constraint management (system normal)		Constraint management (system abnormal)		Balancing Services	
Energy Supplier	**DNO (pre-fault: static)**	**DNO (pre-fault : dynamic)**	**DNO (post fault): instant**	**DNO (post fault): planned**	**NETSO**	
Planning Time	Day ahead	Annual / long term 5yr	Annual / long term 5yr	Annual / long term 5yr	Annual / long term 5yr	3 months – 2 years
Contract Duration	1 year / fixed against supply contract	Annual / long term 5 yr	Annual / long term 5yr	Annual / long term 5yr	Annual / long term 5yr	3 months – 2 years
Geo-Specific	No	Yes	Yes	Yes	yes	no
Dispatch Notice	1 – 7 days	Annual - quarterly	½ - 4 hours	No notice	½ - 4 hours	6min – 2 hours
Confirm Available	n/a	As above	28 days +	Annual	Annual	Week ahead
Duration	½ - 2 hours	2 – 4 hours	2 – 4 hours	<8 hours	<8 hours	½ - 4 hour
Penalty	System pricing	Yes	Yes	Yes	Yes	Yes
Payment	Utilisation only	Utilisation only	Availability & Utilisation	Availability only	Availability & Utilisation	Availability & Utilisation
Criticality	Low	Moderate	Moderate	High	High	High
Driver	Commercial	Operational / commercial	Operational / commercial	Operational / Commercial	Operational / Commercial	Operational

67 Electricity Networks Association. Electricity Demand Side Response Working Group. Demand-Side Response. Shared Services Framework. Concept Paper. Consultation. April 2014

http://www.energynetworks.org/modx/assets/files/news/consultation-responses/Consultation%20responses%202014/Demand%20Side%20Response%20Concept%20Paper_revised.pdf

6.2.2 Customer load and DSR market-match in the 2020's?

Lack of flexible controllable household load at peak – GB policies and measures for household DSR remain based around expectation of major household uptake of electric heat and EVs, essentially to decarbonise - but also with the expected spin-off that automated electric heat & EVs may facilitate a household demand-side in the 2020's & 2030's. Smart wet appliances may have a role, but paper 11 suggests that the potential overall, including at morning and evening peak, may perhaps be relatively modest – even though some customers may be prepared to shift that load. EVs may have some growing traction. **However, there is little sign that a significant market for controllable off-peak household electric hot-water and heat will grow in the near-term**, unless there is near-term promotion of more electric thermal storage (hot water cylinders, storage heaters) and / or better incentives and / or long-term regulation designed to promote a wholesale shift to heat pumps – and this latter may not be popular. Above all, efforts to encourage sources of controllable and flexible household electrical load need to be realistic and give consumers the heating systems they want. Equally, without more forethought about what will drive new uptake of sources of controllable household load by say, the early 2020's, two linked problems could arise :

- **There could be a lack of suitable appliances in homes** – readily switchable at scale via automated load-management schemes - to offset higher industry costs associated generally with low carbon and wind in particular.
- **This may be particularly problematic for suppliers** : who without ready sources of automated controllable load could find themselves facing a commercial environment with even greater risk than outlined in para 5.5 above – because in a heavy wind-system, **voluntary ToU tariffs may increase supplier risk in a half-hourly settled world.**

Chapter 7. Local demand-side : where does local 'fit' in the overall household DSR picture ?

Present impetus, momentum and individual commitment to making the demand-side work, including the household demand-side, lies substantially at the community and local level.

However, local network-level household DSR may not necessarily be where most *overall* value lies in today's electricity system, although beyond the early 2020's this may start to change in a more smart grid world.

As noted, potential distribution network cost-saving / value available today from household DSR is likely to be very location specific : driven by specific constraints on the lower voltage networks or by fault management. Constraints may be rural, or, equally, city-centre. Low cost storage, including at a household level, will be central to unlocking the local demand-side.

Today, community-level energy schemes which incorporate DSR and / or storage are important test-beds, able to show-case how to make demand-side schemes work commercially and institutionally in reality, both for market actors and for customers. Current stimulus and innovation funding from government and others with a focus on local community energy schemes therefore makes a good deal of policy sense. However, the ability to successfully replicate community energy and demand-side schemes beyond trials and pilots will also require DECC and Ofgem to tackle **in a systematic way** some of the key administrative silos and the detail of distribution charging approaches, which we identified in paper 10 [68].

68 i.e to address : present silos between FIT administration & retail supply arrangements to enable suppliers to align their commercial incentives to create tariffs for 'prosumers' ; silos on data-sharing arrangements - to enable market actors to identify local demand-side solutions ; tying household FIT for PV to requirements for low-cost storage (thermal, battery); distribution charge reform (connection charges for PV <3.6 kW ; possible capacity charges for load ; better communication to communities about network 'hotspots' which might benefit from demand-side actions.

Chapter 8. Household demand-side priorities from now to 2020

Our assessment of household participation in the GB electricity markets leads us to conclude that it will be important to identify a number of clear *electricity-focused* priorities from now to 2020, designed to deliver seven basic goals as follows :

- **Critical to affordability, a concerted drive to support those GB customers already dependent today on electricity for their main heating & hot-water.** These customers have the highest annual electricity bills & pick up a disproportionate share of the levies. Some of these customers may also live in poorly insulated homes, rented homes, be on lower incomes and / or be vulnerable. Thermal insulation measures should be targeted at electrically heated homes. Where desirable & feasible, encouragement for : on peak-electric heat to be replaced with off-peak ; and, old inefficient electric hot-water heaters and storage heaters replaced.

- **Encouragement of 'early days' development of a voluntary GB household demand-side** - in tandem with smart meters - through supplier development of customer-friendly voluntary basic ToU offers.

- **Encouragement of a supply-chain and early development of a market in automatable, controllable load** – with a focus on giving customers the heating systems they may want / prefer.

- **Bring together in a far more coherent and concerted way than now those policies, measures and incentives which already exist - for electricity efficiency, thermal insulation and the household demand-side – so that the 'whole' becomes greater than the sum of its parts**.

- **Consideration of whether some present industry cost-allocations** (network charges, levies) **could be better 'shaped' than now** to encourage retail tariffs which are still clear, fair and simple – but which at the same time may also help to encourage household peak-avoidance.

- **Continued government, regulatory and market actor support for local energy schemes as an important show-case and test-bed** for the household demand-side.

- **Concerted push on electricity demand reduction through EU product policy.**

We therefore suggest that pre-2020 the following specific measures should be seen as a priority to support development of these goals.

Electricity demand reduction priorities for households pre-2020 – a concerted government and manufacturer drive on : household lighting efficiency schemes (CFLs (compact fluorescent), LEDs) ; replacement of older less efficient fridges and freezers.

Electricity demand-side priorities for households pre-2020

- **Basic static ToU tariffs** - suppliers to be encouraged to test household appetite with offers of voluntary ToU tariffs to interested customers. Ofgem to stress that RMR does not prevent this.

- **0.5 m 'on-peak' electrically heated customers :** improve their thermal insulation. If desired, feasible and practical, to consider whether 'off-peak' electric heat (hot water, storage heaters, heat pumps) might offer a more economical alternative.

- **Smarten existing Econ 7 customers** – some of these customers are anyway likely to be offered early smart meters (with integrated auxiliary load control switches) due to retirement of the radio-teleswitch. There is a need to understand more about the demographic of the ~3+ million Economy 7 customers today. This could pave the way for suppliers to develop appropriate offers for these customers for better home-insulation and, *where appropriate*, possible renewal of their hot-water tanks & storage heaters (ECO) – **brought together with developing attractive offers to participate in DSR schemes** (off-peak schemes, Balancing).

- **Smaller new-build homes** (flats) – developers (incl social landlords, but not just) to be far more actively encouraged to consider **off-peak heat & hot water options** together with good thermal insulation (instead of predominance of 'on-peak' electric heat, as now).

- **Househhold PV – FIT subsidy** : to explore the feasibility of making household FIT eligibility for PV conditional on installing measures for self-balancing at the household level such as immersion-heater divert switches and / or other low-cost storage (thermal heat, battery).

- **Development of new markets for 'smarter' off-peak hot-water, storage heaters, and heat-pumps** – development by suppliers and third parties (including appliance manufacturers) of 'appliance-led' customer offers for hot-water & electric-heat **combined with DSR propositions**. **Any such developments would need to be <u>appropriately marketed</u>** (see Part II) **& coupled with high levels of thermal insulation**.

- **Explore possible pros and cons of adopting a <u>combined</u> peak / capacity-based (kW) approach to household retail tariffs <u>coupled with</u> energy-charges (p/kWh).** In the longer term, such an approach may produce a better alignment of the growing fixed-cost element of retail customers bills with incentivising peak-avoidance (including critical peaks).

- **RHI, Green Deal, ECO etc** – consider how far these schemes already deliver on measures for increased electricity efficiency *in the round*, especially for low-income or vulnerable customers who are high electricity users. For low-income and vulnerable customers, consider how to extend existing incentives in such a way as to **bring together electricity efficiency schemes with incentives to fund the upfront costs associated with automated household DSR.**

Paper 12

Part II

The Smart Consumer

Issues of principle for future demand-side development

Part II of Paper 12 follows a roundtable discussion at the Smart Demand Forum on 8 May 2014 about 'The Smart Consumer'. Discussion focused on four major issues of principle for household customers for future demand-side development : greater cost-reflection in retail tariffs; how a DSR market can work in the interests of consumers in general ; empowering & protecting the individual consumer ; and possible developments for regulation and consumer representation in a 'smart' world.

Part II is organised as follows.

We are very grateful for the many helpful contributions to this paper from Smart Demand Forum members and others. Responsibility for the paper and its conclusions however rests with Sustainability First.

Part II : The Smart Consumer

Chapter 9. Summary

9.1 Introduction

In March 2014 around 350,000 GB households had smart meters operating in 'smart mode.' By 2018, this number will have increased to many millions. These meters have an in-built sophisticated technical specification which, in principle, will be capable of enabling licensed suppliers and to some extent third parties to provide a variety of complex tariffs and load control arrangements from 'day one'. We do not see this as likely in practice and recognize that it is extremely early days in this market. However, it makes sense to start thinking now about the issues of basic principle for energy consumers likely to need attention in the relatively near future. Discussion in Part II is about starting to think ahead in this way. It is chiefly concerned with questions around the evolution of retail markets and retail tariffs from the domestic consumer point of view.

Previous Sustainability First papers have outlined the *technical* potential for shiftable load and the role that householders might play in achieving this, including, in the longer term, via automation. Previous papers have also pointed towards the potential technical and cost-efficiency benefits to the electricity system overall from eventually introducing more cost-reflection than today in GB retail tariffs. Part I of paper 12 identifies how suppliers, large and small, will have a pivotal role in encouraging their customers to participate in demand-side activity, including via offers of more cost-reflective retail tariffs to householders.

Part II of this paper therefore takes forward this discussion and explores how the full potential of GB household DSR may only be unlocked with approaches that involve greater differentiation of the customer base. It explores how we may be moving away from retail tariff arrangements where households are largely treated the same way, where many underlying industry costs (network & imbalance costs, levy costs etc) are socialised and the risks largely pooled, to a world where different customer responses might be encouraged and there is more cost-reflective retail pricing than now. This could begin to create real winners and losers. We put forward for discussion criteria that could be adopted to assess how far moves to greater cost-reflection are in the overall household customer and consumer interest. These criteria include: clear cost allocation policies; a test of net 'consumer benefit'; simplicity; an understanding of distributional impacts; and the prior existence of social protection measures.

9.2 Consumers in general

As DSR develops, the way in which the retail market is characterized may need to evolve. A fresh look may also be needed at how market actors, market health and its competitive nature are assessed. We therefore consider ways to judge how far the interests of consumers *in general* are to be protected in smarter markets, including possible measures to do this. In doing so, to stimulate some initial discussion, we explore possible ways in which smarter retail markets could perhaps develop and the advantages and disadvantages of these different models from the consumer point of view. We conclude that, although it is still early days, giving the characteristics of future smarter markets much more thought, (including the extent to which different models may enable innovation by third parties while maintaining consumer confidence and safeguarding the most vulnerable), would help ensure that regulatory and consumer protection frameworks are future-proofed.

We recommend that early consideration of the metrics needed to measure market health in household DSR in a smarter world is needed. These could include: a more sophisticated approach to identifying and removing barriers to market entry ; a better understanding of market dominance ; the development of alternatives to switching as a measure of consumer power, such as 'try-before-you-buy' contract provisions and periodic contract reviews; annual customer expectation and satisfaction surveys to assess the impact of the changes; measures to facilitate and assess innovation and co-operation; and mechanisms to better align long term consumer and company interests to ensure that these are built around a common set of long-run commercial objectives and consumer-led needs and values (which may require greater attention to corporate behaviour and governance). We also propose that Ofgem develop annual reviews of *smarter* market health. These could identify problems with the supply and demand sides and chart progress towards addressing these.

9.3 Individual consumers

The paper goes on to review what steps could be taken to ensure that *individual* consumers are genuinely empowered and protected so that they are able to make informed decisions. The real and practical difficulties of householders making meaningful comparisons around DSR offers are examined. We propose consideration should be given now to a need to consult on what consumer education and information requirements will be around DSR offers and what the role of Smart Energy GB could be in this area. This exercise should help forge an agreement between all market actors on the need to address the issue of smarter tariff comparisons for all consumers in a strategic and co-ordinated way. It should also assist market actors in the preparations they will need to make for the increase in enquiries and complaints that are likely to result from DSR. This is likely to involve: increased resourcing and empowering of front-line staff to deal with emerging issues in a timely way; establishment of clear lines of accountability between different actors (such as suppliers, appliance manufacturers etc) for redress and remediation; and, engaging consumer groups and regulators to stress-test accountability arrangements.

We support Ofgem's proposed review of the Tariff Comparison Rate to facilitate comparison of basic DSR offers and recommend that this gives serious consideration to the practicality of developing such tools. We consider that significant obstacles are likely to be met by customers when using these in practice. To address this point, our initial conclusion is that trial-period offers could therefore be an important way of giving consumers confidence to experiment in the new market. For example, 'try-before-you-buy' arrangements. Consideration will be needed of how many such offers a customer might 'test' without incurring penalties / pay back clauses. We note that careful review will be needed of contracts with 'lock-in' arrangements to re-coup equipment costs will be needed to ensure that these do not unnecessarily disadvantage customers. In addition, we propose that Ofgem should facilitate the provision of reliable comparison information for significant smart energy choices to ensure that the information for key smart household decisions is readily accessible, accurate and comparable. Such choices could be significant because of cost, their long term nature or the degree of disruption : for example, choices of a new heating system, household-level storage or new smart-home communications systems.

9.4 Approaches to Regulation

The paper then moves on to discuss the policy and regulatory frameworks that are needed to underpin moves from universal and standardised 'one-size-fits-all' charging arrangements for electricity supply to a more diversified and fragmented market, and one which, at the same time, may also increasingly converge with the communications and financial services sectors. Getting safeguards in place for vulnerable consumers will be central. Mis-judged or mis-timed interventions could unintentionally create a backlash against the innovation needed for successful DSR. A delicate balance clearly needs to be struck between regulation and the open market so that consumer protections are not so onerous that they become a barrier to entry, stifling market development and innovation. The question of how far the initial policy and regulatory focus should be on the majority of consumers who eventually may wish, or be able, to engage successfully with DSR - or alternatively on the minority of consumers who may find this difficult – is also discussed.

Our initial conclusions are that given the unknown pace of change and the lack of certainty around how the DSR retail markets will evolve, it would be prudent to develop a clear hierarchy of priorities for demand-side policy and regulatory activity. This could help focus attention on addressing problems in the standard credit market, on improving thermal insulation and energy efficiency, through to addressing barriers for micro generation and DSR. We go on to propose that modelling demand-side and DSR scenarios to ensure household views are taken into account and assumptions are tested by consumer groups to ensure that they stand up to practical and lived experience will be important. Such scenarios will enable regulators to explore different options for DSR development; help them determine the phasing of their use of different regulatory tools (eg fair market access, facilitation through sign-posting and sharing information or reputational incentives); and when these need to change as the DSR market evolves.

To maintain consumer confidence, we recommend early development of regulatory backstops. Safeguards will be needed prior to DSR offers being more widely encouraged - to protect the vulnerable and those that cannot engage with DSR offers and to enable customer over-rides of automation. Consideration of the need for speedier enforcement to penalise licence breaches in areas such as mis-selling will be important so that the evolving market is seen as worthy of consumer trust. We recommend that the regulatory principles outlined in our earlier Paper 8 for DSR still hold, and, given the uncertainty that exists, could provide a stable regulatory rule set.

9.5 Consumer voice

Ensuring a strong consumer voice will be crucial if the changes in the market are to be driven by consumer wishes and needs as opposed to top-down expectation of the technical possibilities. Effective consumer engagement before key decisions and options are foreclosed will be important in re-building consumer trust. This is a pre-requisite in the much-needed move from consumers being seen as part of the 'problem' to being able and willing to take full advantage of the opportunities of energy efficiency, micro-generation and DSR - and to truly become part of the hoped-for solution. To 'realise the resource' consumers will need to have a sense of ownership, so that the changes envisaged are not done 'to them' but achieved together with them. Part II ends with an analysis of how this might best be achieved.

Our conclusions are that encouragement of a strong consumer voice in DSR development will be important to ensure public confidence in the emerging smarter market. Consumer engagement is needed in strategic debates to ensure that developments are in the long-term interest of the generality of consumers as well as in operational delivery to ensure that the needs of individual consumers can be met. Recent changes in the consumer landscape have seen the transfer of funding for future energy consumer issues to the Citizens Advice service. Once these changes have bedded down, it will be important to review them to ensure that the role is being carried out effectively and is appropriately resourced.

Finally, we propose the development of approaches which might better align consumer and company interests in firm DSR, in return for a dependable and efficient service that is worthy of consumer trust. This could include companies examining how corporate governance approaches and company behaviours may become better aligned with consumer interests in DSR. Assessing the impacts of the RMR's 'fairness' licence conditions could be a useful first step. We recommend that consideration should also be given to establishing on-going mechanisms to share information on DSR development between market actors, policy and regulatory bodies and consumer groups. Such mechanisms can increase learning across the market so that mistakes are not duplicated and could help increase consumer confidence in new DSR retail markets.

Chapter 10. Greater cost reflectivity: how far is this desirable in retail tariffs to encourage DSR?

Arguments for greater cost reflection may well be persuasive 'in principle' from an overall cost efficiency point of view. However, in Part I of this paper we carefully distinguish between (1) how *suppliers* might in due course become faced with greater cost-reflection in any reform of current arrangements for cross-industry charges (for network costs and / or for the social & environmental levies), in order to create a greater incentive on suppliers to take more steps to motivate their customers to engage in demand-side actions and (2) how suppliers might then *in turn* design retail tariffs to encourage greater demand-side participation by their customers. Below, we consider only (2) above. Namely, what might greater cost-reflection *in retail tariffs* look like from the household view-point.

10.1 Customer advantages in cost reflection

10.1.1 Potential benefits to all customers

Paper 7 explored how more cost reflective retail tariffs could, in principle, have some clear economic advantages. They could increase efficiency in the system as a whole and reduce the total costs to the total customer base. Greater cost reflectivity could also provide explicit local signals at network 'hot-spots' to help tackle network constraints and in turn, either remove or defer the need for DNO reinforcement / investment.

If customers can be persuaded to opt-in to cost-reflective offers without necessarily each receiving the *full* benefit of the resulting efficiency savings themselves, some of the resulting efficiency savings could be socialised across the total customer base. In the long run, this could help to reduce everyone's bills, including those of the fuel poor. However, it should be noted that low supplier margins and carefully controlled network costs over successive price-control periods may mean that any benefit available to share with all customers may be very modest indeed (initially at least).

10.1.2 Potential benefits to individual customers

Individual households should also of course obtain a benefit from increased cost- reflectivity as the demand-side is incentivised. For example, in the recent British Gas CLNR trial, around 60% of the TOU trial customers were better off to some extent (and around 40% worse off to a varying degree). Analysis of other UK ToU trials suggest broadly beneficial outcomes[69], but it must also be remembered that such trials are by their very nature 'opt in'. Any benefits will split between individual consumers, market actors and, in principle, the general consumer base.

69 Further Analysis of Data from Household Electricity Usage Study: Electricity Price Signals and Demand Response. Report for DECC & DEFRA by Element Energy. 4 April 2014.

10.2 Customer disadvantages in cost reflection

10.2.1 Customer confidence

From the point of view of some householders, greater cost-reflectivity in retail tariffs may potentially lead to questions of confidence in the energy market. Many customers may simply not wish to micro-manage their consumption, based on more cost-reflective price signals. For this reason, in the short-to-medium term, simple readily-understood ToU tariffs may indeed be more acceptable to householders than more sophisticated tariffs, such as highly dynamic tariffs. Getting the retail tariff design 'right' (e.g. peak - off-peak differentials, time band construction etc) to optimise the benefit both for the electricity system and for the customer will be a challenge for market actors. Beyond 'voluntary' time- or price-related retail tariffs, automated direct load control (DLC) offers a potential solution to help release longer term demand-side certainty for both market actors and customers alike, but customer over-rides are important for user 'buy-in.'[70]

Increased tariff complexity may also bring lack of customer understanding and confusion and has the potential to undermine the simplicity desired by many. It could be argued that tariff complexity is only an issue if all customers have DSR, and that where tariffs remain 'opt-in' it is unnecessary to make tariffs suitable for all. This point is discussed in more detail below.

Although the RMR does not prevent suppliers from adopting DSR tariffs (it permits multiple tariffs and suppliers can apply for derogations), multi-tiered tariffs are banned. Suppliers will now think even more carefully about how their tariffs are designed and perceived by the public. Indeed, proposals in the Labour Party Energy Green Paper for a single unit price and standing charge could discourage actors from pursuing more cost-reflective approaches. How *individual* consumers can be empowered to make decisions in this world is discussed in section 3 below.

In time, customers may come to understand and to accept that somewhat more cost-reflective pricing may be necessary to accommodate the reality of an intermittent renewable world and one where a fully reliable supply comes at an increasing cost. Indeed, the predicted 'tight' winters of 2015-17 may prompt a public discussion about what level of electricity supply security is desired by twenty-first century GB customers and what the associated costs and alternatives might be.

70 Forthcoming CLNR findings on their heat pump & washing machine test-cells – and trial-customer attitudes - with and without customer over-ride, will be useful here.

10.2.2 Fairness

Those who cannot shift their peaks (either in terms of time or location) may well be disadvantaged if there is a move to more cost-reflective pricing for some and retail tariffs rebalanced accordingly for others.

