Sustainability *First*

GB Electricity Demand – *realising the resource*

Paper 5

The electricity demand-side and wider policy developments

By Judith Ward, Gill Owen and Maria Pooley

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Sponsored by : BEAMA ; British Gas ; Cable & Wireless; Consumer Focus ; EdF Energy ; Elexon ; E-Meter Strategic Consulting; E.ON UK ; National Grid ; Northern Powergrid ; Ofgem ; ScottishPower Energy Networks ; UK Power Networks.

Smart Demand Forum Participants : Sponsor Group ; Energy Intensive Users' Group ; Which? ; National Energy Action ; Brattle Group ; Lower Watts Consulting ; DECC ; Sustainability First.

Preface

Sustainability First

Sustainability First is a UK environmental 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 on **GB Electricity Demand** began in April 2011. It was supported in its first year under the Northern Powergrid Low Carbon Network Fund project - and thereafter for a further two years to April 2014 via a multi-sponsor group.

Sponsors include : BEAMA; British Gas; Cable & Wireless; Consumer Focus; EdF Energy; Elexon; E-Meter Strategic Consulting; E.ON UK ; National Grid; Northern Powergrid; Ofgem ; ScottishPower Energy Networks; UK Power Networks.

Work is coordinated through a **Smart Demand Forum** whose participants also include a number of key consumer bodies: Energy Intensive Users Group, Which? and National Energy Action; plus DECC and the sponsor group members.

The project aims to identify the potential resource which the electricity demand side could offer into the GB electricity market through demand response and through demand reduction. The project aims to:

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

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

The project will develop a substantive knowledge-base, and provide 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 projects – emerging lessons and insights from the LCNF projects will be fed into the project.
- Proposals for Electricity Market Reform.

The work programme is being delivered through the Smart Demand Forum, through annual wider stakeholder events, and through a series of published papers and other materials. The project is run by Sustainability First. The Sustainability First team is Gill Owen, Judith Ward and Maria Pooley.

Additional expertise and inputs are provided by Serena Hesmondhalgh of Brattle Group who is developing a quantitative all-sector demand model. Stephen Andrews is supporting the project on Distributed Generation and Micro-Generation.

Key themes for the project include:

- **Customer Response and Consumer Issues –** A key focus for