With greater cost-reflectivity in the future, some groups may find themselves less able to take advantage of off-peak 'deals' and so could experience multiple disadvantage which could compound their vulnerability. For example, this may include those in rural locations, off the gas grid and with electric heating with no storage who are fuel poor, have large families etc and who may be unable to buy the appliances / new heating systems to take advantage of off-peak deals. Not least, 'vulnerability' can change and evolve as household composition or household requirements change. Ensuring protection of such consumers is challenging. This problem is increased by the fact that it can be difficult to distinguish between those that cannot engage and those who may not wish to. Assuming that uptake in GB of more cost-reflective retail tariffs will remain voluntary, certain customers may end-up as 'free riders.' For example, an EV user (who currently is likely to be more affluent), may choose to remain on a standard flat credit tariff – with the underlying higher costs of peak-time charging being socialized invisibly across the wider customer base.[71]

The potential lack of fairness for those who cannot shift their demand could be compounded if treatment of cross-industry charges (network costs, environmental and social levies, which together will make up over half of customer bills by 2020) were to become more peak-related than now, as explored in Part I of this paper. Social protection measures would clearly need to be in place *first* if the ideas floated there for 'peak-sculpting' of the envelope of cross-industry charges were taken up.[72]

10.3 Possible criteria to assess moves towards greater cost reflectivity in retail tariffs

10.3.1 Is there a clear supplier cost-allocation policy?

At present, for household customers, suppliers generally recover almost all of their underlying costs – both wholesale costs and underlying cross-industry charges (for networks & balancing, for social & environmental levies) - via an averaged p/kWh retail price, charged regardless of the time of day or the time of year when the customer uses the power (and with or without a standing charge element).

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71 We discussed such issues at length in Paper 8.

72 Or indeed, the recommendation from the Fuel Poverty Advisory Group to the ECC Committee in 2013 to peak-sculpt environmental policy costs to peak units in *retail* tariffs.

In a competitive retail market, it is up to each supplier to decide how they will recover their underlying costs from their customers, and we do not necessarily know how costs are presently recovered by suppliers between the different retail prices and tariffs that they offer. So although many costs are currently socialised, it is difficult to fully demonstrate that this is being done in a fair way. As discussed in Part I, cross-industry charges (for networks and balancing ; & for social & environmental levies), are allocated to each supplier on a standardized basis[73.] In turn, it is up to suppliers how they then choose to recover these 'fixed cost' elements from their customers.

To move from a world of averaged flat p/kWh retail prices, to a world where suppliers may try to give their customers a somewhat sharper time or cost-related price signal or incentive in their retail tariffs to encourage more 'efficient' customer behaviour, is both difficult yet potentially important.

In a world of more cost-reflective retail tariffs, a number of questions are likely to arise with respect to supplier cost-allocation policy. For example, if different cost-allocation approaches are adopted towards different customer groups (e.g. those on flat fully averaged p/kWh tariffs or those on ToU tariffs); or, if only certain underlying costs are to be charged cost-reflectively but not others (e.g.from among wholesale costs, charges for networks, or charges for social or environmental levies) . In extremis, unwinding present approaches to recovery of industry costs could (1) lead to some instability in supplier cash-flow and also (2) very importantly from a consumer viewpoint, could raise significant questions of 'fairness', including for different customer groups. A transition from a world where certain supplier underlying costs (but not necessarily all) are likely to become more cost-reflective in their retail prices and tariffs could potentially confuse consumers, penalize some customer groups and also perhaps disadvantage new entrant suppliers.

In Part I we argued that there may well be a case for disaggregating / unbundling some underlying industry costs in order to face suppliers with greater cost-reflection in some of their charges. However, the manner in which these charges are then in turn to be reflected through into retail tariffs on offer to customers needs careful consideration by Ofgem, by market actors and the consumer bodies. Not least, a better understanding is needed of how to avoid the so-called 'death spiral' - where certain industry peak-related capital costs (eg peak-related network and / or or generator costs) are potentially recovered from fewer and fewer customers. A clearer understanding will be needed as to which industry costs might continue to be recovered on a largely socialized basis and which, perhaps, might not.

73 These charges are presently allocated to suppliers either as a standard charge per customer (i.e. per meter) ; or, on the half-hourly share of consumption (kWh) of their collective customers at a particular grid-supply point (supplier volume allocation).

10.3.2 Is there a net consumer benefit?

The additional costs associated with greater cost reflectivity (including the costs of tariff design, marketing and billing systems) clearly need to be outweighed by the benefits available to both market actors and crucially to the end consumer. It is worth noting, however, that many costs (eg smart metering, costs of half hourly settlement etc) will be sunk costs in other programmes.

It is important to ask to what extent the cost benefit analysis of more cost-reflective pricing depends on the levels of uptake of different types of tariffs and the associated economies of scale. Smart trials to date certainly suggest some customer appetite to try ToU tariffs. However, this needs to be set against the marketing, administration and IT costs related to tariff set-up for a supplier. A critical mass of customers is needed to make a retail tariff commercially attractive[74]

10.3.3 Is it simple?

Suppliers are able to offer their customers simple ToU tariffs on a voluntary basis under present RMR arrangements. More cost reflective approaches to DSR are unlikely to succeed if this leads to unrestrained retail tariff complexity and the 'confusion marketing' which RMR was set up to avoid. Ofgem's Consumer Empowerment & Protection programme will need to ensure that the RMR review in 2017 carefully examines whether the market has been adequately 're-set' to increase consumer confidence to enable the development of more sophisticated tariffs than basic ToU offers. Customer experience and satisfaction data will be needed to prove that this has indeed taken place. Only if this 'reset' occurs is there likely to be a big enough appetite for more cost-reflective pricing being extended to get a better customer-match with volatile wholesale prices in the 2020s. In order to incorporate simplicity into DSR, our expectation would be that few companies would choose to actively pursue excessive / full cost-reflection in retail tariffs, but instead to develop simple / basic DSR products[75] and / or direct load control with automation.

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74 Our informal understanding is that this is likely to be in excess of 25,000 customers for a standard retail tariff. For more complex types of tariff, or any tariff that entails up-front investment in supplier systems or customer equipment, this is likely to be more.

75 For example, one company's offer of a tariff marketed on the basis of 'free Saturdays' might be such a case.

10.3.4 Are distributional impacts understood?

The 'incidence effects', as those that do not take up DSR get ever-more costs loaded on to them, need to be modelled before a move to greater cost-reflection in retail tariffs to any serious degree. This is important so that the scale and impacts of rebalancing are understood in advance. For example, one possible response from suppliers could be to offer ToU or lifestyle tariffs to customers with low existing peak consumption, in the short term to reduce wholesale costs, but in the longer term, potentially, also to reduce a range of other peak-related charges and to protect their future position in a fully half-hour settled world. This could lead to the unwinding of cross subsidies between high and low peak users, and therefore (1) introduce a degree of instability as low-consuming customers opted for ToU, and (2) flat-rate tariffs would inevitably increase. This potential change would be driven less by the positive benefits of DSR and potentially, instead, by supplier tactical behaviour (and in practice 'rational').

10.3.5 Are social protection measures already in place?

Once distributional modelling has taken place, social protection measures to safeguard vulnerable people who cannot shift their demand by time and / or location can be designed. Again these measures will be needed **before** far greater cost-reflectivity in tariffs is introduced. The form such protection takes may need to evolve as tariffs evolve. For example, to ensure vulnerable consumers can benefit from automation if and when direct load control becomes more prevalent, support may need to be extended to helping them buy smart appliances. Ofgem's Consumer Empowerment and Protection in Smarter Markets consultation paper, (discussed in more detail 4 below), rightly recognizes the need to protect vulnerable users, in areas such as prepayment offers and debt prevention and management.

Paper 11 has proposed that a good use of customer-facing demand side innovation R&D funding would be on helping vulnerable users to be able to participate and access the benefits of DSR markets. UKPN's Vulnerable Customers and Energy Efficiency 2013 LCNF Project, which will trial energy efficiency and DSR with fuel poor and vulnerable customers, should provide useful learning here.

Chapter 11. How do you ensure that the DSR market is working at the macro level - and in the interests of household consumers *in general* ?

To address this question, thought is needed as to how the DSR market is characterised, who the market actors are and how the health of that market is assessed.

11.1 Characterising smarter markets

Household DSR has the potential to significantly transform the energy supply market. If DSR takes off, it could lead to many different market characteristics – and different routes to market. At separate ends of the scale, it would in theory in the long term be feasible for:

- The market to move towards energy service companies where bundled services and tariffs give consumers an easy single point of contact but a world where there may be far less clarity in terms of costs and consumer lock-ins (to ensure capital costs are recouped). These in turn could make the market 'sticky' in terms of customer switching; or

- DSR markets to evolve separately from current retail supply markets. Although this could potentially aid cost-discovery for DSR services, the practicality from the consumer view-point of having potentially *separate* DSR contracts from basic retail supply tariffs could potentially be a barrier. There are however clear precedents in the I&C DSR market. Other precedents include: the Green Deal model where equipment costs remain with the meter - and the tariff is billed separately; the PV rent a roof scheme; and some approaches to mobile phone contracts (especially fixed cost treatment). Whether this DSR market 'niche' could become big enough in the household sector to reach a sustainable critical mass is uncertain.

It could be argued that both of the above models are still to some extent 'business as usual' and that the technology that will be available by 2020 will enable very different market models to evolve. Ofgem's recent decision to move all customers to 30 minute settlement could open the door to longer term market developments which could potentially mitigate or eliminate some of the consumer disadvantages of DSR.

Table 1 below sets out some *possible* characteristics of five smarter market models that could emerge. The Table explores the advantages and disadvantages of each from the perspective of GB households. *Many other models would be feasible – and this is put forward here simply to stimulate initial thinking and discussion*.

Table 4 : Potential retail-market characteristics from the consumer view-point

***Potential* retail market shape (i)**	**Advantages**	**Disadvantages**	**Comment**
Model A - Single 'RMR' market			
Retail and flexibility services combined in one market **Consumers have one contract** **RMR shapes market – limited number of simple ToU offers and limited piloting / testing of other DSR**	Simplicity and clarity in the market Consumer confidence is rebuilt Consumers can choose between limited range of basic ToU offers	Dynamic tariffs unlikely to be available outside trials Innovation may be limited Efficiency of the energy system may not be maximized	Most likely option in short / medium term Unclear how 'customer pull' for innovation could exert itself
Model B - Single unconstrained market			
Retail and flexibility services combined in one competitive market **Consumers have one contract** **RMR rules are relaxed so wider range of DSR offers on market, including a wider variety of energy services**	More opportunities for innovation Potentially greater efficiency of the energy system could increase simplicity for consumers Single point of contact for energy services is convenient	Distributional impacts raise questions of fairness Potential lack of transparency / clarity on how costs are allocated Simplicity eroded potentially reducing confidence Comparisons between dynamic DSR offers are difficult	Possible option in long term – but would require RMR market reset to be seen to be effective
Model C - Separate competitive markets for (1) retail supply (flat, averaged p/kWh) and (2) for flexibility			
Consumers can enter two separate contracts – for supply and for DSR. Either with a single supplier or separate contracts with a supplier and a third-party (DNO or aggregator buying for a group of consumers).	Separate contracts for retail supply and for DSR may bring some clarity and aid cost discovery for DSR More opportunities for innovation Greater scope for development of niche services eg for specific groups / localities Possibly simpler for new entrants & aggregators.	Convenience is eroded as consumers have to make two decisions and enter into two contracts Consumers have greater search and friction costs Comparisons between dynamic DSR offers are difficult Costs of operating two markets could reduce system efficiency	Possible option in medium / long term May be more suited to procurement of household DSR services *outside* the wholesale markets (eg for DNOs, System operator, Capacity). Not clear how separate markets would work commercially for suppliers who might seek household DSR services in the wholesale markets.

Model D - Separate markets for (1) 'regulated' retail supply (flat averaged p/kWh) & (2) competitive markets for flexibility / DSR (ii)			
Consumers have one contract for ***either*** **:** • **a 'regulated' retail supply (for flat averaged p/kWh) designed for those who cannot or do not wish to engage in DSR** ***or alternatively*** **for** • **a *competitive* market which *combines* retail supply and flexibility / DSR services.**	Regulated retail market helps address distributional impacts by providing some social protection for those that cannot engage with DSR More opportunities for innovation Potentially drives greater overall efficiency of the energy system Direct Load Control could increase simplicity for consumers	Not as cost reflective as Model C Simplicity and clarity in DSR potentially eroded by reducing confidence in competitive part of the market Comparisons between dynamic DSR offers are difficult Some consumers will have unsatisfactory experience in highly competitive DSR markets – so safeguards still needed, especially for vulnerable customers	Possible option in medium / long term *Maximum innovation* may be driven by unconstrained competitive markets in DSR, flexibility & low-carbon.
Model E – Alternative automated bidding : agents interface with suppliers using software to agree contracts at the best price			
Consumers have one contract with one bidding agent such as an autonomous broker who buys on the market just for them **This concept, adapted from financial trading, would entail each user requesting bids from all suppliers every 30 minutes based on a predicted set of energy requirements, for a set number of periods ahead. The suppliers would then respond with their best price and the broker agent software would agree the contract that would secure the best price for thatr specific consumer**	All customers should in theory receive the best price possible, whether or not they are taking part in DSR Potentially greater efficiency of the energy system Clear price signals should in some ways make the market more transparent, and make it more difficult for market makers to abuse their position in the generation market to affect supplier prices	The complexity in the broker-agent algorithms could make it difficult to get assurance that optimal outcomes were being achieved for all – thus reducing confidence in the market. Also, problems in financial markets may make some sceptical about the merit of extending this type of approach to an essential energy- market *end-customer* service. Tight regulation of broker-agents likely to be needed (gaming etc). Some customers may not be able to predict their energy requirements and may find themselves facing rapidly escalating prices as they exceed predicted usage Comparisons between autonomous broker agents may be difficult.	Possible option in the long term – but many issues still need to be worked through (e.g. how would settlement, billing etc along these lines work in practice) Public debate may be needed to get acceptance of and build confidence in such a significant change in model. The costs of implementing such a system would clearly need to be outweighed by the benefits.

Source : Sustainability First

Notes

(i) In all of the above possible options, consumers could also have additional contracts (eg for appliances / equipment, heating systems etc) which may be direct with the manufacturers or through suppliers, DSR providers or other market actors.

(ii) Even within cost reflective DSR markets, there could be discrete market segments for different types of tariffs. For example, the ToU market could end up being distinct from the Critical Peak Pricing / Direct Load Control / Pre-Pay markets, perhaps depending on which market actors need a particular service (e.g. supplier, network, system operator).

Our initial conclusion is that Ofgem, consumer bodies and market actors will wish to give these and other possible future models for smarter retail markets – & the potential routes to market for household DSR - far more thought. This includes how far different potential models might enable innovation by third parties - while also maintaining consumer confidence and safeguarding the most vulnerable.

11.2 Market actors

As noted in Part I, suppliers large and small will have a pivotal role in development of household DSR in the short to medium term as suppliers lead on smart meters and can get ready and direct access to appliance controls and to their customer information. Given the problems experienced with customer confidence and trust that led to the RMR, established suppliers may however feel constrained in pushing the boundaries in the DSR market. Getting the basics right in the standard credit market may seem like a sensible course of action before rolling out more innovative tariff schemes at scale. Present uncertainty surrounding the CMA referral may also dampen near-term enthusiasm among established suppliers for entering the DSR space. Those that are not integrated and so more fully exposed to wholesale-market price-risk may perhaps be more likely to develop DSR offers. Whatever the position of individual companies, they will be mindful of their incumbent advantage and the potential benefits, and draw backs, of being a first-mover.

Strategic partnerships with trusted third parties could be a way for existing suppliers to test the DSR market. DSR may well, however, also start to make the energy market attractive to new supply entrants. The market of tomorrow could look very different if the likes of Google or Virgin with their strong brands and relatively sophisticated customer interfaces and extensive consumer intelligence were to take part. The Internet of Things, if it evolves as some predict, could clearly radically change the supply landscape. Further strategic activity[76] should not be ruled out.

76 For example, along the lines of the recent Carphone Warehouse & Dixons tie up

If DSR markets were to evolve separately to retail supply markets, local actors could well have a greater role. For example, DNOs could have a clear incentive to obtain DSR services from particular groups of consumers in constrained network hot spots. They could do this through bilateral relations with groups of local consumers (eg social landlords), with the potential for community-level 'rewards, or, through other intermediaries such as aggregators. LCNF and NEA trials will help clarify the potential here.

The extent to which aggregators and other collective switching groups together with local authorities, community groups and other groups of 'pro-sumers' are able to carve out a space in the DSR market and whether this is in partnership with suppliers, DNOs or independently is uncertain. It cannot be assumed, however, that the interests of these groups will always pull in the same direction. If there are conflicting demands, thought will be needed as to how these can best be managed. In Part I, we note that Ofgem's DSR Framework, being developed for the Smarter Markets Programme, will need to consider 'fair market access' to the household DSR market for actors other than suppliers.

The potential role of electrical appliance and electronic product manufacturers may also take on a new importance. Pre 2020 they will clearly play a crucial part in demand reduction via EU product standards. However, how this role evolves into the 2020s and with regard to DSR is less clear. If Direct Load Control tariffs become more attractive, appliance manufacturers could well have a greater role. However, there could well be a 'chicken and egg' situation here. Without the availability of suitable DLC electricity appliances there will be no uptake of DLC services and without DLC services there will be no reason for manufacturers to create DLC compatible appliances. It could be argued that regulatory intervention may be required to ensure that there are enough electrical appliances with DLC and interoperability to allow the development of the retail market with DLC tariffs.

Tie-ups between manufacturers and suppliers to create energy service companies could create 'back-to-the-future' virtual electricity show rooms. Again, the market could potentially fragment here with separate business models for different types of users and potentially specific market niches for different segments and DSR services : EV, PV and Electric Heat (hot water cylinders, storage heaters, heat pumps). Alternatively, aggregators could seek to contract across all of these DSR services.

11.3 **Market health**

Given the potentially significant changes that household DSR development may bring, it is appropriate to ask to what extent traditional measures of assessing the health of retail markets will be relevant in a smarter world. Additionally, depending on how far the standard credit and DSR markets begin to converge or diverge, it is worth considering how different metrics may be relevant for different market segments.

Competition is normally seen as the best method of ensuring wholesale and retail market efficiency, optimal resource allocation and as a driver for innovation. The extent to which barriers to entry are removed so that the retail-side works effectively and new entrants can compete for DSR services will be an important determinant of the health of the market. In an embryonic market, however, it can be difficult to identify where the barriers to entry will be. It is also worth noting that what is a barrier to entry for a fast- moving high tech company could be very different to a barrier to entry for an established supplier, an aggregator, or, to a DNO interested in bilateral location-specific services. In a new and evolving market, it can also be challenging to identify other sources of market dominance or to make way for potentially transformative technical changes.

Encouraging consumers to drive competition through exercising their choice in the market can be a powerful way to lower costs and stimulate innovation in products and services. Smart metering is meant to make switching much easier. However, there is already some question as to how far switching has been a good indicator of the health of the energy market to date. Additionally, the sales practices that drive this have fallen into disrepute. Some consumers may consider that some of the innovations in product-features to date have led to confusion rather than customer benefits and may question how much innovation is indeed possible in a market for what is essentially a homogenous service (noting the differences with the communications market where convergence with *content* has exponentially increased the scope for innovation). Others will point out how the potential convergence of energy with automated appliances means that innovation in the sector may still have significant potential. The choice and control and integrated heating and safety ‘experience’ offered by smart thermostats and alarms, for example, could well point the way here.

However, in the context of DSR, scepticism may well increase, should switching rates slow as result of potential ‘bundling’ of multiple services together : for example with tariff tie-ins and / or contract lock-ins until DSR equipment and kit-related costs are recovered. In the communications sector, bundled contracts with ‘staggered’ end-dates for particular services are understood to have served to make switching more difficult (e.g separate end-dates in a single customer agreement for broadband, TV packages, fixed line rental or mobile). If there were similar bundling developments in the energy sector, alternative ways may well be needed to assess consumer power in the market. These could include contract provisions to enable consumers to ‘try-before-they-buy’ and periodic contract reviews to ensure that consumers are still on appropriate tariff / DSR arrangements. Annual consumer experience and satisfaction surveys carried out by Ofgem could help gauge how effective these measures will be.

In order for a healthy DSR market to develop for transformative rather than just incremental innovation, there may also need to be an assessment of the extent of co-operation - both across the supply chain to deliver useful end-to-end services for consumers - and between suppliers and their consumers. It is worth remembering here that Economy 7 was a 'product' of a far more integrated era and devised for more efficient management of the wholesale / production side and not a retail-driven initiative as such. Regulators will have an important role in facilitating such co-operation for innovation, for example through encouraging the sharing of information between as wide a cast of actors as appropriate.

Our initial conclusion is that metrics and mechanisms that seek to align consumer and company interests in providing a firm response for a dependable, efficient service will be worthy of examination. These are likely to include: a more sophisticated approach to identifying and removing barriers to entry; a better understanding of market dominance; the development of alternatives to switching as a measure of consumer power : for example, 'try-before-you-buy' contract provisions and periodic contract reviews; annual consumer experience and satisfaction surveys to assess the impact of such steps; and new measures to facilitate and assess market innovation and co-operation. Annual reviews of *smarter* market health by Ofgem could also help identify problems with the retail side, in terms of barriers to entry and market dominance, and chart progress to addressing them. However, in the end, the mechanisms needed are also likely to go beyond these more traditional economic levers and short-run measures and also focus on long-term relationships and how these are built around a common set of long-run commercial objectives and consumer-led needs and values. This may require greater attention to corporate behaviour and governance. Assessing the impact of the RMR's commitments on 'fairness'(where suppliers now have legally binding standards of conduct to treat consumers fairly) will be instructive here.

Chapter 12. Empowering and protecting consumers at the individual level

This section builds on SF Paper 8,[77] and the principles outlined there, to discuss some specific issues around DSR tariff development at the individual customer level.

There is clearly a need to balance the information consumers need to participate in markets on fair and informed terms with the fact that by participating in DSR they will be taking a risk which will hopefully be beneficial,[78] but if not, that they can extricate themselves quickly and painlessly. This could be through 'try before you buy' arrangements (accepting that some re-payments may be necessary if customers have had kit installed) which could enable incremental experimentation in a least-cost, least-loss way.

12.1 Education and information

DSR is likely to be a complex proposition for many customers, and a lack of awareness and understanding could be as great an obstacle as any technical or regulatory barriers. Making DSR comprehensible and accessible will not only speed its uptake but will also make its impact more equitable, since in the absence of clear and simple information, participation is likely to be limited to those few consumers who have the time and education to engage with a subject that is potentially confusing.

It may be that the greater availability of consumption data enabled by smart meters will trigger a general improvement in consumers' grasp of their usage and what it would mean to shift it. On the other hand, the current low levels of trust in energy companies could make it less likely that significant numbers of consumers will want to engage in an unknown and untested new process[79]. It is worth noting, however, that evidence from LCNF trials shows that some consumers do have an appetite for innovation and DSR and are certainly willing to engage[80]. To stimulate wide spread engagement, there is an onus on the parties offering DSR tariffs or

77 Sustainability First. Paper 8. 'Electricity Demand and Household Consumer Issues'. July 2013.

78 60% of those who took part in the recent BG CLNR ToU trials were gainers overall.

79 Ofgem. Ipsos Mori Report. Customer Engagement with the Energy Market : Tracking Survey 2014. p.9 & pp 46-47.

28% of customers responded that they tend to trust their energy suppliers to be open and transparent in their dealings with customers ; 27% responded 'neither trust nor distrust' ; 44 % of customers responded that they tend to distrust their energy suppliers to be open and transparent in their dealings with customers.

80 Also, recent research carried out for the Smart Meter Central Delivery Body suggested that customers with smart meters, when asked about lack of trust in their energy supplier, may express a higher level of trust than those who do not (30% versus 42% indicated a lack of trust). 'Smart meters help consumers trust UK suppliers, finds UK survey'. 11 June 2014. 10,000 adults surveyed.

services to accompany these with a clear explanation of the mechanism and benefits. Beyond that, there may be a role for other organisations to provide a broader programme of education and engagement and basic smart meter / DSR / ToU tariff information. Lessons should be learned here from the range of trials and research that is being undertaken in the UK, from overseas and from other comparable sectors and successful change and behavioural economics programmes (e.g. the 1988 'Fire Kills: You can prevent it' campaign, the more recent 'Change 4 Life' initiative and digital TV roll out programme).[81]

It would not be desirable or feasible to mandate one style of communication for all DSR offers. Decisions about information material to accompany a specific tariff or service will ultimately be up to the party making the offer and will be principally determined by the market. The basic minimum that should be assured by the regulator is that offers do not mislead and come with enough information that an ordinary consumer can make sense of both the risks - and potential benefits. Some customers may of course also themselves seek out market actors to indicate what they are able to offer to the market – in which case information about DSR products *needed* by the market will also need to be clear.

There is also a role here for Smart Energy GB[82]. In their recent consumer engagement plan the introduction of more complex time-of-use tariffs is referenced as one among several medium-to-long-term benefits of the smart meter roll-out. Smart Energy GB's smart meter campaign therefore has the potential to lay valuable groundwork for DSR. But, the risks and benefits to consumers first need to be much better understood if, for the future, Smart Energy GB is to take on a role of *promoting* household DSR.

On a larger scale, organisations – including those without a vested interest in DSR services – might choose to provide information on a more general basis. Suppliers, trade associations or aggregators could decide to provide this kind of resource, but it might also be appropriate for this role to be filled by Ofgem[83] and/or other groups such as local authorities, community groups, housing associations or charities such as Citizens Advice or National Energy Action. This information might include: guidance on the variety of DSR offers available and on which kind might suit consumers according to their situation; advice on how to shift electricity usage; a ballpark estimate of what savings customers could reasonably expect for a given behaviour change; information on how customers will know when peaks are and how much they may be saving on a given offer at a given time[84]; and a guide to the common pitfalls of DSR and how much consumers could lose out. It is also possible, as we observed in papers 8 & 10, that energy companies may work increasingly closely with public or third sector groups in order to get their message about DSR across to consumers.

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81 SmartGridGB (2013), 'Smart Grid: A great consumer opportunity'

82 previously the Smart Meter Central Delivery Body

83 Who have already produced a basic factsheet: https://www.ofgem.gov.uk/ofgem-publications/63998/20130430how-managing-your-energy-use-could-help-you.pdf

84 The Irish electricity smart meter trial final report showed that consumers – even those who saved electricity – were confused about this.

Mis-information and mis-selling also need to be thought-through in detail to safeguard positive market developments and the specific actions that market actors will need to have taken to avoid this, need to be clarified. This could be along the lines of Green Deal energy efficiency criteria checks.

Our initial conclusion, given that not only basic voluntary ToU offers but also more sophisticated DSR tariffs (including direct load control of appliances) are in theory possible from day one of the smart meter roll out, is that it is important that DECC, Ofgem, the CDB and consumer bodies start to consult *now* on what consumer education and information requirements will be needed around DSR offers to ensure clarity and transparency in the offers that start to emerge.

12.2 Comparing price and service

The ability to compare tariffs will be essential to consumers' ability to get a fair DSR deal. Customer appetite for an 'appropriate' range of financial reward for shifting their usage is still to be established, and in order for competition to function effectively in setting a price- point for DSR, different DSR and non-DSR offers must be easily and accurately comparable. For this to happen now, given current supplier data-access restrictions, customers have to explicitly 'opt-in' to data sharing. The smart meter programme review of data-access rules, scheduled for 2016, will be important in establishing whether this is proving to be a barrier. A lack of comparability based on real-user profiles could stall the development of a DSR market. It could also lead to a persistently inefficient market, as illustrated by the current situation with Economy 7.[85] For new DSR offers to improve on this record, new tools and/or rules to facilitate comparison may be required.

As noted above, Ofgem's Consumer Empowerment and Protection Programme will wish to clarify how DSR will sit with the Retail Market Review (RMR), given that one of the aims of the RMR was to make it easier to compare tariffs. Furthermore, the Tariff Comparison Rate (TCR) introduced by the RMR will not be applicable to DSR offers in its current form. The TCR combines a tariff's unit price and other associated costs to assign an approximate price in p/kWh, but this could not usefully apply to a ToU tariff. Even if each time band was assigned its own TCR, the picture of the tariff would be incomplete unless there was some way to factor in a consumer's current usage pattern, how much load-shift would be needed to make a saving, and a consideration of the possible 'inconvenience cost' of that load-shift. Data from GB DSR trials can be a useful indication of the elasticity of the average consumers usage[86]. These trials have consistently shown that customers on average shift peak by 7-10% and on average reduce

85 Consumer Focus (2012), 'From devotees to the disengaged' : research found that 38% of Economy 7 customers were not in a position to save money from the tariff (as they did not have a storage heater or run any extra appliances at off-peak times).

86 For example, see : 'Further Analysis of Data from the Household Electricity Usage Study. Electricity Price Signals and Demand Response. Report for DECC & DEFRA by Element Energy. 4 April 2014.

overall consumption by 3%. However, for those in the 'tails' of this average distribution, the picture could of course be different. It's also important to remember that in order for all sides to gain the benefits of DSR, sustained behaviour change is needed – even if household circumstances change.

More useful might be the provision of **detailed examples as a part of a comparison tool -** so that a ToU TCR would give a result along the lines of 'this tariff would cost X with a load shape of Y, and would offer Z savings if the dishwasher was run at night/a storage heater was installed/the fridge was automated etc.' This is only one example of how the problem could be approached however, and other examples of even greater complexity, would be needed to accurately compare dynamic ToU tariffs or other DSR-related services. Providing comprehensive comparison tools to cover every option is unlikely to be feasible, but in that case it should be recognised that customers choosing DSR offers may be doing so to some extent with their eyes shut.

Ofgem have stated their intention to develop an extension to the Tariff Comparison Rate that will accommodate ToU tariffs (if not more complex forms of DSR), and other parties such as price-comparison sites or energy companies might decide to try to do the same, but it remains to be seen whether it is possible to devise a satisfactory tool of this kind. Certain resources might be a partial help but not necessarily fully solve the problem. For instance, the Ontario Energy Board has developed an Energy Calculator which allows consumers to compare three-band ToU offers on the basis of how much of their usage falls into each band. This is certainly a useful prop, but it makes a number of assumptions including that (1) all available tariffs have the same time bands, but different prices (as is the case in Ontario) and (2) the consumer's future usage is known and either fixed or changeable in an easily predictable way. Only highly engaged and numerate consumers are likely to want to experiment with inputting different usage splits to test this. These points call into question the extent to which some consumers will be able to actively engage in this way. This situation may be no different to the position with mobile phones, but electricity supply is arguably a more essential service.

Clearly, as the market evolves, more ways of comparing offers may become apparent. For example where a consumer downloads a file containing 12 months of half hourly smart meter consumption, it could provide them with a data-file that could be used on a price-comparison website, thus resolving some of the difficulties of comparing time-of-use tariffs with different peak- and off-peak times. How price comparison services respond to the new possibilities of DSR, and the extent to which these are seen as independent and robust, will help shape regulatory interventions in this area.

In conclusion, Ofgem, market actors and consumer bodies will need to be confident that producing DSR comparison services and tools are practically achievable and usable, reliable and cost effective if they are to be promoted further.

Given the significant practical difficulties of developing and using a meaningful DSR comparison tool, several *options* would be open to the regulator or, on a voluntary basis, to energy companies, to make offers more comparable. For example :

- A degree of complexity could be removed from comparing static ToU tariffs if time bands were broadly standardised, as is the case in Ontario, or, indeed with Economy 7 and

Economy 10[87]. This option would not be compatible with all DSR services, but need not stand in the way of a common goal for suppliers and DNOs trying to avoid high costs at a particular time of day.

- If smarter markets evolve in such a way as to separate out certain household DSR services (eg Balancing Services to National Grid) (see Table 1 in section 2 above), it may in some ways make customers' choice more manageable. This might enable the concept to be grasped more quickly by customers and the incentives more directly compared. However, this would increase the number of choices the consumer had to make, and contracts that they would need to enter into, which could be off-putting for some and could be seen as adding another layer of complexity in an already difficult market. This concept of 'multiple' contracts may well also be difficult to apply to some demand-side markets. For example, ToU or price-matching tariffs designed to deliver greater *wholesale* market cost-efficiency.

- The surest way for consumers to evaluate both the financial and non-financial outcomes of a load-shifting deal would be a trial period. Parties offering DSR might find it advantageous to offer this kind of 'try-before-you-buy' trial, and it would also be possible for the regulator to insist on this possibility if no other means of comparison could be found (although it would be important that consumers repaid the costs of any DSR equipment installed if they exit early from their trial period). In practice, this would help to compare a DSR offer to a consumer's current arrangement, but it would not solve the problem of comparing two or more new offers at the same time. Thought would be needed on how many offers might be trialled sequentially by a consumer without incurring exit penalties.

Given the limited savings that may be achievable from DSR offers (at least in the near-term) and the time it may take to compare them, some customers may not consider that it is a good use of their time to do this. They may give higher priority to making decisions that have a greater net impact, particularly over the longer term – such as decisions on purchasing new heating or storage systems. Regulators and other actors may need to recognise that not all customer choices necessarily carry the same weight and providing comparison information to aid these other more basic decisions may be more productive than trying to produce a comprehensive smart tariff or DSR comparison service[88]. In smarter markets, accreditation schemes for energy tariff comparisons may need to be complemented by mechanisms to ensure that less frequent but more significant household energy decisions, such as buying new storage systems, can be based on accurate and comparable data. These could clearly build on the experience of the Renewable Energy Consumer Codes, which cover things such as pre-installation visits, sample quotations etc.

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87 As with Economy 7 and 10, it might be necessary to introduce a degree of staggering or randomisation to avoid ramp-up problems

88 See later footnote on an 'Energy Pyramid'

As long as DSR is voluntary, it could be argued that problems with DSR tariff comparisons and tariff complexity can be restricted to those that choose to take them up. On the principle of 'buyer beware' and with appropriate warning, any difficulties could potentially be self-limiting. Different rules could thus be designed regarding complexity for DSR as opposed to standard credit tariffs. Following this logic, a case could be made that no rules may be needed at all : if it is too complex, there would be low take-up. Again, the example of the mobile phone market could be used where some claim that although no one is necessarily on the 'right' tariff, the market has nevertheless delivered significant and desirable benefits around services and innovation.

This point of view, however, may need to be weighed against the point that complex DSR tariffs, even if only marketed for a relatively short period of time, could have knock-on effects in terms of customer confidence in the wider market. The potential perceived impact of DSR tariffs which are confusing or over-complex on the wider energy supply market should not be under-estimated - given current levels of consumer confidence and the essential nature of the service. An assessment will be needed as to how customers perceive the market and how aware they are of how it works and their rights and choices within it.

In conclusion, it may therefore be advisable for Ofgem to seek prior agreement between market actors on the need to address the issue of tariff complexity and comparisons for all consumers in a strategic and co-ordinated way - rather than relying on post-event regulatory interventions.

12.3 Ease of switching

The importance of switching between DSR offers is closely linked to the difficulty of comparison.

Even with implementation of the kind of the measures noted above, engaging in DSR may be a risky and unpredictable option, so unconstrained switching would be needed as a backstop. The new DSR market will only develop if consumers feel confident to experiment, and any suggestion that they could be locked-in to DSR offers may seriously damage this confidence. As discussed in section 2, it would be simplistic to take switching rates as a straightforward measure of market health, but given the need for customers to explore new territory, other things being equal, any impediment to switching would be damaging to the DSR market other things being equal.

In addition to its broad effect on customer willingness to participate in DSR, impediment to switching could also inhibit the process of 'price-discovery' for consumer flexibility in the DSR markets. Where consumers are free to opt-out of a DSR offer, they can weigh up the potential 'reward' available to them from a change in their consumption pattern - against what they might pay on a flat p/kWh tariff, or, perhaps pay on an alternative DSR tariff. The level of reward therefore starts to indicate a 'value' in the market – both for market actors who want to procure a DSR service and for customers willing to make their DSR service available. However, if

consumers are tied into a particular DSR arrangement, any change in their behaviour may instead become rather more linked to avoiding some form of penalty. Without an ability to switch fairly readily out of a DSR arrangement, consumers may therefore find themselves pushed towards providing more flexibility at a given price than they otherwise might. While in the short-term this outcome might seem desirable from a market actor viewpoint, in the long-term this may not be either desirable or sustainable from the consumer point of view (even where some customers may allow themselves to be 'penalised' simply through inertia).

These arguments need to be weighed up against the case for DSR offers, where it is hard not to envisage some form of 'lock-in'. For example, it might be possible for suppliers or Energy Service Companies (ESCos) to offer DSR as an intrinsic part of equipment purchase to reduce pay-back periods (eg for heating, hot water or storage). Such offers could be constructed on a similar principle to the Green Deal's 'golden rule', that is, using some or all of the savings attributable to that equipment. This model would have certain advantages, in that it would address the problem of some forms of DSR being dependent upon upfront costs of equipment that might otherwise be prohibitively expensive. However, there would also be practical difficulties around estimating savings in advance, attributing them during the payback period and preventing mis-selling. In addition, in the Green Deal, the 'golden rule' ensures that the customer never loses out because payments are offset against savings. By contrast, commitment to a particular DSR tariff or service, could in some situations (e.g. a change in household circumstance) push the net benefit into negative and so break the 'golden rule'.

Apart from offers that would firmly lock customers in, certain aspects of the smart grid architecture may pose barriers to switching once smart appliances are introduced. Although significant efforts have been made to ensure interoperability with smart meters and also via consumer access devices (CADs), it is nonetheless possible that an automation system provided or operated by a service provider, or indeed purchased by the customer themselves, might not be compatible with other kit. 'Smart product' labels could ensure that consumers are made aware of this before entering into such an arrangement, including, arguably, purchase of smart thermostats and / or other smart controls.

Switching between DSR offers might also be inhibited by the diversity and liquidity of the market, since there may be no directly equivalent deals available. This effect might be an argument for standardising DSR offers as discussed above in relation to time bands, at least in the early stages of the evolution of smarter markets. Likewise, increased complexity of contracts might make switching harder. For example, if a situation was to emerge where customers were in contracts with multiple parties, and those parties were perhaps in contracts with each other for access to data and meter commands, then changing supplier without changing ESCO might cause problems. As part of the broader question around regulation of ESCOs discussed below, consideration should be given to smooth transfer of an ESCO contract from one supplier to another. Clearly, the importance of removing barriers to switching and ensuring interoperability needs to be weighed against the risk of stymying innovation.

12.3 Responsiveness and redress

If consumers are to take a more active role in their energy-use and enter into more complex market arrangements, systems for protections and accountability will need to evolve accordingly. At the most basic level, energy companies will need a strong awareness of their responsibilities to grow a DSR market which is responsible and therefore successful. They will need to ensure that they have sufficient resources to deal with the increased level of enquiries and complaints that DSR will inevitably trigger. At the other end of the spectrum, as section 5 explores, a strong consumer voice and active feedback will be key.

Should the market evolve in such a way that consumers are able to enter into more than one agreement for their energy (See earlier Table e.g. if supply and DSR markets are somehow separate transactions), there is a particular risk to accountability. Clear lines of accountability need to be drawn in these situations, from a legal, operational and communications perspective. If for example a smart appliance manufacturer provides a fridge through partnership with a supplier, and it is automated by an aggregator responding to calls for DSR from a DNO or potentially the National Grid, then:

- It should be clear to the consumer who to contact in the event of a malfunction or a query. There should ideally be a single point of contact rather than multiple depending on the nature of the problem, and this should be clearly advertised from an early stage of the arrangement.
- It should be agreed between all parties who will be responsible for each eventuality of fault repair and maintenance, and DECC, Ofgem and consumer groups should be responsible for stress testing this accountability and ensuring that there are no cracks that could leave the consumer 'stranded'.
- There may be a legal question of liability if, for example, in the event of technical or operational error – especially in respect of refrigeration.

From the customer viewpoint, complex contractual arrangements are undesirable. The regulator (or regulators) may wish to consider certain standard 'model' features in a DSR contract to clarify accountability and liability in a given situation. Another option would be to leave these matters out of contracts altogether and handle them through licence conditions or similar. But, this may require certain licence conditions to extend to parties such as ESCOs or even, somehow, to appliance manufacturers. The complexity of the risks and solutions in this area require consideration by regulators, but this may be preferable to acting only retrospectively.

Contractual complexity with multiple parties may also fuel consumer concern around data ownership and protection. It cannot be assumed that resistance amongst some groups to bodies holding data about their daily routines and private lives will have abated by the time that DSR is more widely available.

Chapter 13. Regulatory and policy frameworks

Energy markets, policy and regulation face an uncertain political environment. Ofgem's Consumer Empowerment & Protection programme, the impact of RMR, the outcome of the CMA review and potential political change could all lead to significant change. In this context it is challenging, not just for market actors, but importantly also for policy makers and for regulators to navigate their way through the clash of two worlds – that of energy utilities who may be generally 'risk averse' and that of 'fast-to-fail' communications and IT companies. The pace of change in the latter and the potential dawn of a fully digital, interconnected end-to-end and increasingly automated energy sector - underpinned by massive computing power for processing vast data-sets - makes it difficult to assess how best to set the frameworks for DSR so that ordinary consumers are protected without, crucially, stifling innovation and market development.

Taking the stance of letting the market emerge on its own - or through the development of self regulatory checks – on the face of it has much to commend. Regulators and policy makers find it hard to second-guess let alone create markets. And regulation can clearly make markets less attractive to new entrants. However, given the essential nature of electricity supply, current low-levels of confidence in the sector and the fact that some changes have a long lead-time before their effectiveness can be assessed, a complete absence of regulatory oversight or policy intervention is also not an option. So how best to achieve the right balance ? And over what time-horizons are various regulatory activities most appropriate ? Distinguishing between near term, medium term (beyond 2018) and long-term actions may be helpful.

13.1 Regulation and policy – priority and focus?

From the consumer view point, a clearer and more logical hierarchy of regulatory and policy focus would be helpful in smarter energy markets. For example, this could start from the remaining standard credit market then move through thermal insulation and energy efficiency, to micro-generation and DSR[89]. Priorities for DSR may need to focus *initially* on providing targeted regulatory backstops for those customers that are unable to engage or those who have suffered licence breaches. As section 12 notes, Ofgem's Consumer Empowerment and Protection document proposes a phased approach. However, this does not necessarily mean that policy makers and regulators should wash their hands of the remaining household customer base in the early days for DSR. There is much that can still be done for this group but in a world where innovation is to flourish and be encouraged, different approaches may be appropriate. This *could* include providing the right conditions for consumers to play an active part in the market (such as ensuring offer information is comprehensive, clear, simple and as comparable as possible) and proactive enforcement of general consumer law (for example around mis-selling)

89 One depiction of this suggested to us was an 'Energy Pyramid' to give an order of priority to management of a building's energy-use : (1) demand reduction ; (2) energy efficiency ; (3) micro-generation and, possibly, (4) DSR to sit on top of that pyramid. Clearly, not all customers will either wish or be able to engage with all the activities through the entire pyramid.

and facilitating the use of class actions. However, we note that in the communications sector, much regulation remains sector specific.

13.2 Regulation and policy in converging smart markets

Given the potential for rapid convergence in household DSR between the energy and communications worlds, there is a need for greater co-ordination between different regulators and policy makers. Ofgem, Ofcom, DECC, DCMS & BIS need to lead. But others, such as the Information Commissioner's Office, BIS (for appliance and building standards), DWP / BIS (for changes to debt management practices) and DfT for EVs will also need to be involved. Such coordination is presently in its infancy via the UK Regulators Network (UKRN), which covers economic regulators, but not relevant government departments and the ICO. Nor is the Network's initial priority likely to be strongly focused on smart and / or bundling and convergence of energy & communications retail markets and services, although one of its priorities for 2014/15 is 'promoting customer engagement and switching in regulated markets.'

A thorough understanding of the dependencies and different time scales to which different actors are each working will be required, particularly when the impacts are driven internationally or from Europe (where this is clearly still a desire to push for more choice and more consumer offers in less liberalised markets) [90]. Only once this picture is better understood can joint goals for consumer safeguards in a smart world be developed, clear roles and responsibilities be assigned and protocols for data-sharing agreed[91]. Understanding and thereafter breaking down the policy and regulatory silos in this way will be crucial if greater efficiency and more innovative solutions are to be achieved. The UK Regulators' Network may help partly to fulfill this function in the early days but it does not involve all the relevant bodies or necessarily have adequate resources to drive forward thinking in the smart consumer area.

90 For example, EU legislation on debt management.

91 For example, it may be more appropriate for the DfT to lead on regulations around product standards on EV charging mechanisms than Ofgem

13.3 Dealing with uncertainty – scenarios and modelling

Even with a more joined up policy and regulatory framework, there is still likely to be significant uncertainty surrounding the push and pull for DSR. Scenario and modelling work can help regulators think through how best to fulfill their roles in this area and will assist in future-proofing the frameworks they develop. The work done by the DECC / Ofgem Smart Grid Forum, the Transform network model that the Forum anticipate, and the work on regulatory and commercial issues of Work Stream 6 is welcome. Nonetheless, how strongly these will factor-in the consumer view-point, or the needs and timescales of the different actors identified above, still needs some clarification[92].

In paper 11[93] we suggested a need for demand-side scenarios to be developed, either by DECC and / or Ofgem. For example, such modelling may help to shed light on whether there is likely to be an '80/20' rule in smarter markets, where 80% of householders are able to engage and 20% need safeguards - or whether indeed it could be the other way round. Modelling could also help work out how different changes will need to come together if DSR potential is to be realized. For example, it could assess whether the rate of building of homes which are large enough to include space for the energy storage required for some types of DSR is sufficient for this to be practicable. There is clearly a role for consumer representatives to help test the assumptions that underpin such scenarios to ensure that they stand-up to lived-experience and practical application.

Modelling and development of demand-side scenarios would enable policy makers and regulators to explore in a more systematic way than now what policy options and responses might be if, for example: voluntary DSR failed to lead to adequate scale to be sustainable; or if too few flexible and controllable household appliances are bought by customers; or if only customers with certain household or load-characteristics engage in DSR. It would also help DECC, Ofgem, market actors and consumer bodies to explore questions such as what combination of circumstances might lead to consideration of regulated or mandated DSR, and, if so, in what ways this might best be targeted or achieved (e.g. because security of supply was at risk). Such scenarios could also consider how consumer acceptability and potential consumer resistance to DSR might impact and possibly be addressed.

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92 We are pleased to note that Workstream 6 now has sub-groups dedicated, inter al, to Consumers and to Community Energy.

93 Sustainability First. Paper 11. 'How could electricity demand-side innovation serve the electricity customer in the longer term ?'. Joint paper with Frontier Economics. April 2014.

13.4 Policy flexibility – different approaches

A range of regulatory interventions are likely to be needed rather than a 'one-size-fits-all' approach, and given the levels of uncertainty, incentives for specific actors could be counter-productive. Regulatory interventions might cover harder levers as well as softer behavioural and reputational approaches. National and local approaches should also be considered, the latter enabling the trialling of new techniques and tools.

The role of the regulator and policy-makers in facilitating the changes necessary for household DSR development is important. Both need to recognize the role that they can play not only in providing fair market access (removing barriers to entry and bottle necks in the system) but also in developing a 'forward view' as well, at a more prosaic level, access to, sign-posting and sharing information that is needed to make a DSR market work.

Regulation and policy will need to evolve over time : as the market takes shape, as the potential for DSR is revealed; and as changes in the attractiveness of different types of tariff emerge (potentially more scope initially for ToU to more eventual demand for Direct Load Control). Ofgem's 'Consumer Empowerment and Protection in Smarter Markets' consultation takes this kind of phased approach, identifying three project phases: foundation (to 2015 and the start of the mass smart meter roll out); innovation (until mid 2018) ; and emerging market models for up to 2020. These phases seem like a sensible approach but will be need to be kept under review and may need to adjust as things change. The fact that focus on marketing and sales does not occur until the innovation phase may, for example, need review in the light of continuing issues around mis-selling. Similarly, the fact that debt prevention and management tools for smarter markets are not the focus until post-2018 could be problematic given rising fuel poverty and the need to get social safeguards in place *before* consumers are fully exposed to a full-blooded DSR market.

As DSR evolves, regulation may need to extend into new areas. For example, consideration is already being given to extending some regulatory licence requirements to groups such as aggregators and third and fourth generation intermediaries.

13.5 Regulatory back-stops

In order to build consumer confidence in the newly emerging DSR market, it will be important that there are clear regulatory back-stops in the following areas, **before** the markets are developed further:

- **Enforcement** – speedy and meaningful enforcement action should be taken when licences are breached, particularly in high profile areas such as mis-selling. Regulators will need to work together pro-actively to monitor trends and outliers in the newly developing markets in order to be able to identify when such action is appropriate and what form it should take.

- **Safeguards** – These will be needed primarily for vulnerable consumers and those who cannot engage with the DSR market. The definition of vulnerability in respect to DSR will require careful consideration, but it is likely to include those with electric heat and no storage, people in rural areas and those off the gas grid. Specific targeted protections may also continue to be needed, or indeed to be tightened, for consumers who cannot shift their load and remain on standard credit tariffs. Finally, if direct load control develops, customer safeguards will need to enable customers to over-ride controls[94]. Depending on the results of modelling, if the majority of consumers (the '80%') choose not to voluntarily engage, there could be an argument for safeguards also being extended to them too.

Table 5 below explores some of the possible options for social protection in smarter markets and raises some associated questions. We put these forward not as our firm conclusions but to stimulate discussion. Some of the measures proposed would clearly be dependent on how smarter markets evolve (see previous Table 4).

94 ie an over-ride facility will need to be a part of any initial contract, albeit a customer 'penalty' for over-ride may be involved

Table 5: Possible options for social protection in evolving smarter markets

Possible social protection measure	Associated questions for discussion
Targeted retail price re-regulation for those that cannot engage with DSR	
This could be in the form of a regulated 'social' retail tariff	Should this only be available to those on certain passport benefits? Should those who do not want to engage (as opposed to who cannot) be able to take up such tariffs? Would the expected changes in the pre-payment market reduce the need for such intervention? Or alternatively, make such tariffs easier to target and deliver?
Contractual mechanisms	
Could include 'try before you buy' clauses	How would you ensure that market actors were able to re-coup the costs of any capital equipment they had installed in the trial period? Would 'trial-periods' yield meaningful data and give a true picture of how much consumers may be able to save once signed up? How long would trials have to be to provide meaningful data? Eg would they need to cover at least one winter? How would you avoid people just trying out a number of offers in succession to avoid any down-side risk?
Limited liability	
Losses to the consumer from DSR offers limited to a certain range to protect people from significant bill shock	How would you set the limits? How would you administer such a scheme and at what cost? Would it be practical? To what extent would this erode the signals necessary to get behavior change?
Next generation intermediaries	
Third parties acting in the public interest could make energy decisions for vulnerable consumers	To build consumer confidence, would these groups need to be regulated themselves in some form? How would you know that these groups were making the right decisions for diverse groups of vulnerable consumers? Who should pay for such groups to do this work?
Source : Sustainability First	

13.6 Regulatory principles

Given the uncertainties that exist around smarter markets, a principles based approach to regulation has merit. In Paper 8[95], we identified a series of principles that could help provide a stable regulatory rule-set against which to judge the DSR market, and DSR offers. We consider that the following principles still hold and would be very useful from 2015 onwards – especially in Ofgem's 'phase 1' for smarter markets:

- **Clear regulatory and policy objectives and consumer outcomes.**
- **Clear DSR propositions.**
- **DSR offers appropriate to the customer.**
- **Clear information.**
- **Flexibility for the customer.**
- **Customer choice.**
- **Well-timed offers.**
- **Intermediaries and aggregators able to protect the consumer.**
- **Dispute resolution and remediation processes in place; and**
- **A thorough understanding of the distributional impacts of the proposal.**

95 Sustainability First. Paper 8. **'Electricity Demand & Household Consumer Issues'.** July 2013. Discussed in detail at pages 62-64

Chapter 14. Consumer Voice

The challenge of building and maintaining consumer confidence as an essential household utility service undergoes a long-term transformation to potentially greater cost-reflection and DSR was always going to be difficult. Add to this present low levels of public confidence in the energy sector, a widely perceived breach of industry stewardship, the fact that there are still some monopolistic elements and a backdrop of rising prices and the task becomes significant. Given these points, it is worth stepping back and asking what role the consumer voice should play in the smart world and what form it could best take. Wider debates in society around inclusive capitalism and the social license to operate of essential service providers make these questions timely.

14.1 What role should the consumer voice play?

The primary purpose of consumer advocacy is to ensure that the interests of consumers are understood and reflected by policy makers, regulators and above all companies in their decisions.

Consumer interests clearly have both a long and short term dimension. In the long term, security of supply and sustainability, and hence reliability, are important. Shorter term issues are more focused around ensuring good-quality services and consumer choice. Both short and long term consumer needs combine to have an impact on costs that in turn influence affordability.

This picture is familiar. What is likely to change in the smart world, however, is how the consumer interest could become increasingly bespoke / fragmented and how this could potentially happen relatively rapidly. Indeed, as consumer segmentation becomes more sophisticated, it may not be very helpful to talk about the 'smart consumer' as it could become increasingly obvious that not all consumers are the same. Even a simple binary split between those engaged in DSR who can fend for themselves and the disengaged or vulnerable who need protection could become more difficult in the future.

Just as this complexity will be challenging for regulators, so too will it be challenging for consumer advocates. Once the lid comes off on cost reflectivity and segmentation, it may be impractical to put it back on. Consumer advocates will therefore need to consider carefully how best to balance their 'pro-active' role in helping to set the smart agenda and shape market developments which have the full range of consumer interests at their heart, and a more 'reactive' role in terms of helping the markets that emerge to operate smoothly in the interests of specific consumer segments.

Given the potential technical complexity of smart approaches and the interaction of DSR with wholesale and capacity market issues, along with the big distributional questions that are raised, it could be argued that the more proactive strategic advocacy role is best left to policy makers and regulators. In such an analysis, it may be seen as more effective for consumer advocates to focus on more detailed delivery and acceptance issues such as how services and tariffs are designed. After all, even this more limited remit would require extensive consumer in-put and resourcing as DSR offers would need to be considered as part of the end-to-end customer journey and be tested against practical day-to-day adoption.

Focusing the consumer voice chiefly on delivery issues however, would remove a potentially important source of external challenge as to whether the long term benefits of household DSR indeed flow back to customers at the macro level. An independent strategic consumer voice can play a vital role in establishing a fresh consensus amongst different consumer segments about what their future interests are in the smart world. Without a strong consumer voice in these more strategic debates, the public may not really feel part of, or able to strategically influence, future energy market development and therefore DSR development. Without consumer in-put at an early and formative stage in these discussions, consumers may feel that the die have been cast and there is little point in any further involvement. This sense of something 'being done' to people, rather than 'with people,' may be exacerbated if debates around data-ownership in the smart world become more heated.

Taken together, these points could clearly and unfortunately serve to erode consumer confidence. As has been seen in recent years, this could well increase political interest in the sector. The resulting rise in uncertainty, if it led to delays in smart investment or increases in the cost of capital, would not be in the long-term consumer interest. Declining levels of public confidence and trust could also make it more difficult to get people to recognize their personal responsibilities in terms of managing their energy usage to support overall electricity system efficiency and also therefore to help tackle climate change. It may make some households reluctant to seize the opportunities of energy efficiency, micro-generation and DSR and become part of the energy solution. A strong consumer voice therefore seems important not just for its own sake but also as an enabling force to help policy makers, regulators and companies work more effectively.

14.2 What form should the consumer voice take?

There are sound arguments for the form of consumer advocacy following the function / sector and having different arrangements depending on the purpose.

A strong, central and independent consumer body, able to deal with long-term issues which effect the macro consumer picture, is clearly important. Having a consumer voice wholly separate from companies has the advantage of increasing public trust. Being separate from the regulator should enable the body to focus purely on the consumer interest rather than a potential multiplicity of goals. The model of having a consumer panel which is separate to but located within the regulator, as is the case with the Ofcom and Financial Conduct Authority Consumer Panels, could be one way round this latter point. However, a perceived lack of independence from the regulator could become an issue in the highly charged world of energy. Such arrangements may also reinforce sectoral silos and make it more difficult for the co-ordination that will be needed between sectors and regulators to ensure that the end-to-end demand side customer journey is understood and the impact of consumer engagement is maximised.

From April 2014, as well as its existing advocacy work, the Citizens Advice service is funded through licence-payer levies to represent the interests of future energy consumers - and it has committed to work on smart issues and DSR over the coming year. Going forward, it remains to be seen how far it is appropriately resourced to maintain a focus on longer-term strategic issues (DSR included), given the many significant and pressing demands in delivery of its front-line

service, plus major developments such as RMR and the CMA referral. Also unknown is the extent to which the Citizens Advice service will be able to extend its future consumer work across other regulated and non-utility sectors so that it is able to identify synergies and dependencies in a smart energy DSR world. Once Citizens Advice has had the chance to bed down its consumer 'futures' work, the new consumer landscape arrangements will benefit from a formal review to assess how fit-for-purpose these might be in terms of helping to shape strategic energy decisions, including on DSR in a rapidly evolving smart world.

In terms of ensuring that the consumer voice is heard on questions of DSR retail tariff development and delivery, again the Citizens Advice service has a crucial role to play. Here, the front line nature of its operations should be a strength and enable real consumer experience to be recorded and fed back in a systematic way to companies. Other agencies, such as NEA (National Energy Action), can also play a role here. Another option for the development of a consumer voice on more operational DSR issues, and on specific protections for vulnerable consumers, is Smart Energy GB. If this delivers success in the smart meter roll out, then its role may sensibly extend into the DSR space. However, as noted in section 12 above, Smart Energy GB needs to take care not to endorse DSR offers and tariffs before their benefits to consumers are proven.

Finally, the role of consumer engagement by and within companies must not be overlooked. Although this is likely to be more suited to ensuring a consumer voice in retail tariff design and delivery, getting this embedded within company policies and procedures will be important if companies are going to take ownership of these issues for themselves and are able to act in a timely manner. Involving consumers in decision making within companies in this way can open up scope for collaborative innovation and across a wide variety of delivery issues. Mechanisms to involve consumers within companies range from standard market research techniques (focus groups etc) for shorter term issues to 'standing' engaged or expert consumer panels for longer term strategic issues.

For the latter to work, panels need to be adequately resourced and have the necessary access to the appropriate level of decision makers in companies. Providing a recognized route into the Board and governance structures, for example through non-executive directors, can also help facilitate this and ensure the activity is seen as independent and robust. Regular public reporting on what is being done in this area and how this fits in with the company's longer term vision, values and strategies, can help build understanding and trust. Examples of good first steps in this direction can be taken from some of the DNOs in their preparation for ED1 and from some of the Customer Challenge Groups established for the current periodic price review in the water industry.

The consumer engagement activity carried out within companies will clearly help shape their individual commercial propositions. However, some of this information could also have a much wider value to consumers. Companies should be encouraged to publicise such findings and analysis if, in doing so, it leads to wider consumer benefits or prevents others from repeating mistakes which could undermine consumer confidence across the sector. Self-regulation and pan-sector working groups, potentially facilitated by Energy UK, could help. Demonstrating leadership in this area, and a recognition of the benefits of co-operation, should help increase consumer trust at a pivotal time in the evolution of the energy sector and the household demand side.

Chapter 15. The Smart Consumer : Conclusions & Suggested Recommendations

Ofgem, market actors and the consumer bodies to address:

- **To give the characteristics of potential retail market models for DSR and low-carbon more thought, along the lines of our Table 4** (p72). Including the extent to which different models enable innovation by third parties while maintaining consumer confidence and safeguarding the most vulnerable. This will help ensure that regulatory and consumer protection frameworks are future-proofed.

Ofgem to address :

- **Consideration of the different models that could emerge for smarter markets.** From a consumer viewpoint, it will be important to think through in advance how the different models could stimulate innovation whilst maintaining consumer confidence and safeguarding the most vulnerable.

- **Development of criteria to be used to assess moves to greater cost reflectivity in DSR offers.** These could include the need for: a clear cost allocation policy; a net consumer benefit test; simplicity; an understanding of the distributional impacts; and the prior existence of social protection measures.

- **Consideration of the metrics needed to measure market health in household DSR in a smarter world.** These could include: a more sophisticated approach to identifying and removing barriers to entry; a better understanding of market dominance; the development of alternatives to switching as a measure of consumer power, such as 'try-before-you-buy' contract provisions and periodic contract reviews; annual customer expectation and satisfaction surveys to assess the impact of the changes; measures to facilitate and assess innovation and co-operation; and mechanisms to align long term consumer and company interests to ensure that these are built around a common set of long-run commercial objectives and consumer-led needs and values (this may require greater attention to corporate behaviour and governance).

- **Development of annual reviews of smarter market health.** These could identify problems with the supply and demand sides and chart progress towards addressing these.
- **Active consideration of the practicality of developing new tools, such as the proposed Tariff Comparison Rate, to facilitate comparison of basic DSR offers. S**ignificant obstacles are likely to be met by customers when using these in practice.

- **Seeking an agreement between all market actors on the need to address the issue of tariff comparisons for all consumers in a strategic and co-ordinated way.**

- **Encouragement of trial period offers.** These could have 'try-before-you-buy' arrangements. Consideration will be needed of the number of consecutive offers that a customer might test without penalty / pay back clauses. Careful review of any contracts that have 'lock-in' arrangements to re-coup equipment costs to ensure that these do not unnecessarily disadvantage customers.

- **Facilitating the provision of reliable comparison information for significant smart energy choices.** Ensuring that the information for key smart household decisions is readily accessible, accurate and comparable. Such choices could be significant because of cost, their long term nature or the degree of disruption required and include choices of new heating, storage or communications systems for smart energy controls.

- **Consideration of whether any liability for DSR issues should become a standard feature for certain types of flexibility / DSR contracts or a licence condition for market actors.** The latter may entail extending certain licence conditions to aggregators, ESCOs, appliance manufacturers etc.

- **Modelling demand side and DSR scenarios to ensure household views are taken into account and assumptions are tested by consumer groups to ensure that they stand up to practical and lived-experience.** Such scenarios will enable regulators to explore different options for DSR development; help them determine the phasing of their use of different regulatory tools (eg fair market access, facilitation through sign-posting and sharing information or reputational incentives); and when these need to change as the DSR market evolves.

- **Early development of regulatory backstops**. Some basic safeguards are needed prior to DSR offers being more widely encouraged - to protect the vulnerable and those that cannot engage with DSR offers. Consideration is also needed of the need for speedier enforcement to penalise licence breaches in areas such as mis-selling so that the evolving market is seen as worthy of consumer confidence.

- **Adoption of a principles-based approach to provide a stable regulatory rule-set**. The regulatory principles outlined in Paper 8 for DSR could be followed to help deal with uncertainty and respond to a potentially rapidly changing market landscape.

DECC to address:

- **Developing a clear hierarchy of priorities for 'smart' policy and regulatory focus.** This would help to clarify which measures require attention and when as between the standard credit market, driving forward on measures for thermal and energy efficiency, through to micro generation and for DSR.

DECC and Ofgem to address:

- **Encouragement of consumer voice in DSR development to ensure public confidence in the emerging smarter market.** Consumer engagement is needed in strategic debates to ensure that market developments are in the long term interest of the generality of consumers as well as in operational delivery issues to ensure the needs of individual consumers can be met. Once the new consumer landscape changes have bedded down, it will be important to review them to ensure that they are carrying out this role effectively and are appropriately resourced**.**

- **Consideration of the need to consult now on what consumer education and information requirements will be around DSR offers**. To ensure agreement on the role of Smart Energy GB in this area and clarity and transparency in the DSR offers that start to emerge, without actively endorsing them.

Market actors to address:

- **Preparation for increase in enquiries and complaints that are likely to result from DSR.** This is likely to involve: increased resourcing and empowering of front line staff to deal with emerging issues in a timely way; establishment of clear lines of accountability between different actors (such as suppliers, appliance manufacturers etc) for redress and remediation; engaging consumer groups and regulators to stress test accountability arrangements.

- **Development of mechanisms to align consumer and company interests in providing firm response in return for a dependable and efficient service that builds consumer trust.** This could entail companies examining how their corporate governance and behaviours meet the DSR needs of consumers. Assessing the impacts of the RMR's 'fairness' licence conditions could be useful here.

- **Consumer engagement at both a strategic and operational level to ensure consumer confidence in the emerging smarter market.** Market actors will need to consider how they engage with consumers in the DSR market to ensure that their offers meet customer needs – both short- and long-term.

- **Consideration of establishing on-going mechanisms to share information on DSR development between market actors, policy and regulatory bodies and consumer groups.** Such mechanisms can increase learning so that mistakes are not duplicated and could help increase consumer confidence in the new market.

PAPER 12

THE HOUSEHOLD ELECTRICITY DEMAND-SIDE & PARTICIPATION IN THE GB ELECTRICITY MARKETS.

PART I - ANNEXES

The material in these Annexes informed the content of Part I of Paper 12.

A full list of Tables in the Annexes can be found at pages 161-162.

Annex 1 : GB electricity demand-side markets & potential for household participation

Annex 2 : Possible electricity market 'drivers' for flexibility in household load (via voluntary peak avoidance ; automated flexibility)

Annex 3 : Initial discussion of possible DSR values in different parts of the electricity markets & how these might be shared with households.

Annex 4 : Composition of the end electricity bill & effect of levies : today, 2020 & 2030 (social & environment levies)

Annex 5 : Current electricity-related support measures (RHI, Domestic Green Deal, ECO & Eco Framework Directive) – & implications for electricity demand reduction and for future DSR development.

Annex 1 : GB electricity demand-side markets & potential for household demand-side participation

Annex 1 aims for a high-level overview of present 'state of play' for potential household demand-side participation in different parts of the GB electricity markets. The following sections of the electricity markets are considered with respect to potential household demand-side participation (present & future).

Table 1 : Capacity Markets & EDR (Electricity Demand Reduction)

Table 2 : Wholesale Markets

Table 3 : DSBR (Demand-Side Balancing Reserve)

Table 4 : Capacity Market & DSR

Table 5 : Balancing : Response, Reserve

Table 6 : Avoided Transmission Investment (TRIADs)

Table 7 : Distribution. Constraint Management (Peak avoidance for avoided network investment).

Table 8 : Distribution Networks – Emergency Support.

Each Table has a common framework as follows.

Section of the Electricity Market : Potential for Household DSR Participation ?	
DSR cost-saving potential	
Main demand-side service sought	
Cost recovery mechanism	
I&C participation	
Household participation	
Likely load characteristics	
Community participation	
Benefit to other market actors ?	
Likely timetable	
Actors most likely to facilitate	
Main enablers	
Main barriers	
Gaps / catalysts ?	
Comment	
Source : Sustainability First	

Table 1 – Capacity Mechanism. Electricity Demand Reduction Pilot.

Capacity Market : EDR Pilot. Potential for Household Participation ? [96]	
EDR cost-saving potential	A two-year pilot to test whether Electricity Demand Reduction could participate in the GB capacity market. £20 m being made available (over 2 years) in upfront funding to support projects that bring 'additionality' & deliver lasting reductions in electricity demand (e.g. more efficient lighting ; more efficient pumps, variable speed drives). *Not load-shifting (& not 'behavioural', initially).* So, the electricity industry cost- & carbon savings would relate to avoided-costs of peak plant (peak operation, peak capacity ; avoided transmission network investment to meet peak demand). The customer cost-savings would relate to lower retail bills than otherwise. Long-run aim is to understand how electricity demand reduction can participate in the enduring capacity market.
Main demand-side service sought	An auction to deliver a lasting capacity saving (kW) from electricity demand reduction – (and not an overall energy saving (kWh) (so reducing total consumption is not the main priority of the scheme). Applicants will bid in a price (£/kW) for which they are prepared to 'sell' that capacity saving (i.e. permanent electricity demand reduction). Funding will be allocated up to the total amount available in the auction (up to £10 m. in January 2015 auction) – subject to value-for-money criteria. Successful bids will secure funding - & sign a contract to deliver the capacity saving bid for. After measures are installed, parties will receive an up-front grant payment from the pilot as a contribution to the cost of the more efficient equipment installed - & a further payment once evidence of the savings demonstrated. Distributed generation is excluded from the pilot.
Cost recovery mechanism	Tax payer (pilot)
I&C participation	Minimum bid-size of 100 kW in the auction. Payback to exceed two years. Can be a single project (no cap on

96 Electricity Demand Reduction Pilot. Information Update & Fact Sheets. April, May & June 2014.

Full details in : DECC EDR Pilot Participant Handbook. 29 July 2014.

	project size) – or several aggregated projects. Any sector: public, private, voluntary (unless exempted – i.e. processes / measures already covered by CCAs, CRC Efficiency Scheme, Salix loans to public sector entities). Lighting schemes (eg street lighting) will be eligible *in terms of their likely kW contribution to savings at winter peak.*
Household participation	In principle yes (but not main focus) (Also, may be exempted e.g. measures already covered by ECO, Green Deal, RHI – may not be 'additional').
Likely load characteristics	Capacity savings need to be **'demonstrably relevant to the peak period for electricity demand' : 16.00h – 20.00h winter weekdays (November to February).** Participant guidance – published 29 July 2014.
Community participation	Yes (unless measures exempted / not additional).
Benefit to other market actors ?	Should benefit suppliers (reduces costs in wholesale markets pre-2020 & capacity markets). Depending on scheme *location* - could help to defer and / or avoid transmission or distribution network investment.
Likely timetable	July 2014 - Pilot launch. July to October 2014. Submit applications. January 2015 – submit £/kW bids, auction held & contracts issued. February to October 2015. Measures installed (up to 9 months). First 50% payment. Once *evidenced* proof of savings over 12 months – final 50% payment.
Actors most likely to facilitate	Individual large energy users, energy suppliers, ESCOs, local authorities, aggregators. Non-GB parties may bid (but scheme must be in GB). Projects need to qualify – subject to a project plan with estimated savings - & a plan for measuring & verifying. Applicants may submit more than one application for different projects. Schemes may include mix of technologies & cover a number of sites or facilities. No cap on bid size.

Main enablers	Main customer benefit : *associated electricity bill savings from measures they would not otherwise have taken*. (Half-hourly settled I&C customers would save on : any ToU energy payments – plus lower transmission & distribution charges). Verification may need half-hourly metering ?
Main barriers	Potential complexity – esp in auction process. Lack of demonstrable peak-related efficiency measures - other than commercial & household refrigeration and lighting efficiency schemes - which must also be 'additional' ?
Gaps / catalysts ?	Households – high transaction costs/kW reduced. Without half-hourly smart meter data, challenges on agreeing basis for measurement of 'additionality'.
Comment	Households have 'peakiest' load – so both refrigeration scrappage and lighting-efficiency savings would be worthwhile.
Source : Sustainability First	

Table 2 : Wholesale Electricity Markets & Potential for Household DSR

Wholesale Electricity Markets : Potential for Household DSR Participation ?	
DSR cost-saving potential	Generators sell electricity (£/MWh) to suppliers via the wholesale markets in different time-periods (day head, month ahead, two-years ahead etc) . This allows (1) generators & suppliers to 'hedge' price risk & (2) provides price signals by which generating plant / or **DSR providers** can be despatched – (also provides signals w.r.t. flows over interconnectors). In principle, suppliers should be able to obtain cost-savings in the wholesale markets from DSR (altho' vertically integrated suppliers may have less commercial incentive to seek such savings). **Near-term cost saving** : lower operating costs through better management of (1) wholesale local energy procurement risk and (2) imbalance risk. (Networks – constraint management). **Long-term cost saving** : avoided investment (peak generation; other generating capacity ; Networks – avoided investment). Wholesale price amounts to ~40-50% of end price – so wholesale cost-savings from DSR might arguably save ~3-5% ?? of total end-bill (say, based on an overall 5-10% peak saving, assuming peak-costs represent highest energy- & capacity related costs in wholesale markets) .
Main demand-side service sought	**Pre-2020 : peak-avoidance.** In particular, winter evening peak avoidance – but also year-round peak avoidance (winter & summer ; morning & evening). **Post-2020 : peak-avoidance services should still bring DSR value**, from avoided investment (peak generating capacity, networks). **PLUS** a growing need for more responsive (automated) turn-

	down & turn-up services **outside of peak periods -** driven by short-run wholesale market prices97. **Turn-up services** may have particular value to the electricity system **in the night if windy** – when wind otherwise constrained off – esp in summer.
Cost recovery mechanism	Benefit should flow to both supplier & customers via lower wholesale market costs *overall* & lower retail bills. Other than smart meters & implementation costs of any voluntary ToU , any *extra* upfront cost of DSR equipment (e.g. for automation) may need to be borne by supplier but recovered from the customer.
I&C participation	Half-hourly settled customers already on time-related /peak-related energy prices. LP 5-8 presently may have STOD tariffs – but more so once half-hourly settled (from 2016).
Household participation	**Now** : • Econ 7 customers (off-peak midnight to 07.00h. Some pay a higher day-time rate). • Static ToU pilots & trials. **Future** : • **Voluntary static ToU tariffs**. • **Voluntary dynamic ToU tariffs.** Wld need validation and / or settlement if more than just a handful of 'critical peaks' – so more likely post-2020 ?. • **Scope to automate for 'firm' peak avoidance** – from 2015 via smart meter auxiliary load control switches & / or CAD arrangements. • **Once automation & half-hourly settlement** : scope for dynamic price-led turn-down / turn-up tariffs. Post 2020 – so coincides with likely potential 'need'.
Likely load characteristics	**Voluntary peak-avoidance** : lights, heat, wet appliances. **Automated peak-avoidance** : controllable load – hot water, heat, EVs, (fridges ?).

97 DECC central assumption is for one-third of electricity in 2020-12 to be from renewable sources (NAO).

Community participation	?
Benefit to other market actors ?	Peak avoidance also benefits : capacity markets ; networks (T & D).
Likely timetable	Voluntary ToU tariffs : available now. Dynamic ToU tariffs : need settlement for variable and complex dynamic peak pricing.
Actors most likely to facilitate	Supplier. (Aggregators may also deliver for suppliers).
Main enablers for households	**Pre-2020 :** smart meters, static ToU tariffs (voluntary), Auxiliary Load Control Switches (ALCS) if controllable load available. **Post-2020** : may need half-hourly settlement if 'dynamic tariffs' widely desired.
Main barriers for households	**Now** : limited supplier business case. (~20% within-day average wholesale price differential - peak (day-time) : off-peak (night-time).
Gaps / catalysts ?	Greater ring-fence betw. generator & supplier activities : may (1) increase market liquidity - (so, more trading of wholesale energy market 'products' over more timescales (day-ahead, month-ahead, year-ahead etc)) & which may lead (2) to more pronounced differentials in peak- & off-peak wholesale market prices.
Comment	How might the opposition proposal for a wholesale Pool system impact wholesale price differentials (within-day ? seasonally ?). What might be the knock-on impacts for DSR in the wholesale markets ?
Source : Sustainability First	

Table 3 : Demand Side Balancing Reserve & Potential for Household DSR

Demand Side Balancing Reserve : Potential for Household DSR Participation ?	
DSR cost-saving potential	National system adequacy : ensuring availability of *additional* reserves, to help meet government 'Reliability Standard' (Loss of Load Expectation) over an entire winter at evening peak. Any cost-saving equates to avoided costs to the GB economy of sustained black-outs at evening peak over an entire winter.
Main demand-side service sought	**Weekday winter peak avoidance for the system operator**. New sources of *additional* turn-down of load & / or distributed generation (turn-on) (ie load not already on ToU or participating in STOR). (& despatched *ahead of* frequency, fast reserve & STOR services). >1 MW units sought (can be aggregated). Available to 'turn-down' at 2-hours notice for at least one-hour between 16.00h – 20.00h as & when called, during four winter months (weekdays Nov-Feb). Payment : £/kW upfront 'set-up' fee (£10/kW if can sustain two hrs, less if not) – plus - kWh Use fee – determined by customer 'stepped' bids which can vary from £0.25p/kWh up to £15.00/kWh (so implicit choice on whether to be called frequently or very rarely (but below VLL). Administration fee also available at the end of the winter where >50 sites successfully aggregated to 1MW.
Cost recovery	Initially via RIIO-T1. Eventually via imbalance prices (post-cash-out review (Electricity Balancing Significant Code Review)).
I&C participation	Half-hourly settled sites >100 kW. Despatch notification by smart app. ? Lighting ; HVAC ; Chillers ?
Household participation	Not included.
Likely load characteristics	Minimum 1-hour firm peak turn-down.
Community participation	Does every participant need to be half-hourly settled ? Potential role perhaps instead for **voltage control** at primary or secondary substation level ? (CLASS project). ~500 MW

	could be achieved by voltage control by system operator with no impact on the customer or equipment98 .
Benefit to other market actors ?	Network peak avoidance (T&D). Over-lap w. TRIAD - and possibly capacity market (system stress event) ?
Likely timetable	Winter 2014-15 & 2015-16
Actors most likely to facilitate	I&C customers; suppliers; aggregators. 4 April 2014. 850-1000 MW indicated. (13 'customer portfolio' providers ; 8 aggregators & suppliers ; 5 single sites).
Main enablers for households	Smart meters : load-limiters ; automation via auxiliary load control switches & / or CADs; DUOS capacity (or ToU) charges.
Main barriers for households	Other than lights, lack of electrical household load which already runs every winter evening – which could offer '**firm' additional turn-down**. Verification also needed – (but half-hourly settlement may not necessarily be required if auxiliary load control switches are used to control appliances (electric heat, hot water)). **Voltage control** - could have same effect – esp on lighting (CLASS).
Gaps / catalysts ?	Firm control of household appliances which would otherwise use electricity at winter evening peak ? Any suitable appliances available in the life-time of the initial DSBR scheme? If DSBR were to be 'life-extended', then, possibly, household refrigeration, lighting ?.
Comment	In the long-run, households could probably provide this service via some form of voluntary load-limiting or 'critical peak pricing' scheme. (See also capacity mechanism).
Source : Sustainability First	

98 Final report for Ofgem & DECC. The Value of Lost Load for Electricity in Great Britain. July 2013. p.42 & p. 48

Table 4 : Capacity Markets & Potential for Household DSR

Capacity Markets : Potential for Household DSR Participation ?	
DSR cost-saving potential	Aim is to ensure 'capacity adequacy' on the national electricity system, to avoid the alternative costs to the GB economy of sustained black-outs at evening peak over an entire winter. On behalf of suppliers, National Grid will pay for capacity (£/MW/p.a) to meet forecast demand to a government-set 'reliability standard'99 , thereby ensuring that sufficient generating capacity is available (payments may be either for existing plant, or for new plant)100. In principle, any cost- saving created by DSR would need to equate on a £/kW/p.a basis (or be less than) the alternate cost of paying generators to keep open their plant for purposes of capacity adequacy (or of investing in new capacity). All fossil generators *must participate* in the capacity market - to be available & produce energy when the national system is tight. In return generators will receive an annual £/MW payment for availability (price set in an auction), to recover their share of fixed costs which they may otherwise be unable to recover readily in the wholesale markets, (due to their reduced running hours due to 'must-run' low carbon plant – plus unpredictability of total annual income). There will be a penalty for non-delivery of capacity if there is a capacity market warning (so-called 'stress event'). Capacity contracts will be for up to fifteen years years for new plant, 3-years for refurbished plant & 1-year for existing plant. Contracted positions can be adjusted by trading in secondary capacity markets. **Demand-side providers may also participate via one-year capacity contracts. Following a transitional scheme, long-run aim is for full integration of DSR into the GB capacity market.**

99 The reliability standard is based on an expectation (Loss of Load Expectation (LOLE)) that there will be **no more than 3-hours p.a. of black-outs due to a shortage of available generating capacity.** Assumed cost-savings from a capacity mechanism equate to a value attributed to the avoided cost of black-outs (esp. in winter). This assumes an average customer valuation of a loss of load (value of lost load (VLL)) of £17,000 /MWh (Ofgem indicates this equates to £5/kWh in a peak winter half-hour). Beyond this price-level, on a willingness-to-accept basis, it is assumed that customers would 'choose / prefer' the alternative cost / inconvenience of black-outs instead.

London Economics study (op cit) suggests that households value *weekend peak* (15.00h – 19.00h) *more highly* than week-day (but for time of cut-off / black-out, do not seem to have a strong preference between peak or off-peak). Off gas-grid households value supply more than households dependent on gas for heat. Vulnerable households were not analysed separately. And, a single average VLL value is given for *all* households - which seems somewhat crude. SMEs value supply more than households (on a willingness-to-accept (WTA) basis).

100 Below a pre-determined cost-of-new-entry (e.g. OCGT - £47/kW (with an overall auction price cap of £75/kW).

Main demand-side service sought	**Load turn-down at times of system stress / capacity market warning (or, turn-up of storage, CHP & distributed generation).**
Cost recovery arrangements	The costs of the payments made to capacity providers will be **recovered via a levy payable by all suppliers amounting to £1-2 bn p.a.** In turn, suppliers will recover the costs of the levy from both household & I&C customers. Estimated additional net cost 2016-2030 is ~£2 per household customer p.a.101 . Suppliers' annual share of total costs of capacity support will be payable monthly. This share will be calculated each year on the basis of their total forecast market share (? assume kWh) over four winter months between peak hours 16.00h – 19.00h. **This is designed to give suppliers a *separate* albeit *indirect* incentive to reduce their customers' winter peak load – and retains a link with the basis for charging TNUOS - & so, over-time, hoped-for impact to encourage suppliers to offer more ToU tariffs to households.**
I&C participation	Yes
Household participation	Not ruled out, provided load response is 'firm'. Some unresolved questions around how far household load in the capacity market will need to be capable of 'dynamic' metering and settlement - and therefore whether half-hourly settlement will be a pre-requisite for household participation, or not.

101 23 June 2014. DECC. Electricity Market Reform – Capacity Mechanism. Final Impact Assessment.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/324430/Final_Capacity_Market_Impact_Assessment.pdf

Modelling in the final IA indicates an increase in the average annual domestic electricity bill of £2 over the period 2016 to 2030 (in 2012 prices) due to the capacity mechanism. This is assessed on a 'net' basis (i.e. inclusive of impacts on wholesale prices). In the end, the annual cost to customers will depend on the level of potential capacity shortfall and the level of wholesale prices in any given year of the scheme.

Earlier modelling undertaken for DECC, estimated the additional cost per customer per annum in the period for 2016-2030 as ~£5-£13.

Report for DECC. Estimating the costs and the benefits of the Capacity Market. Redpoint. December 2013.

	Arguably, could meter a sufficiently dynamic response via a settlement adjustment to Load Profile 1. However, firm automated household load in the capacity market more likely to be successfully facilitated *at scale*, once half hourly settlement.
Likely load characteristics	**Over 2 MW (but may aggregate up to a 50 MW cap).** Can be new or 'existing' resource. Initially, **time-banded 'products' e.g. 16.00h – 20.00h** (expectation is for DSR to transition to a standard capacity 'load-following' product). **Notice period :** Contracted DSR to **respond within 4-hours** of a DSR despatch instruction – or face penalty. Penalties for DSR lower in Stage 1 than in Stage 2 scheme. Penalties capped at providers total annual capacity payment (lower penalties in Stage 1 than Stage 2).
Community participation	Not ruled out - but likely to depend on satisfactory means of monitoring and verification.
Benefit to other market actors ?	Suppliers (because ensures reliable electricity supplies to their customers). May also offer local DSR benefit to DNO – if extremely high local load (e.g. an anti-cyclonic cold-snap & no / low local wind to offset).
Likely timetable	**Stage 1 Preparatory DSR auctions** : in 2015 & 2016 for delivery one-year later. (Envisaged as Follow-on Scheme from DSBR). One-year agreements. **Stage 2 Transitional Arrangements** (subject to Stage 1 review for ~three years.) **:** First 4-year ahead generation auction in November 2014 - & **first one-year ahead DSR auction in November 2017 in Stage 2 . (**From November 2017 for delivery in winter 2018-19). **Enduring DSR arrangements in the capacity market – for delivery from early 2020's**. Some 'reserved' capacity in each year-ahead auction (slightly less DSR capacity to be auctioned each successive year (against previous year) to ensure 'liquid' auction). Aim to ensure some DSR regardless of capacity needed. Validation needed. DSR penalty regime.
Actors most likely to facilitate for households	Supplier load management arrangements (eg via smart meter load-limiters, maximum demand registers, and / or auxiliary load control switches). Aggregators (via bilateral agreements with suppliers to control ALCS – or via CAD arrangements).

Main enablers for households	Automated response. Most likely need : at evening peak **(but not only.** Depends upon declaration of 'stress-event'**).** Smart meters (load limiters, ALCS for automated control) & load available to switch off (or not switch on) – see above (? Heat, refrigeration, EVs ?).
Main barriers for households	Scheme administered by annual auctions one-year ahead – **so would this give supplier / aggregator sufficient predictability to market a load management scheme to customers ?** **Validation** : See text above on Household Participation - on questions to clarify around dynamic metering and settlement. Supplier could use dedicated smart meter registers to settle post-event and / or ALCS critical command process to confirm that load was switched.Arguably could monitor & validate via a settlement adjustment to Load Profile 1. However, M & V more likely to be successfully facilitated *at scale*, once half hourly settlement. Given that capacity providers face penalty for non-delivery, DSR providers may prefer the long-run option of half-hourly settlement.
Gaps / catalysts ?	What is likely to be the automated controllable load which customers are content to be repeatedly turned off remotely – possibly for a sustained winter period (although if multiple customer appliances are aggregated and 'controlled' via ALCS in a staggered way, this would produce the same effect). Voltage control instead could have similar effect - **see DSBR above** (e.g. ENWL CLASS project).
Comment	What are the underlying economics for household DSR in the capacity market ? First, any cost- saving created by DSR would need to equate on a £/kW/p.a basis (or be less than) the alternate cost of paying generators to keep open their plant for purposes of capacity adequacy (or of investing in new capacity). Second, the DSR-provider would need to realise sufficient income via the DSR capacity auctions (£/kW/p.a. payment) - to exceed the likely costs of implementation & transaction to make a sufficient return for themselves - *plus* have some available surplus to 'benefit-share' with the participating householder.
Source : Sustainability First	

Table 5 : Balancing Markets : Response - & Potential for Household DSR

(Balancing = 1% of end price of ely).

Balancing Markets – Frequency Response: Potential for Household DSR Participation ?	
DSR Cost-saving potential	National Grid must ensure that the Transmission System is balanced on a second by second basis. This involves ensuring the network can withstand a credible fault to the network and or to the transmission-connected generation fleet. As well as ensuring that the moment-to-moment fluctuating electricity demand is managed. To achieve this National Grid procures a range of static and dynamic frequency response products which will automatically respond to pre-set frequency conditions. Typically National Grid pays balancing providers a capability / availability fee (£/MW/hour) over procured periods – plus potential nomination / use fees depending on the which commercial service.
Main demand-side service sought	Frequency Response services are required on a continuous basis (but the exact volumes fluctuate over time of day and over the time of the year). Providers must be able to increase or decrease demand at any time upon frequency deviation.
Cost recovery arrangements	National Grid pays balancing service providers for the services provided for moment-to-moment balancing of the system. In turn National Grid charges the cost of those services to BSC signatories (suppliers and large generators) via BSUOS. Suppliers recoup the costs through consumer bills.
I&C participation	Yes
Household participation	Potentially
Likely load characteristics	**Generally 3 MW or above of demand reduction and or increase (but may aggregate).** **Static service**; service to begin & deliver within 2 seconds, usually sustained for 30 minutes **Dynamic service**; service to begin within 2 seconds (ideally quicker) and deliver full response to 10 seconds, 30 seconds and up to 30 minute time periods. Linear and proportional response is also

	required to the size of the system frequency deviation. Normally 100% response is required for +/-0.5Hz deviations .
Community participation	Not ruled out
Benefit to other market actors?	Potential benefits could be to BSC signatories (generators, suppliers) who may receive lower BSUOS bills due to competition in balancing services.
Likely timetable	Theoretically possible now. Technical trials point the way to household frequency response services for system balancing (e.g. Npower CERT smart fridge trial; LCNF trials (e.g SSE NINES trial) ; Ireland & PJM (hot water cylinders). Making household frequency response work commercially at scale will be a challenge. Commercial challenges include delivery of an economically competitive service (costs of control, communication systems, metering validation).
Actors most likely to facilitate	Aggregators, Suppliers & large I&C companies
Main enablers	Availability of controllable electrical household load at scale for dynamic switching for fast response services (eg potentially electric heat, refrigeration)
Main barriers	See text above on Likely Timetable. Virtually instantaneous speed of response required.
Gaps / catalysts ?	Challenges of validation and metering. To clarify how far existing SMETS 2 capability could suffice in practice.
Comment	
Source : National Grid & Sustainability First	

Balancing Markets – Reserve : Potential for Household DSR Participation ?	
DSR Cost-saving potential	National Grid must ensure that the Transmission System is balanced on a second by second basis. This involves ensuring that : (1) energy procured by suppliers can be replaced where a credible fault occurs to the network and / or transmission-connected generation – and - (2) Mismatch in suppliers' wholesale contracts to meet their forecast demand - and forecast error in generation volumes (wind) - are managed in real time. To achieve second-by-second balance National Grid procures a range of reserve products which can be manually instructed to provide energy. Typically, National Grid pays Balancing providers a capability / availability fee (£/MW/hour) over the procured periods and use fees (£/MWh) depending on the balancing service required.
Main demand-side service sought	Reserve Service requirements are subject to many factors – many of which are time-specific. For example the procured hours of STOR (Short Term Operating Reserve) vary across the year but generally are procured for approximately 12 hours a day - split between morning and evening periods. This pattern reflects the scarcity of available 'headroom' from large generators (who would otherwise provide reserve as a function of the wholesale market). Reserve providers must be able to increase or decrease demand upon instruction from the system operator.
Cost recovery arrangements	National Grid pays balancing service providers for the services provided. Balancing providers are paid for an 'option' (£/kW) for the system operator to buy energy or DSR from them at an agreed price (£/MWh). This approach allows NG to have sufficient capacity 'in reserve' to manage the system at least cost to its customers - & to procure 'system balancing' services not valued elsewhere in the energy (wholesale) or capacity markets i.e. • Capacity that is situated at particular locations • Capacity that is particularly flexible In turn National Grid charges the costs of these services to BSC signatories (suppliers and large generators) via BSUOS. Suppliers recoup the costs

	through consumer bills.
I&C participation	Yes
Household participation	Potentially
Likely load characteristics	**Generally 3 MW or above - of demand reduction and or increase (but may aggregate). Individual services have specific requirements** **Fast Reserve**: providers must be able to deliver full response within 2 minutes and sustain for at least 15 minutes. **STOR** (Short Term Operating Reserve) : providers must be able to respond within 240 minutes (but more beneficial within 20 minutes) - and sustain for 2 hours. New or modified reserve services may be developed as the system develops technically and commercially to greater low carbon. In time, this could include the development of **'negative' reserve** products.
Community participation	Not ruled out
Benefit to other market actors ?	Potential benefits to BSC signatories (generators, suppliers) who could receive reduced BSUOS charges where competitive DSR balancing services are provided.
Likely timetable	Theoretically possible now. Fast reserve is perhaps more likely than STOR. Historically, ~250 MW of household storage heaters were made available to the system operator over-night for fast reserve purposes, in ten 25 MW blocks. Making household reserve work commercially at scale however, will be a challenge. Commercial challenges include delivery of an economically competitive service (costs of control, communication systems, metering validation).
Actors most likely to facilitate	Aggregators, Suppliers & large I&C companies
Main enablers	See text above on Likely Timetable.
Main barriers	See text above on Likely Timetable.

	Speed is a particular challenge.
Gaps / catalysts ?	
Comment	
Source : National Grid & Sustainability First	

Table 6 : Avoided Transmission Investment (TRIADs) & Potential for Household DSR Participation ?

Transmission Networks. 'TRIAD' response at winter peak. Potential for Household DSR Participation ?	
DSR cost-saving potential	A key physical challenge for the transmission networks are the prevailing north-south flows of bulk power : much generation located in the north ; much customer demand in the south & south-east. The physical location of both generation & demand remains a major factor in terms of new or avoided transmission investment & cost-efficient bottleneck / constraint management. DSR (and / or distributed generation) at maximum winter peak - in particular regions / zones - can therefore offer cost-saving potential against transmission charges (i.e. in principle for avoided incremental / marginal investment).
Main demand-side service sought	**TRIAD response** - active DSR / load-reduction (and / or distributed generation) – especially in the south - to coincide with *the three highest evening peak half-hours* of each winter (separated by at least ten days). This has a *physical* benefit to the transmission network in terms of helping to delay peak-related investment (security-standard related investment (SQSS)).
Cost recovery mechanism	Transmission charges (TNUOS) are both capacity related and quite strongly zonal, designed to reflect the costs associated with location of both generation and demand on the transmission network - & so to convey a signal to large transmission-connected generators and also to suppliers (& indirectly through them to their very large half-hourly metered & settled I&C customers) about the costs of providing the transmission network – including new transmission investment. ~Around three-quarters of annual TNUOS charges (~£1.7 bn in 2011) are levied via demand customers. I&C customers able to demonstrate that they deliberately avoided the three TRIAD periods can avoid payment of their full annual transmission charges. (This is not at present the case for non-half hourly customers). • For an I&C customer : the zonal charge is on a £/kW basis (for example, with over a two-fold differential between the highest (£38.79 /kW – south west) and lowest (£16.17 /kW - Northern Scotland). These zonal differentials seem to incentivise southern I&C customers to avoid their charges more. (There is also a non-locational 'residual' element (£22.83p/kW) in 2012-13, regardless of zone). • The zonal non half-hourly customer charge to a supplier (including, in effect for their household customers) is on a p/kWh basis, charged all year round for consumption Monday to Friday 16.00h – 19.00h. For non half-hourly customers, (household customers included), TNUOS charges are just over twice as much for a customer in the south 5.38 p/ kWh – as in the north 2.19 p/kWh (Northern Scotland). For non-half hourly metered customers, the sums relating to TNUOS are likely to amount to a

	relatively small element of their overall end bill (because the charges are socialised according to Load Profile 1 (plus apply only to peak-related consumption)[102] . (TNUOS & Balancing = ~4% of end bill). The initial benefit of a household TRIAD would fall to suppliers – as an avoided liability for full TNUOS charges for their participating customers. Suppliers could then be expected to share that benefit with participating customers. Under present TNUOS arrangements, there may then be a knock-on shortfall in National Grid's TNUOS revenues – as the overall fixed cost of providing a transmission network for household customers in a particular zone would remain unchanged. This may result in an increase in supplier TNUOS charges for suppliers – and suppliers will pass-on those higher charges to customers who do not (or cannot) participate in the TRIAD response.
I&C participation	Yes. Half-hourly metered & settled I&C customers presently provide ~1 to 1.5 GW of TRIAD response each year [103].
Household participation ?	Yes, potentially. Would, in effect, be a critical-peak pricing approach.
Likely load characteristics	Any load which can be turned-off or turned-down either manually or by automation – (or any 'additional' micro-generation which can run) – in the three 'critical' winter evening peak half-hours.
Community participation?	Yes, potentially.
Benefit to other market actors ?	Suppliers : reduction in peak-related wholesale costs ; reduced capacity market liability. System operator (balancing). Distribution networks at winter evening peak.
Likely timetable	Once smart meters (& arguably once more wide-spread automated controls via smart meters). As this is a relatively limited dynamic response, in principle, it may be feasible by an SSC settlement adjustment to Load Profile 1 - & arguably may not need full half- hourly settlement.
Actors most likely to facilitate	Suppliers. Aggregators on behalf of suppliers.
Main enablers	Smart meters (load limiters, maximum demand registers etc).
Main barriers	The three half-hour TRIAD periods each winter are highly unpredictable – and, at present, are only determined *post-hoc*. I&C customers presently need

[102] National Grid. Forecast TNUOS tariffs from 2014-15 to 2018-19. May 2014.

[103] UK Future Energy Scenarios. National Grid. July 2014

	to take action on *many other* evenings during a winter, in order to get the benefit of avoided annual transmission charges. Some questions on the need for half-hourly settlement, depending on how 'dynamic' a TRIAD response in practice would be.
Gaps / catalysts ?	Household appetite for critical peak pricing approaches unclear. (Back-of-the envelope : say, 1000 kWh p.a. classed as annual 'peak' hours – might amount to an avoided TNUOS charge of ~£50 p.a. per *participating* customer). Could be very inconvenient – especially given a need to somehow 'anticipate' the TRIAD (similar to former EDF Tempo tariff). So, at scale, a household critical peak response would most likely need full automation to succeed.
Comment	Before seeking TRIAD responses at scale from households, **there would need to be : a concerted discussion as to how the peak-related fixed costs of the transmission networks would be paid for. Non-participating customers risk becoming smaller group picking up a larger share of the fixed costs through no fault of their own, with potential distributional impacts.**
Source : Sustainability First	

Table 7 : Distribution – Constraint Management (Peak Avoidance for avoided investment). Potential for Household DSR Participation ?

Distribution Networks - Avoided Peak : Potential for Household DSR Participation ?	
DSR cost-saving potential	Either permanent demand reduction or a DSR response *at a particular network location* - that is sufficiently predictable or firm - to justify deferring or avoiding network reinforcement or other investment at that location - in order to manage a physical network constraint (i.e. thermal, voltage, boundary) and maintain required standards of supply quality & security. In practice, the total cost savings to the network obtained from the DSR actions, must *exceed* the alternative of the total avoided costs of investment (both 'shallow' & 'deep' investment). See Annex 3 for a discussion of a possible range of cost-savings from avoided network investment at low-voltage (£30/kW/p.a. to £60/kW/p.a.). The annual costs to the DNO of obtaining and implementing any firm DSR-savings from households, including any share of the benefit to the customer, would need to cost *less* than such annualised £/kW sums.
Main demand-side service sought	Firm peak avoidance at *network* evening peak – 17.00h to 20.00h – day-in-day out in winter. Summer load 'turn-up' 11.00h – 16.00h - to offset local voltage problems from network 'spill' from household PV clusters.
Cost recovery mechanism	The benefit created by the DSR will manifest itself as (1) a lower connection charge than otherwise and (2) in the long-run, a lower DUOS charge than otherwise. The cost-saving will split between differently – *and in different time-scales* - between (1) the customer who provides the DSR ; (2) the network via their efficiency incentives ; and (3) eventually, via lower DUOS / network charges to suppliers, who in turn should pass on this benefit to their customers in general. See more detailed discussion in Annex 3 on DSR values available to GB market actors & customers.
I&C participation	Yes. Large half-hourly customers already directly incentivised for winter weekday peak avoidance via ToU DUOS charges. LCNF trial experience on commercial non-firm connection agreements (SSE Thames Valley Vision ; NPG CLNR; WPD Falcon). Commercial I&C DSR approaches now being developed by DNOs in collaboration with aggregators.
Household participation ?	Yes – in principle. More likely once smart meters & scope to automate. (Aggregation of many individual small loads – transaction costs etc).

Likely load characteristics	Firm peak avoidance at *network* evening peak – 17.00h to 20.00h – day-in-day out in winter (so, for the future, ToU & 'restricted hours tariffs' for electric heat, EV charging etc. E.g. CLNR). Summer load 'turn-up' 11.00h – 16.00h - to offset local voltage problems network 'spill' from household PV clusters. May wish to encourage : more on-site use (thermal storage (hot water, heat) or household-level battery) : or, promote 'neighbour use' on sunny days – say from 12.00h – 16.00h.
Community participation ?	Yes. More likely once smart meters & scope to automate. Scope for location specific community level agreements at secondary substation – with delivery via aggregator, local authority.
Benefit to other market actors ?	Local winter evening peak avoidance would serve interests of suppliers (wholesale markets, capacity market) and system operator. Distribution winter evening peak generally around one-hour later than national system peak
Likely timetable	Once smart meters, auxiliary load-control switches (ALCS) and controllable household electrical load widely available (so, post 2020 at scale).
Actors most likely to facilitate	DNOs – together with aggregators, local suppliers, local authorities / social landlords.
Main enablers	DNOs have a number of incentives which may enable them to be creative in developing 'community' schemes at constrained network locations (e.g. social obligations under RIIO-ED1, other ED1 incentives, & TOTEX). DNOs may need to modify Smart Energy Code to enable *direct* access for DNOs to the DCC 'critical command' arrangements for ALCS appliance-control. (Prior to that, will need supplier cooperation). Settlement : could adjust SSC for Load Profile 1 (so individual half-hourly settlement therefore not a pre-requisite).
Main barriers	Achieving demonstrable cost-savings from household DSR – plus a *firm* response – against the investment alternative.
Gaps / catalysts ?	Community energy schemes – DNOs may find it helpful to map prospective community schemes against major network 'hotspots' - & actively seek out those communities.
Comment	
Source : Sustainability First	

Table 8 : Distribution Networks – Emergency Support. Potential for Household DSR Participation ?

Distribution Networks. Emergency Support : Potential for Household DSR Participation ?	
DSR cost-saving potential	DSR response *at a particular network location* - that is sufficiently predictable or firm - to support management of a network fault over a long-period - and to subsequent restoration of local supply. In some events, at lower voltages, DSR may be the only readily available option open at that location to the DNO to the alternative of wider disconnection.
Main demand-side service sought	Firm DSR response, available to be called at any time – (but perhaps more likely at evening peak 17.00h to 20.00h) – and available for a sustained number of days, weeks or possibly months.
Cost recovery mechanism	The benefit created by the DSR for post-fault management will, in the long run, manifest itself as (1) better customer relations and (2) a lower DUOS charge than otherwise. Any cost-saving from the DSR will be realised via the distribution network incentive arrangements on (1) supply interruption (Interruption Incentive Scheme (IIS) – and potentially (2) via a lower 'penalty payment' than otherwise to the customers off-supply, under the standards of performance incentive (Guaranteed Standards of Performance (GSOP)). Eventually, any efficiency savings achieved via either of these incentives should pass to suppliers, via lower DUOS / network charges, who, in turn should pass on this benefit to their customers in general. See more detailed discussion in Annex 3 on DSR values available to GB market actors & customers.
I&C participation	Yes. Large half-hourly customers already participate in DNO DSR pre- & post-fault management schemes. LCNF trial experience (ENWL – C2C trial). Commercial I&C DSR approaches for fault management now being developed by DNOs either bilaterally or via aggregators.

Household participation ?	Possibly in an emergency (if only alternative was rota disconnection).
Likely load characteristics	DSR response *at a particular network location* - that is sufficiently predictable or firm – and able to be a repeated / sustained response - to support management of a network fault over a long-period – until restoration of local supply. Two main types or response sought *at a particular network location* : • Automatic response for the duration of the interruption • Post-fault, but before permanent repair. This may be needed for one-month or more. Firm DSR service may be most needed at times of very high demand 17.00h to 20.00h in winter. In the future, household DSR for fault management might be based around ToU & 'restricted hours tariffs' for electric heat, EV charging etc. (E.g. CLNR)
Community participation ?	Yes - potentially. Once smart meters & scope to automate. Scope for location specific community level agreements at secondary substation – with delivery via aggregator, local authority.
Benefit to other market actors ?	Potentially, system operator or transmission networks – if the 'local' distribution network problem happens to coincide with a wider 'regional' system emergency. (NB – Electricity Networks Association. Shared DSR Services Framework. April 2014).
Likely timetable	Once smart meters, auxiliary load-control switches (ALCS), full half-hourly settlement – plus controllable household electrical load widely available (so, in 2020s).
Actors most likely to facilitate	DNOs – together with aggregators, local suppliers, local authorities / social landlords.

Main enablers	DNOs have a number of incentives which may enable them to be creative in developing 'community' schemes for fault / emergency management (e.g. social obligations under RIIO-ED1, other ED1 incentives (IIS, GSOP), & TOTEX). DNOs may need to modify Smart Energy Code to enable *direct* access for DNOs to the DCC : 'critical command' arrangements for ALCS appliance-control; and / or activation of 'load-limiters' in smart meters. (Prior to that, will need supplier cooperation). Settlement : a Load Profile 1 adjustment would work for a static ToU emergency response. Otherwise, full half-hourly settlement needed if a wholly 'dynamic' household response.
Main barriers	Achieving demonstrable cost-savings from household DSR for emergency / fault management – plus a *firm* response – against any other alternative (e.g distributed generation).
Gaps / catalysts ?	Households and communities may prove willing / open to providing emergency support via a DSR scheme to a DNO for a clearly limited period.
Comment	Household DSR schemes for emergency / fault management DNOs seem some way off. Community-level schemes might be a good first step for DNOs to explore (see Sustainability First Paper 10).
Source : Sustainability First	

End Annex of 1.

Annex 2 : Possible electricity market 'drivers' for market actors to seek flexibility from households pre & post-2020

(Via voluntary peak avoidance & firm automated flexibility).

Table 9

<u>Pre-2020</u> : Possible main drivers in the electricity markets for seeking flexibility from households - via Voluntary Peak Avoidance (Static ToU, CPP) and / or via Automated Load Response ?

Pre-2020 – Market 'drivers' for flexibility in household-load			
Market Driver	**<u>Voluntary</u> peak-pricing (static ToU or CPP) ?**	**Firm automated peak-load response ?**	**Limits / barriers ?**
Supplier 'market advantage'	Yes	Costs of automated load-response may exceed realisable benefits (Existing Econ 7 excepted).	Present business-case unclear. Smart thermostats in GB targeted at gas heating (so, not at ely DSR).
Smart meters & flexible load	Smart meters from 2015 – so basic ToU feasible (plus billing & settlement adjustment to LP 1). Questions over what responsive load available (peak heat, wet appliances). CLNR ToU trial w a 1:2 off-peak / peak price ratio : Annual overall saving : ~ 3%. Peak-saving : 7-9%. Average benefit – £10 per customer p.a. – w a big range for individual 'winners' & 'losers'. 40 % of trial customers 'worse off'.	With ALCS & CADs (from 2016 onwards) – can more readily automate appliances – but limited controllable load presently available (other than present Economy 7 storage heaters & hot-waters)	Costs & benefits of early appliance automation not clear. Lack of appliances which can be directly controlled / automated (limited electric heat in GB, EVs). Complex automated dynamic tariffs would need half-hourly settlement.
Wholesale market risk	Pre-2020, highest wholesale costs still **'peak-related'**.	**<u>Firm</u>** peak response desirable for better DSR 'match' w supplier wholesale contractual	Limited supplier benefit, due to modest 'within-day' peak–off-peak wholesale price differential (~20%).

		position.	
Capacity market	Capacity mechanism payment scheme may encourage suppliers to reduce their share of winter evening peak load – by offering voluntary ToU tariffs to their customers – to reduce suppliers overall capacity market expenditure. **Non-firm** – so could create a penalty risk for capacity *providers*.	Capacity *providers* will prefer to offer firm peak response, with validation / settlement.	Capacity providers need a firm response to avoid risk / exposure to penalties
Balancing	N/A	Yes – for frequency response & fast reserve	May need sophisticated metering & validation
TRIAD avoidance	Yes – but no way presently for supplier to recognise TNUOS benefit brought by individual customer actions (Likely to need dedicated smart meter register and / or LP1 settlement adjustment and / or full settlement).	Yes - but no way presently for supplier to recognise TNUOs benefit brought by individual customer actions	So, could reduce need for additional transmission investment - but without more sophisticated settlement (prob half-hourly) no way for supplier to recognise an individual customer's DSR contribution via reduced TNUOS charges.
Distribution constraints at particular 'hotspots'	Yes – but may need to be consistent & firm to justify deferred investment	Yes – **and also firm**, so may support deferred or avoided investment	Customer load may increase anyway – so hard for DNO to judge 'firmness' of response - & therefore basis for deferred network investment.
Structure of DUOS charges **(Development of either new capacity or ToU DUOS charges)**	Yes	Yes	Capacity charge in DUOS may be better 'targeted' approach than ToU (which may be a blunt instrument).
Distribution network fault management	No	Yes	Household customers would need to agree to curtail load for a **long period**. In the long-run,

			voltage reduction (e.g. ENWL CLASS project) might be a better alternative approach.
Cash-out review. **EBSCR**	Non-firm – so if customer is less 'predictable' at peak, may increase supplier risk	Firm response desirable to fine-tune imbalance risk	
Source : Sustainability First.			

Table 10

<u>Post-2020 :</u> What are the main drivers in the electricity markets for household flexibility via Voluntary Peak Avoidance (Static ToU, CPP) and / or via 'Firm' Automated Load Response ?

Post-2020 – Market 'drivers' for flexibility in household-load			
Market Driver	**Voluntary peak response (static or dynamic)**	**<u>Dynamic</u> firm automated load-response ? (peak or non peak).**	**Comment**
Wholesale market risk	Wholesale prices may become more wind-led – (unpredictable, volatile) - **but GB household load will nonetheless still be characterised by a winter peak.**	Firm response increasingly important - & flexibility needed to counter wind intermittency – **so not necessarily always peak-related**. Benefits of automated load-response may start to outweigh costs, to fine-tune pre-gate closure contracted exposure in wholesale markets. Complex dynamic tariffs need half-hourly settlement.	Supplier business case for DSR may increase. Unclear how far, post-2020, peak will remain a main 'shaper' for retail tariffs. For example : • Post CMA referral, if generation & supply activity becomes more separate, then 'within-day' peak–off-peak wholesale price differential may increase if market becomes more 'liquid'. • Depends on how levies are passed-through into retail prices by suppliers (e.g. should levy costs become increasingly peak-related *for suppliers* ?).
Half-hourly settlement & higher cash-out prices	Increased supplier risk from imbalance - unless customer consumption patterns are generally predictable - so **voluntary** peak-tariffs **at scale** may start to increase	Firm automated load-management increasingly desirable from a supplier viewpoint : to fine-tune and reduce imbalance risk from unpredictability of	

	supplier imbalance risk.	customer actions; to match customer usage with half-hourly network charges.	
Smart meters & flexible load	Universal smart meters – & more flexible load available (electric heat, EVs, household level storage).	Market & customer 'expectation' that new loads will be controllable via ALCS & CADs	Benefits of appliance automation for DSR likely to become more clear-cut against initial capital outlay and any ongoing operational costs.
Capacity market	Reducing peak reduces expenditure by supplier on capacity mechanism. **Non-firm response** – so could create penalty risk for capacity market *providers.*	**Firm response** needed with validation & settlement - & more controllable load available (EVs, HPs).	Capacity providers need a firm response to avoid risk / exposure to penalties. Long-term future for capacity market not clear.
Balancing	N/A	Yes – for frequency response & fast reserve	Balancing costs expected to increase into the 2020's. May need sophisticated metering & validation
TRIAD avoidance	Yes – but half-hourly settlement increases risk associated with lack of predictablility of voluntary response.	Yes – reduces risk of supplier uncertainty	Half-hourly settlement enables benefit to be recognised in TNUOS at an individual customer level.
Network Hotspots & Structure of DUOS charges **(Development of either new capacity or ToU charges)**	Yes – half hourly settlement recognises individual customer actions – even where non-firm.	Yes – half hourly settlement recognises individual customer actions. Firmness desired if to justify deferred network investment.	A householder capacity charge in DUOS may be a better 'targeted' approach than ToU (blunt instrument).
Source : Sustainability First			

Annex 3 : Initial discussion of DSR values in different parts of the electricity markets & how these might be shared with households.

Thanks to Jon Bird, Associate, Sustainability First. Co-author of this Annex.

The issue of what value might be put on DSR in different parts of the electricity market and how this value might be shared has a number of different elements :

1. **Resource cost basis** – This is the potential benefit **to the economy as a whole from the use of DSR** : for example, from lower costs of generation, lower network investment or fewer power cuts.

2. **The value available to the industry actor concerned** – This will often be the same as the resource cost, particularly in the competitive part of the market. But this value may also be affected by regulatory issues, by the transaction costs of establishing the service, or by customer appetite and / or other policy interventions (e.g. incentive / subsidy). Where a particular DSR action affects two (or more) industry players, the value could be enhanced if the action benefits them all. Or, the value could be 'reduced' if there is an unresolved technical or commercial conflit between the parties.

3. **The value shared with the individual customer who provides the DSR** – This value needs to be large enough to persuade the customer to take part - while still leaving sufficient value with the industry player for the DSR to be worthwhile. Any aggregator involved in the transaction will also want a share of the value.

4. **The value that <u>other customers</u> may gain from a more efficient electricity system** – This is, after all, one of the reasons for implementing DSR. It should be noted that the benefits may not accrue evenly to all customers, and would be dependent on how cost-reflective both charging methodologies and retail tariffs might become in the future.

1. Resource cost basis

There have been several attempts recently to assess the value on a resource cost basis of DSR in the different parts of the electricity market. These assessments have also considered the implications of the possibility of conflict between the requirements of these players[104].

In 2011, for ENWL & National Grid, Pöyry modelled a range of scenarios, looking at the relative value that different market participants place on the use of DSR, and explored when participants' use of DSR will be in tandem or conflict. It concluded that, in general, the price signals that DNOs could offer for DSR would be weaker than those of suppliers and the SO. Only in post-fault conditions at particular network locations were DNOs likely to place a greater value on DSR than other industry players.

Pöyry's paper also included some useful avoided-cost figures that were used to underpin their analysis: transmission investment c. £500/kW; DNO investment between £40 and £300/kW, depending on voltage and rural/urban location; STOR £283/MWh for 60-80 hours a year; cost of (involuntary) load shedding (or VOLL) £4/kWh (National Grid estimate) or £16/kWh (Ofgem upper estimate). It also included a wholesale price duration curve for 2030 and a related distribution graph which showed that, in the absence of DSR, there were likely to be around 1400 hours by 2030 a year where the wholesale sale price exceeded £125/MWh and 400 hours where it exceeded £150/MWh (as well as about 800 hours where the wholesale price was negative). Pöyry did not quote a figure for the value of DSR to DNOs in post-fault situations, but said that it was "very high".

A recent paper by Frontier Economics was commissioned by Elexon to help improve industry understanding of cross-party impacts of DSR[105]. Frontier's modelling also concluded, for the period to 2030, that suppliers were likely to get greatest value from, and make most use of, flexible DSR resource in the wholesale markets, and, in addition, that further efficiency gains could be made if suppliers trade this resource between themselves. DNOs' use of DSR could act as a substitute for network reinforcement, but was likely to be called upon relatively infrequently - and then, principally, for tackling network faults at particular locations. This in turn meant that (1) information problems created by the lack of visibility of DSR actions by DNOs to other players were not large, and (2) that there was potential spare capacity from DNO DSR, available to share with other parties to increase the overall efficiency with which it might be used.

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104 The most relevant are Pöyry (2011) *Assessment of DSR Price Signals*

http://www.poyry.co.uk/sites/www.poyry.uk/files/717_DSR_Price_signals_Report_v1_0.pdf and

Frontier Economics (May 2014) *Cross-party impacts of DSR actions.* The latter also contains a valuable literature review.

105 Frontier Economics. Cross-party impacts of DSR actions. Paper for Elexon. May 2014.

Frontier ran a number of different scenarios to obtain the total benefit from DSR to the different industry players in three snapshot years. In their base case, benefits per year were broadly as follows:

(£m)	**2015**	**2023**	**2030**
Suppliers	**70**	**190**	**620**
DNO	**25**	**50**	**-40**
TSO	**10**	**20**	**30**

Frontier derived these DSR values on the following basis:

- **Value to suppliers** : derived from the possible gains suppliers might make in their wholesale purchase costs and in reduced imbalance payments. (The wholesale price differentials were generated to be consistent with a recent paper by Baringa for Ofgem)[106].
- **Value to the system operator / TSO** : derived from current average STOR prices and scaled in line with the increase in wholesale prices (Baringa model).
- **Value to DNOs** – derived from the reinforcement costs in the 2011 Pöyry paper, and, in the case of post-fault situations, the assumption, (derived from discussions with UKPN) that about 1% of substations might at any time be in a fault situation and a value of DSR in such cases related to the value of lost load.

2. The value available to the industry actor concerned

There are a number of reasons why the full potential value of DSR may not, or not yet, be available to the industry actor concerned. These include:

- **Technology and data** – the involvement of domestic customers in *dynamic* DSR will be difficult ahead of the roll out of smart meters and the introduction of individual settlement (as more dynamic tariffs will need half-hourly settlement).

106 Baringa (2013) *Electricity Balancing Significant Code Review – Quantitative analysis to support Ofgem's Impact Assessment* (https://www.ofgem.gov.uk/ofgem-publications/82296/baringa-ebscr-quantitative-analysis.pdf).

- **Set-up costs and customer appetite** – the *commercial* value of DSR to suppliers does not yet appear to justify the effort and costs involved.

- **Retail tariff complexity, fairness / distributional issues** – the current initiative to simplify tariffs under the Retail Market Review presently makes more cost-reflective retail tariffs potentially more difficult to introduce.

- **Regulatory incentives** – in retail supply (or generation), where costs and prices are subject to competitive pressure, the full value of the benefits from any DSR actions by their customers are likely to be available to the industry player. It is then for industry actor to choose how to best to share that DSR 'benefit' with their customers.

  In the regulated monopoly parts of the value chain (networks, balancing), the benefits available to the market actors will be shaped by their present regulatory incentives. **Potentially, this makes the position for distribution networks on DSR benefit-sharing with end-customers quite complex.** For example :

  - *For non-firm connection arrangements (or other DSR)* : under the Common Connections Charging Methodology, the investment costs relating to new connections and network reinforcement split between (1) the customer who requires a new connection at a particular location ('shallowish' connection charging) and (2) customers more generally, through DUOS charges. A newly-connecting customer (or another customer providing DSR at that point on the network) may therefore benefit directly and fully from a lower connection charge. Any avoided knock-on cost of 'deeper' network reinforcement (i.e. as a result of DSR and / or a non-firm connection arrangement), *would be shared by the distribution network as a benefit with customers in general*. (This is because underspend by DNs against certain regulatory allowances is shared with customers in general (in this case the Information Quality Incentive)). Thus, in this example, the benefit from avoided investment costs resulting from implementation of DSR (non-firm connection or other DSR) is shared three-ways (1) with the DSR provider (2) with the DNO and (3) with customers in general.

  - *Post-fault management & DSR* : where DSR is used by a DNO for purposes of 'post-fault' management, the financial incentives on the DNO are driven by the Interruption Incentive Scheme (IIS) and Guaranteed Standards of Performance (GSOP). However, the value of lost load is relevant to establishing the value to customers of preventing or shortening a power cut. (Ofgem are currently consulting about an increase in GSOP payments by DNOs as a result of storms in December 2013).

3. The value shared with the individual customer who provides the DSR

Pre-2020

A number of studies have looked at the value available to the domestic market from DSR. Caution needs to be applied in all comparisons between studies as assumptions may vary, particularly between the studies mentioned below and the studies by Pöyry and Frontier Economics.

a. Peak avoidance value

- **Wholesale markets** : seem to hold greatest overall market cost-saving potential from DSR by households from now until at least 2020 in terms of peak avoidance (avoided short-run & long-run costs)[107]. The DECC smart meter impact assessment identifies £930m of total benefits over the period to 2030 from household load-shifting from basic static ToU tariffs, (split between avoided generation SRMC (£114m), avoided generation capacity (£631m), network capacity (£42m) & carbon benefits (£26m) [108]. This equates to a ~£50m p.a. saving. So, in crude terms, if shared across one million customers, a possible £50 p.a. saving per ToU customer[109]. At WS6 on 29 April 2014, a strawman figure was mooted of £100-200 / MWh market peak saving (& up to £50 BM payment from system operator) *So, say a total 10-25 p/kWh total wholesale market cost-saving at peak – available to be shared among market actors and customers*. Earlier calculations seem to suggest that only modest value may be available to *individual* households. The Frontier Economics paper for the CLNR trial suggested that in 2020 wholesale peak savings available to share with households were likely to be rather small. For customers agreeing to have their load occasionally directly controlled at peak, the cost-saving / value as calculated available to share with the customer in 2020 ranged from £2-4 p.a for wet appliances – and up to £15 p.a. for hot water heaters.[110] In practice, headline findings from the CLNR trial with ~600 customers, suggest a £12 per customer *average* annual cost saving – but with a wide range of customer cost-savings from the CLNR basic ToU peak tariff (average saving: £22 ; average 'loss' : £-14) [111].

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107 Ofgem estimate an 'electricity shaping cost assumption' of 70% for 'base-load' costs – and 30% for 'peak'-related costs in the wholesale markets Ofgem. Supply Market Indicator. March 2014.

108 DECC Smart Meter Impact Assessment. January 2014. Assumes a 1 in 5 uptake of ToU tariffs by smart meter recipients from 2016 onwards, over and above existing Economy 7 customers, who then shift between 7-10 % of peak demand.

109 Back of the envelope calculation : £931m divided by 18 years is £50 m per annum saving. 5 million smart meters per annum from 2016 – with a 20% uptake of ToU = ~ 1 million customers. So, 1 million customers delivering £50 m avoided costs would represent a saving £50 per customer.

110 Domestic and SME tariff development for the Customer-Led Network Revolution. A report prepared for Northern Powergrid. June 2012.

111 Source : British Gas slides. DECC Benefits Monitoring & Review Group. 4 March 2014.

- **Distribution constraints & fault management** : distribution networks represent ~20% of the end electricity bill. However, distribution networks are designed, built and operated at low voltage to meet *today's* household peak loads. Depending on local changes in electricity peak demand and when the network was last reinforced locally, new reinforcement needs will be very locationally dependent. For the foreseeable future (so beyond 2023), any DNO value to share with household customers therefore is likely to be extremely locational, at identifiable network 'hot-spots', where general peak demand is increasing or where clusters of low-carbon technologies are causing a network to invest in new assets. *Households able to offer DSR would need to be located at a particular place for their DSR to offer value to the DNO*. The Frontier 2012 analysis for CLNR, suggested a cost-saving at low-voltage to a DNO of deferred or avoided investment of £30/kW/p.a. Our own inquiries for paper 4 suggested a guess-timate of £40-60/kW/p.a. This means that the annual costs to the DNO of obtaining and implementing any firm DSR-savings from households, including the share of the benefit to the customer, would need to cost *less* than such annualised £/kW sums. Over this period, the national system and local network peaks are likely to coincide and so DNOs will gain in any case from peak reduction that results from wholesale market DSR.

b. Balancing Services value

- **Frequency, Fast Reserve** (STOR provision by households unlikely) – households can and have provided frequency control by demand management and fast reserve services to the Balancing Market (Frequency : Npower CERT fridges, Nines project ; Fast Reserve : Economy 7 customers) - but so far none of these schemes have operated on a commercial 'benefit-share' basis with the customer. The sum available to pay per household for being 'tripped' for a low-frequency event, say 10-30 times p.a is likely to be high relative to payments / rewards for other household demand-side services noted in the preceding paragraphs. With smart meters and load switching arrangements via ALCS or CADs, there seem no insuperable *technical* barriers for households to provide these balancing services, provided satisfactory validation of the demand-side actions can be provided to the system operator.

Of the ~600 trial customers, average bill saving 3% ; of those who saved : 7% saving ; of those who lost : 7% loss. 72% of customers saved ; 28% lost. Maximum saving : £192 ; maximum 'loss' : £-73.

Average annual electricity consumption of the trial group fell by 7.67 % against 4.89% for the control. ToU weekday peak is now 7.35% less than comparable control group customers. ToU customers' weekday consumption fell as a proportion of their weekday consumption from 25.3% to 22.9% (of their total week consumption from 17.6% to 16%).

Finally revised ToU trial results now indicate trial customers who saved / lost as 60% saved ; 40% lost.

CLNR Update to Ofgem. June 2014.

NB - Numbers are 2009 unless otherwise indicated. Frequency : In 2011-12 National Grid expenditure on frequency was £193 m. Indicative payments of £50-60/kW/pa split between a tendered availability, holding & use fee. Fast Reserve : In 2011-12 National Grid spent £92 million on fast reserve. Availability payment : £44k/MW p.a. Usage payment - £6k/MWp.a. (plus additional fee for matching run-up, run-down rates)[112]. STOR has more demanding parameters, and lower available value, so household involvement seems unlikely. *Balancing presently represents only 1% of the end bill. Even if this sum was to double by 2020, the cost-saving value to the cost-efficiency of the market as a whole would be minor – but value available to share with an individual customer who provides frequency or fast reserve services for the system operator may be worthwhile to the customer in return for only modest inconvenience.*

So, in the period pre-2020, the greatest overall potential cost-savings to the electricity market *as a whole* from DSR, (and therefore also to customers *collectively*) seems to sit in the wholesale markets. At the same time, the wholesale markets may offer the smallest potential *individual-level* customer savings to each participating customer, and so, perhaps, little evident reason for customer 'pull'.

The value shared with the individual customer who provides the DSR

Post-2020

Peak avoidance / capacity adequacy values

- **Wholesale markets** : beyond 2020, GB wholesale markets are likely to be characterised by 'base-load' prices and 'flexibility' prices. Each of these may tend towards short run marginal prices and not reflect the full underlying costs of supply due to the EMR & capacity arrangements[113]. Wholesale prices may be comparatively low for substantial periods at times of high-wind and / or non-peak demand periods[114] – 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. It is conceivable post-2020, that greatest cost-savings from household DSR in the wholesale markets may well still be associated with shifting household load away from the morning and evening peak periods, especially in winter. Greatest cost-savings from household demand-side

112 Sustainability First. Paper 4. What demand-side services can provide value to the electricity sector? June 2012. Annex.

113 Sustainability First. Paper 9. GB Electricity Demand – 2012 and 2025. Impacts of demand reduction and demand shifting on wholesale prices and carbon emissions. Results of updated Brattle modelling.

114 As indicated in the Pöyry study mentioned above.

actions may not just be associated with avoiding the peak periods however – but also perhaps with shifting available flexible household load *into the night-time* (on a staggered basis to avoid creating new night-time peaks) : because at night, demand may be low and wind may otherwise need to be constrained off (especially on summer nights). Goran Strbac suggests an average night-time 'flexibility value' today per customer of £3, which may rise to over £100 per participating customer in 2025. His assumption is that if half of all household customers take part, and half do not, there could be 1 : 3 difference in their end-bills [115] [116]. Redpoint modelling estimated a £90 p.a. saving per participating customer in 2030 from automated direct load control.

- **Capacity markets** : the first DSR stage 1 capacity auctions will take place in 2015 & 2016 for implementation in the winter of 2017 – with the potential for being incorporated into the enduring scheme by the early 2020's. Household participation seems to be neither explicitly included or excluded. Subject to being able to satisfy the technical conditions for ensuring dynamic 'firm' household response, there is no obvious reason – other than the administration / transaction costs of activating the load of multiple households - why households should not obtain an 'equivalent' £/kW/p.a. benefit in the capacity market as I&C providers.

Transmission networks : **peak avoidance.** Around three-quarters of annual transmission network use of system charges (TNUOS) (total ~£1.7 bn in 2011) are levied via demand customers, but TNUOS charges represent a small portion of the overall end-bill at the individual level (~4%). I&C customers able to demonstrate that they deliberately avoided the three TRIAD periods can avoid payment of their full annual TNUOS charges. This is not at present the case for non-half hourly customers.

- For an I&C customer : the zonal charge is on a £/kW basis (for example, with over a two-fold differential between the highest (£38.79 /kW – south west) and lowest (£16.17 /kW - Northern Scotland). These zonal differentials seem to incentivise southern I&C customers to avoid their charges more. (Regardless of zone, there is also a non-locational 'residual' element (£22.83p/kW) in 2012-13)).

- The zonal non half-hourly customer charge *to a supplier* (including, in effect for their household customers) is on a p/kWh basis via the supplier volume allocation process, and charged all year round for consumption Monday to Friday 16.00h – 19.00h. For non half-hourly customers, (household customers included), TNUOS charges are just over twice as much for a customer in the south 5.38 p/ kWh – as in the north 2.19 p/kWh (Northern Scotland). For non-half hourly metered customers, the sums relating to TNUOS are likely to amount to a relatively small element of their overall end bill

115 Sustainability First. Paper 9. GB Electricity Demand – 2012 and 2025. Impacts of demand reduction and demand shifting on wholesale prices and carbon emissions. Results of updated Brattle modelling.

116 SUPERGEN HiDef Dissemination Event. 29 April 2014.Goran Strbac. Imperial College. Slides on GB 'flexibility value' (& material not yet published). NB - This calculation seemed to include some distribution and other savings too.

(because the charges are socialised according to Load Profile 1 (plus apply only to peak-related consumption)[117] . (TNUOS & Balancing = ~4% of end bill). However, a back-of-the envelope estimate, assuming, say, 1000 kWh p.a. were classed as annual 'peak' hours – might amount to an avoided TNUOS charge of ~£50 p.a. per *participating* customer.

Given smart meters, a household TRIAD (effectively three critical peaks avoided per winter) could become *technically* feasible (See Annex 1. Table 6 on this)[118].

The initial benefit of a household TRIAD would fall *to suppliers* (avoided allocation of p/kWh at the Grid Supply Point). Suppliers could then be expected to share that benefit with participating customers.

Under present TNUOS arrangements, there may then be a knock-on shortfall in National Grid's TNUOS revenues – as the overall fixed cost of providing a transmission network for household customers in a particular zone would, in general, remain unchanged (unless an overwhelming response). Rationally, suppliers would in turn be likely to pass-on residually higher transmission charges to customers who do not (or cannot) participate in the TRIAD response.

This in turn may call into question the present basis on which TNUOS charges for non-half hourly customers are calculated and apportioned.

Perhaps, in the future, if households were to be given a signal to participate in a TRIAD, their TNUOS charges in the future may also need to be **capacity-based –** rather than energy based (just as I&C customer zonal charges now). Although a dynamic response, it is a limited one (contrary to DSR in the capacity market). It may therefore be feasible for households to opt to participate in a limited dynamic **voluntary** critical peak scheme prior to half hourly settlement. But, if a wide-spread market response was sought, half-hourly settlement is likely in the end to be preferable from an overall market point of view.

Before seeking TRIAD responses at scale from households, there would need to be : a concerted discussion as to how the peak-related fixed costs of the transmission networks would be paid for. Non-participating customers risk becoming a smaller group picking up a larger share of the fixed costs through no fault of their own, and with potential distributional impacts.

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[117] National Grid. Forecast TNUOS tariffs from 2014-15 to 2018-19. May 2014.

[118] For example, peak-load controlled by an auxiliary load control switch could be 'switched off' (this would also allow a 'firm' response & validation (assuming the load was otherwise operating when the TRIAD occurred).

4. The value that other customers gain from a more efficient electricity system

If the electricity market was *wholly* cost-reflective, ie if customers were charged individually for the full cost of generating and delivering the electricity at the time they needed it, then DSR would benefit only those customers providing the resource**.** Each user would decide their level of electricity usage in relation to the cost of the electricity at that particular time and the value they placed on that level of usage compared with a reduction at that time.

However, retail pricing is far from wholly cost-reflective:

- Tariffs may be flat-rate p/kWh or simple TOU
- Distribution and transmission use of system charges contain only broad locational and TOU signals
- Customers do not bear any cost relating to the connection of domestic low carbon technologies (<3.6 kW micro-gen or major new household loads).

This *averaging effect* which comes from cost-simplification in electricity pricing (network & balancing charges, retail prices) *enables other customers to benefit from the effects of DSR*. Paradoxically, at the same time, it is the lack of reflection of *actual underlying* industry costs that inhibits the development of DSR (because individual incentives / 'rewards' may prove too weak or insufficient). Simple tariffs also have a social and distributional effect : put simply, *some cost-reflection is needed to encourage DSR, but socialisation is also still needed to spread the benefits among consumers in general*. In principle at least, universal half-hourly settlement potentially opens the door to greater cost-reflection in individual retail prices and potential unwinding of current 'fairness' in distributional terms delivered by cost-socialisation. There is therefore a fundamental policy question to be resolved going forward as to the balance between promoting cost reflection in retail tariffs in order to encourage DSR - and how far it is desirable to maintain a degree of socialisation (in any or all of its forms) in order to share the benefit of DSR. We discuss the implications of this at length in Part II (section 10) of this paper.

End of Annex 3.

Annex 4 : Composition of the end electricty bill & effect of levies : today, 2020 & 2030 (social & environment levies)

Table 11 – Composition of the end electricity-bill today.

Today, the average end-customer electricity bill is broadly composed as shown below.

Real 2012 prices	**Average Electricity Bill £**	**Electricity Bill %**
Wholesale energy cost	215	**37**
Network costs	133	**23**
Other supplier costs & margin	121	**21**
Energy & climate change policies – *of which*	80	**14**
ECO	22	**4**
RO	30	**5**
EU ETS	8	**1**
Carbon Floor Price	5	**1**
Warm Home Discount	6	**1**
FITS	7	**1**
Smart meters & better billing	1	**-**
VAT (5%)	27	**5**
Total - without Warm Home Discount	576	
Average rebate (incl VAT)	-£13	
Total – with Warm Home Discount	563	
Source : SF adapted from DECC. Estimated impacts of energy and climate policies on energy prices and bills. March 2013. Table 3 p. 13		

DECC has estimated that current energy and climate change polices added around £80 net (14%) to an electricity bill in 2013 [119]. At the same time, policies and measures are estimated to have cut electricity bills by around 3% compared to what they would have been without the policies [120]. Real increases in typical bills to 2020 are forecast to be 6% for both gas & electricity – **with the full range of polices projected to cut typical electricity bills by 11% in 2020 as illustrated in Table 12 below** (and gas bills by 1%).

At the same time, as Table 12 shows, DECC estimates that its policies will add 33% (35%) to the average electricity price paid by UK households in 2020 (plus any wholesale price rises) and 41% in 2030[121]. This will especially impact households reliant on electric heat.

Note – the electricity policy expected to have greatest impact on electricity bill reductions are EU product regulations (£167 in 2020). The gas policy expected to have most impact are the Condensing Boiler Regulations (-£107 by 2030).

The ECC Committee report 'Energy Prices, Profits and Poverty'[122] published in July 2013 states that: 'The Secretary of State explained that the Government's assumption was that companies would "pass on these costs the way they are levied, typically on the basis of relevant units of energy supplied". It was up to energy companies to decide how to recoup costs, and Government expected approximately one-third of policy costs to be passed on directly to household bills. Approximately two-thirds of policy costs would fall on non-domestic customers, reflecting the share of energy consumption across these customers. However the majority of costs are still likely to be passed through to domestic consumers through higher prices for services and products. A policy such as the ECO, which applied only to households would be funded only by domestic customers'.

DECC stressed to the ECC Committee that the combined effect of policies on energy prices in 2020 was on average expected to be offset by the impact of policies which improved energy efficiency by helping households reduce energy consumption.

In other words, the assumed combined effect of policies and measures by DECC is one of spend to save.

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119 (and £33 – 5% to a typical domestic gas bill). Energy Prices. House of Commons. Standard Note. SN/SG/4153. 31 January 2014 – taken from : **DECC. Estimated impacts of energy and climate change policies on energy prices and bills. March 2013.**

120 Policies include energy efficiency savings from earlier bill-funded schemes, the impact of policy on wholesale prices, & EU minimum standards of electrical efficiency.

121 Energy Prices, Profits and Poverty. Volume 1. Energy & Climate Change Committee. HC 108. 5th Report of Session 2013-14. July 2013.ECC Report – p.59. July 2013 – which in turn draws from **DECC. Estimated impacts of energy and climate change policies on energy prices and bills. March 2013**.

122 Energy Prices, Profits and Poverty. Volume 1. Energy & Climate Change Committee. HC 108. 5th Report of Session 2013-14. July 2013.ECC Report – p.59

Table 12 : Breakdown of estimated average impact of energy & climate change policies on household electricity bills (incl VAT) 2020 & 2030.

Breakdown of estimated average impact of energy & climate change policies on household electricity bills (incl VAT) 2020 & 2030			
Real 2012 £ - on typical electricity bill	**2013**	**2020**	**2030**
Estimated bill without policies	582	670	667
Estimated bill with policies	563	598	734
Estimated impact of policies on ely bills *	-18 (-3%)	-72 (-11%)	67 (10%)
Estimated costs of policies			
ECO support cost (+Green Deal Admin)	27	33	-
Warm Home Discount support cost	7	8	6
Smart meters (Ofgem say supplier annual net cost of £7.26 per customer (dual fuel) in 2015)[123].	1	-	-
EU ETS carbon cost	10	17	19-115
Carbon floor price (pre-Budget 2014 changes)	6	50	96 to 0
RO support cost	37	63	24
EMR support cost (assumed to include the costs of CfDs but not CM. See NAO chart below (Redpoint CM costs £5-13 per customer pa 2016-30)	-	47	114
Small scale FITS support cost	9	22	18
Wholesale price effects	1	-	0.3
Costs of policies as a %age of average ely bills	**98 (16.6%)**	**240 (35%)**	**277 (41%)**
Estimated benefits of policies			
EEC 1&2, CESP, CERT efficiency savings	-48	-55	-11
Green Deal & Eco efficiency savings	-3	-29	-20
Warm Home Discount rebate	-14	-15	-13
Smart meters (s.m. impact assessment assumes 2.6% overall reduction, rather than load-shift benefits)		-18	-28
Better billing	-2	-2	-2
Products policy (i.e. EU product efficiency standards)	-51	-167	-137
Wholesale price effects (i.e lower wholesale prices due to policy)	-	-24	-
Benefits of policies as a %age of average ely bills	**-117 (-20%)**	**-310 (-46%)**	**-211 (-31%)**
Source : Sustainability First adapted from DECC. 'Estimated impacts of energy and climate change policies on energy prices and bills'. Annex F. Table F1. p.83. March 2013 * - a minus sign = a bill reduction			

123 Ofgem. Supply Market Indicator. Report on Methodology. March 2014. Appendix 1.

Understanding the Levy Control Framework & potential implications for electricity bills[124]

HMT and DECC describe the purpose of the Levy Control Framework to make sure that DECC achieves its fuel poverty, energy and climate change goals in a way consistent with economic recovery and minimising the impact on customer bills. The Framework is designed to encourage DECC to control the burden on consumers and ensure that oversight on spending is equivalent to that for general taxation – 'so that trade-offs are considered between schemes to minimise impacts on consumer bills'.

The cap for the framework was set at £11.8bn for the period 2011-15 (£2 bn in 2011-12) and included RO, FITs & Warm Homes Discount. From 2014 onwards, the Framework will expand to include Contracts for Difference (CfDs) to a total levy cap of £7.6 bn for 2020-21 (2011-12 prices).

The £7.6 bn Framework to 2020-21 therefore covers the RO, the FIT and CfDs. It does not currently cover all consumer-funded energy schemes (eg ECO ; Capacity Mechanism (including any *enduring* Electricity Demand Reduction scheme)125 ; nor, other non-electricity policies which are levy-funded (e.g. Warm Home Discount)[126].

In its November 2013 report on the Levy Control Framework, the National Audit Office indicate that DECC estimates the Contracts for Difference scheme will add £30 to the average household's annual electricity bill in 2020 [127]. At the same time, DECC estimates that changes in the generation mix and capacity margins resulting from CfDs and the RO will *reduce* the wholesale price of electricity by £16 in 2020. NAO says that DECC estimates that overall the cost of schemes within the Levy Control Framework will on average account for up to £90 of annual household electricity bills in 2020, but, that DECC expects the *net impact* of all existing government policies will be to reduce household electricity bills by an average of £72 in 2020 (see Table 14 below).

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124 National Audit Office. The Levy Control Framework. HC 815. Session 2013-14. 27 November 2013.

125 Implementing Electricity Market Reforem. 24 June 2014. Pp 19-20.

*'The LCF sets limits on the overall costs of all DECC's low-carbon levy funded policies until 2020-21. These comprise the Renewables Obligation (RO), small-scale Feed-in-Tariffs and CfDs (including FIDs / Investment Contracts). The annual cap in 2020-21 has been set at £7.6 bn, a level which will enable us to meet our low-carbon and renewables ambitiions…..**In future, the capacity market will also be included in the LCF. However, it will not fall within the spending cap for low carbon electricity** (£7.6bn in 2020-21 in 2011-12 prices). Expenditure on the Capacity Market will not begin until 2018. **When there is greater certainty on the size of the levy, its own separate budget will be set.** A future government will consider when to set an LCF cap beyond 2010-21'.*

126 Warm Home Discount is included in Framework from 2011 to 2015-16.

127 National Audit Office. The Levy Control Framework. HC 815. Session 2013-14. 27 November 2013.

Table 14 also indicates how the end electricity bill will recover the costs of the levies for the Contracts for Difference (£1-2 bn p.a. by 2020) and the Capacity Mechanism (£5-13 per customer p.a.) – but those costs need to be 'off-set' by the expected bill savings from smart meters & the expected savings in wholesale prices due to EMR and low carbon policy. Smart meter costs are expected to amount to £6 per dual fuel customer pa in 2020 – but the Table indicates only the expected saving on the average electricity bill.

Table 13 : National Audit Office : The cost of schemes within the Levy Control Framework will account for up to £90 of the average annual household electricity bill in 2020

National Audit Office : The cost of schemes within the Levy Control Framework will account for up to £90 of the average annual household electricity bill in 2020	
Policy	**Electricity bill impact in 2020 (2012 prices) for a household consuming 3.03 MWh (3,300 kWh) of electricity each year (£)**
Estimated bill without government policies	**670**
Cost of Contracts for Difference	30
Renewables Obligation	41
Feed-in Tariffs	14
Warm Home Discount	5
Total cost of schemes within the Levy Control Framework on average annual household electricity bill	**90**
Wholesale price effects	-16
Net effect of other policies	-146
Estimated bill with government policies	**598**

Notes

1 Other policies include the Carbon Price Floor, EU Emissions Trading Scheme, Green Deal and the Energy Companies Obligation, Smart Meters, Better Billing, Products Policy (DECC chart : expected to save £158 p.a. off a dual fuel bill by 2020), and the Carbon Emissions Reduction Target as well as the impact of VAT at 5 per cent.

2 The Department's estimate of the impact of policies on bills does not include the costs or potential savings for consumers from the Capacity Market scheme in 2020.

Source: National Audit Office analysis of Department of Energy & Climate Change data.

National Audit Office. The Levy Control Framework. HC 815. Session 2013-14. 27 November 2013. P.36 Figure 12.

NAO also says that DECC publishes information on the impact of its policies on prices and bills128 – but this does not give a complete picture. NAO notes that (para 15) : 'In the future, **because of the interaction between government interventions and market prices, t**he Department will need to report levy costs alongside outcomes and impacts on energy bills to consumers to provide a complete picture of the overall impact'.

Last, the ECC Committee pulled together a chart to show the impact of expenditure on social and environmental policies on *as split between* taxpayers and consumer energy bills (both electricity & gas) – adapted below by Sustainability First.

Table 14 : Social & environmental policies : split between taxpayers & energy bill levies.

Total expenditure on fuel poverty and environmental programmes (eg including expenditure capped by the Levy Control Framework) NB THIS IS ON GAS AS WELL AS ELECTRICITY BILLS

Programme	**Who pays ?**	**Estimated Expenditure**
Warm Front England	Taxpayers	£370 m (09-10)
CERT	Consumers** - standard sum per household p.a.	£564 m (09-10)
CESP	Consumers – standard sum per household p.a.	£101 m (09-10)
ECO	Consumers – standard sum per household basis p.a. Not yet decided whether or how to be incorporated into Levy Control Framework cap.	£466 m (2013)
Winter Fuel Payments	Taxpayers	£1.723 bn (2013)
Cold Weather Payments	Taxpayers	£228 m (est) (2013)
Warm Home Discount*	Consumers – standard sum per household p.a.	£237m (2013)
EU ETS	Consumers via wholesale prices – (presumably on a p/kWh basis) (? electro-intensive customers compensated (? Subject to state-aid ruling?))	£700m
Carbon Floor Price	Consumers via wholesale prices – (presumably on a p/kWh basis) (electro-intensive customers exempt).	£900m (2013-14)

128 DECC. Estimated impacts of energy and climate change policies on energy prices and bills. March 2013.

Renewables Obligation*	Consumers – p/kWh levy	£2,156 m (2012-13) (budget available under the levy control framework
Feed-in Tariffs for small-scale renewables*	Consumers – standard sum per household basis p.a.	ECC : £196 m (2012-13) NAO : £497 m estimate (2012-13); £817 m estimate (2014-15).
Contracts for Difference (EMR)*	Consumers – p/kWh levy (electro-intensive customers exempt – subject to state aid ruling ?)	£/kWh levy Forecast cost of £2.5bn in 2020-21 under cap. Actual levy costs will depend upon the difference between the CfD strike prices & prevailing wholesale prices & how much contracted generation comes on stream.
Capacity Payments	Consumers – both I&C & households. Presume as a standard sum per customer p.a. Capacity Market : costs will be included in a new & separate Levy Control Framework – but not before 2018. **Electricity Demand Reduction pilot** : £20m over two years (2014-16) funded by taxpayer. Not yet decided whether or how the costs of an enduring EDR scheme might be incorporated into the Levy Control Framework.	Annual costs of capacity required to meet LOLE (£/kW plus admin costs). Redpoint129 (Dec 2013) estimate CM costs at £1-2 bn p.a. 2016-2030. Part of this cost expected to be offset by lower marginal wholesale prices. Redpoint also estimate a possible average annual cost-increase on household electricity customer bills of £5-13 (range subject to modelling assumptions). Annual supplier levy to be based on monthly payments of total forecast market share (? kWh) over four winter months between peak hours 16.00h – 19.00h.
RHI	Taxpayers	£133m (2012-13)
CCS competition	Taxpayers	£1 bn.

** - consumers : could be gas or electricity, domestic or non-domestic.
* - scheme covered by the cap for the Levy Control Framework.
Source : **Adapted by Sustainability First**.
ECC Cttee. Ibid. July 2013. Table 10 p. 58. Their sources include : NEA, Control Framework for DECC levy-funded spending ; HM Treasury Budget 2013. Office for Budget Responsibility, Economic & Fiscal Outlook. March 2013.

129 Redpoint. Estimating the costs and benefits of the Capacity Market. A report to DECC. December 2013.

The ECC Committee Report : 'Energy Prices, Profits and Poverty' published in July 2013, draws a number of conclusions, noted below, which will be highly relevant to future thinking on household DSR and DSR retail tariff development.

These conclusions will need re-visiting by DECC, Smart Energy GB, Ofgem and others in the light of the smart meter roll-out, the Retail Market Review and Ofgem's Consumer Empowerment & Protection programme.

ECC Conclusion – para 151.

'We have noted that tax-funded public spending is a less regressive mechanism than levies, and that the impact of levies on the bills of the fuel poor is perverse when they will derive no direct benefit. Shifting the emphasis from levies to taxation would help to protect vulnerable households. There is no widespread understanding by consumers of how much of their bills are made up of levies….we have called for an honest conversation about the fact that energy bills are highly likely to continue to rise. Government also needs to be in the lead in ensuring that consumers understand its decision to fund policy in this way, and of what the breakdown of these costs within bills are. This can only enhance transparency'.

ECC Recommendations

'Ofgem should : 'Identify the various components which make up the costs of the bill (ie wholesale price of fuel, costs of supply (transmission, distribution & metering), the costs of UK/EU policy (including support for low-carbon renewables and energy efficiency schemes) and company margins (ie operating costs & profits)' (p.71).

'We conclude that the increasing use of levies on bills to fund energy and climate change policies is problematic since it is likely to hit hardest those least able to pay. We note that public funding is less regressive than levies in this respect'. (Paragraph 136)

'We are particularly concerned by the significant projected increase in the wholesale electricity price and how this will impact on households reliant on electric heating. It is clear that vulnerable and fuel-poor consumers require protection from the impact of rising bills and extra support to ensure affordable warmth in their homes. *We therefore recommend that Government consider introducing a "protected block of consumption" on bills exempt from levies, as proposed by FPAG and Consumer Focus'*. (Paragraph 137)

'We note that under the current tariff structure, energy users are effectively penalised for low consumption, with reduced rates for high energy consumption. This is at odds with both energy conservation and fuel poverty aims. *We therefore recommend that the Government and Ofgem consider how tariffs could be restructured to ensure that energy conservation is incentivised, while ensuring that high consuming vulnerable consumers are protected'*. (Paragraph 138).

End of Annex 4.

Annex 5 : Current electricity-related support measures (RHI, Domestic Green Deal, ECO & EU Eco-Design Framework Directive) - & implications for electricity demand reduction & DSR development

This Annex aims to understand the present range of electricity-related measures supported under current mechanisms (RHI, Green Deal & ECO). Inter al, these schemes support electricity-specific measures for electric heat and / or greater electricity efficiency.

The aim here is simply to understand a little more *about what further measures might - in due course - be considered for possible future support to enable certain domestic electrical appliances & installations to be 'smartened'* (for example, Green Deal eligibility for, say, auxiliary load control switches and / or smart communication systems (for remote switching of heat pumps, storage heaters, hot water cylinders), or for 'smart' electrical appliances (in particular storage heaters, hot-water cylinders and heat-pumps).

Taken together with the smart meter roll-out, one possible goal may be for future electricity-related support-mechanisms to start to factor in 'smart'. The aim would be to begin to *bring together in a systematic way* measures which can help to develop *smarter approaches to* household electricity demand-side reduction & management, electricity demand-response and electricity & energy efficiency. **Such combined 'smart' approaches will become increasingly important for all-electric households, and in particular the vulnerable and those on low incomes.**

To this end, the Annex looks at the following measures :

- **RHI (Renewable Heat Incentive)**
- **Domestic Green Deal**
- **ECO (Energy Company Obligation)**

The Annex also looks at how the ECO Design Framework Directive is expected to impact the electricity efficiency of household electrical products going forwards. This is a particularly important area in the light of DECC's expectation that electricity product regulation will significantly offset the impact of the likely costs of policies in electricity bills in 2020 and 2030.

The Domestic Renewable Heat Incentive (Domestic RHI)

Domestic RHI is a government financial incentive to promote the use of renewable heat. It offers incentives for homeowners, private landlords, social landlords and self-builders who have invested in an eligible renewable heating system (since 15 July 2009).

To be eligible the system must only heat a single residential property and applicants must have had a green deal assessment and hold a domestic Energy Performance Certificate (EPC).

Payments under the Domestic RHI

People who join the RHI receive quarterly payments **for seven years** for the renewable energy generated by their renewable heating system. The majority of beneficiaries of the scheme receive payments based on an estimation of their heating system's annual heat production. The Domestic RHI covers the following products:

Current tariffs130 (per kWh of renewable heat)

Biomass boilers and biomass pellet stoves	12.2 p
Air source heat pumps	7.3p
Ground source heat pumps	18.8p
Solar thermal panels (flat plate or evacuated tube only)	19.2p

130 Payments for new claims may be adjusted in future depending on uptake of the RHI

The Domestic Green Deal

Extent of financing available under the Green Deal

There are no caps on the financing that domestic customers can receive through the Green Deal so long as the 'Golden Rule' is met. This rule stipulates that the estimated annual saving from a proposed measure must be expected to be equal to or greater than the expected annual repayment costs.131

For certain measures an extra upfront subsidy can be sought – via the Energy Company Obligation (ECO). Alternatively, a householder can pay some of the cost upfront to reduce the repayment cost and may also be eligible to partial funding via the Green Deal Home Improvement Fund.132

The following domestic sector improvement measures have been eligible under the Green Deal since its launch in October 2012.

131 Energy Savings Trust – http://www.energysavingtrust.org.uk/Take-action/Find-a-grant/Green-Deal-and-ECO

132 The Green Deal Home Improvement Fund has replaced the earlier Green Deal cashback scheme (ended in spring 2014). The three-year £540 million Green Deal Home Improvement Fund was launched in June 2014 with an initial £120m allocation. The success of the scheme meant that it was closed to new applicants on 24 July 2014. A further £120 m will become available from April 2014.

Table 15 : Domestic Green Deal Measures & 'Cashback' available

Domestic Green Deal Measure	**Cashback available[133]**
Air source heat pumps	
Biomass boilers	
Biomass room heaters (with radiators)	
Cavity wall insulation	£250
Cylinder thermostats	
Draught proofing	£50
External wall insulation systems	£4000
Fan-assisted storage heaters (new or replacement).	**£150**
Flue gas heat recovery devices	£100
Gas-fired condensing boilers	£270
Ground source heat pumps	
Heating controls	£100
High performance external doors	£100
Hot water cylinder insulation	£10
Hot water showers (efficient)	
Hot water taps (efficient)	
Internal wall insulation (of external walls) systems	
Loft or rafter insulation (including loft hatch insulation)	£150
Micro combined heat and power	
Micro wind generation	
Oil-fired condensing boilers	
Photovoltaics	
Pipework insulation	
Replacement glazing	£650
Roof insulation	£550
Room in roof insulation	£1000
Secondary glazing	£500
Solar water heating	
Underfloor insulation	£200
Variable speed drives for fans and pumps	
Warm-air units	£320
Waste water heat recovery devices attached to showers	£100
Water source heat pumps	

133 'Cashback' now replaced by the Green Deal Home Improvement Fund. Cashback applications redeemed on or after 13 December 2013 will receive these rates. See 'The Green Deal – Cashback for energy-saving home improvers', DECC.

Links between Green Deal and ECO

ECO requires energy companies to support the installation of energy efficiency improvements in homes. It was designed to work alongside the Green Deal to assist certain householder groups (lower income and vulnerable households where Green Deal finance is less likely to work) to implement energy efficiency measures.

Table 16 below shows all the measures that qualify for the Green Deal and ECO.

Table 16 : Measures which qualify for the Domestic Green Deal & ECO

Green Deal Measures	In ECO (Affordable Warmth)?	In ECO (Carbon Reduction)?	In ECO (Carbon Saving Communities)?
Measures/text in **bold** were added after the consultation	Low income and vulnerable households identified individually through benefits data (measures which reduce the cost of heating the home)	All households	Homes in defined low income areas.
Green Cells	Always eligible		
Blue Cells	Eligible when delivered as part of a package with solid wall insulation or hard to treat cavity wall insulation		
Red Cells	Never eligible		
Air source heat pumps	Y	N	N
Biomass boilers	Y	N	N
Biomass room heaters (including with radiators)	Y	N	N
Cavity wall insulation	Y	P	Y
Cavity wall insulation (HTT)	Y	Y	Y
Cylinder thermostats	Y	N	N
District heating (not GD)	Y	P	Y (if has LI or CWI)
Draught proofing	Y	P	Y
Duct insulation	N	N	N
Hot water showers (efficient)	Y	N	N
Hot water systems (efficient)	Y	N	N
Hot water taps (efficient)	Y	N	N
External wall insulation systems	Y	Y	Y
Fan-assisted replacement storage heaters	Y	N	N
Flue gas heat recovery devices	Y	N	N
Ground source heat pumps	Y	N	N
Heating controls (for wet central heating system and warm air system)	Y	N	N
Heating ventilation and air-conditioning controls (including zoning controls)	Y	N	N
High performance external doors	Y	P	Y
Hot water controls (including timers and temperature control)	Y	N	N
Hot water cylinder insulation	Y	N	N
Internal wall insulation (of external walls) systems	Y	Y	Y
Lighting systems, fittings and controls **(including rooflights, lamps and luminaires)**	N	N	N
Loft or rafter insulation (including loft hatch insulation)	Y	P	Y

Mechanical ventilation with heat recovery	N	N	N
Micro combined heat and power	Y	N	N
Micro wind generation	Y	N	N
Pipe-work insulation	Y	(external pipework only)	(external pipework only)
Photovoltaics	N	N	N
Chillers	N	N	N
Gas-fired condensing boilers	Y	N	N
Replacement glazing	Y	P	Y
Oil-fired condensing boilers	Y	N	N
Warm-air units	Y	N	N
Radiant heating	Y	N	N
Roof insulation	Y	P	Y
Room in roof insulation	Y	P	Y
Sealing improvements (including duct sealing)	N	N	N
Secondary glazing	Y	P	Y
Solar water heating	Y	N	N
Solar blinds, shutters and shading devices	N	N	N
Transpired solar collectors	N	N	N
Under-floor heating	Y	N	N
Under-floor insulation	Y	P	Y
Variable speed drives for fans and pumps	N	N	N
Waste water heat recovery devices attached to showers	N	N	N
Water source heat pumps	Y	N	N

Table 2: Taken from 'Which energy efficiency improvements qualify for Green deal finance', DECC, June 2012

EU Eco-Design Framework Directive

This directive provides a framework for the mandatory setting of eco-design requirements for certain products across the EU. For example, the Eco-design Regulation on 'standby' requires that many domestic electrical and electronic products such as TV's, washing machines and personal computers do not consume more than 0.5W in off mode as of 2013.134 The directive ensures that in cases where a specific product does not comply with ecodesign requirements it will not qualify for CE marking and consequently cannot be sold in the EU.

Transitional period 2005-2008

The first 13 measures under the transitional period of the framework are projected to produce annual savings by 2020 in excess of 12% of the consumption of the EU in 2009.

Table 17 : Eco-Design Framework Directive Measures. 2005-08

Ecodesign Measure	Adoption	Estimated annual savings by 2020
Standby	December 2008	35 TWh
Simple set top boxes	February 2009	6 TWh
Street & Office Lighting	March 2009	38 TWh
Domestic Lighting	March 2009	39 TWh
External power supplies	April 2009	9 TWh
Electric motors	July 2009	135 TWh
Circulators	July 2009	23TWh
Domestic refrigerators	July 2009	4 TWh
Televisions	July 2009	28 TWh
Domestic dishwashers	November 2010	2 TWh
Domestic washing machines	November 2010	1.5 TWh
Fans	March 2011	34 TWh
Air conditioners and comfort fans	March 2012	11 TWh
Total		**366 TWh**

Table 3: From "Ecodesign your Future", European Commission

134 See 'Ecodesign Your Future – How Ecodesign can help the environment by making products smarter', European Commission

First Working plan 2009-2011

The first Working Plan of the Ecodesign Directive was adopted on 21 October 2008.

The domestic product groups established in this working plan for implementing measures in 2009-2011 were:

- Air-conditioning and ventilation systems
- Electric and fossil-fuelled heating equipment
- Food-preparing equipment
- Network, data processing and data storing equipment
- Sound and imaging equipment
- Water-using equipment

Second Working plan 2012-2014

The Ecodesign Commission funded a study to identify energy-related product groups not covered thus far that have significant potential for energy efficiency improvement.135 The Commission established an indicative list of seven priority product groups and five conditional product groups.

From these twelve those most relevant for domestic energy efficiency are noted in Table 18 below.

135 Commission Staff Working Document – Establishment of the Working Plan 2012-2014 under the Ecodesign Directive, European Commission, Brussels, 7.12.2012

Table 18 : EU Eco-Design Directive. Future Priority Product Groups (domestic energy efficiency).

EU-Eco Design Directive **Future Priority Product group**	**Estimated energy savings potential (in PJ/year as of 2030)**	**Considerations for inclusion in the working plan**
Priority list		
Water-related products (e.g. showers and taps)	885	Large savings potential (both energy and water) representing an opportunity for an EU labelling scheme.
Window products for buildings	785	Large savings potential and opportunity for an energy labelling scheme
Smart meters/appliances	802	Large savings potential identified in the impact assessment of the Energy Efficiency Directive (June 2011)
Conditional List		
Lighting controls/systems	610	Large savings potential identified, but potential savings overlap with lighting in both domestic and tertiary sectors
Heating controls	319	Large savings potential identified, but potential regulatory overlap with water heaters and storage tanks
Thermal insulation products for buildings	1500	Large savings potential identified, but regulatory overlap needs to be avoided. Savings are likely to be achieved at the level of buildings (affected energy system) and relate to characteristics of the building components, in which insulation materials are used

Table 4: adapted form Annex II: Non-exhaustive assessment for the product groups on the indicative list for the 2012-2014 working plan, Commission Staff Working Document – Establishment of the working plan 2012-2014 under the Ecodesign Directive

End of Annex 5.

Annexes : Full list of Tables

Annex 1. GB electricity demand-side markets & potential for household participation

Annex 2. Possible market 'drivers' market actors to seek flexibility from households. Pre- & Post-2020. (via voluntary peak avoidance ; automated flexibility).

Annex 3. Initial discussion of DSR values in different parts of the electricity markets & how these might be shared with households.

Annex 4. Composition of the end electricity bill & effect of levies : today, 2020 & 2030 (social & environment levies)

Table 11 : Composition of the end electricity bill today.

Table 12 : Breakdown of estimated average impact of energy & climate change policies on household electricity bills (incl VAT) 2020 & 2030.

Table 13 : NAO. The cost of schemes within the Levy Control Framework will account for up to £90 of the average annual household electricity bill in 2020.

Table 14 : Social & environmental policies. Split between taxpayer & energy bill levies.

Annex 5. Current electricity-related support measures (RHI, Domestic Green Deal, ECO & EU Eco-Design Framework Directive) - & implications for electricity demand reduction & DSR development

Table 15 : Domestic Green Deal Measures & 'Cash-back' available

Table 16 : Measures which qualify for the Domestic Green Deal & ECO.

Table 17 : Eco-Design Framework Directive Measures. 2005-08

Table 18 : Eco-Design Framework. Future Priority Product Groups (domestic energy efficiency).

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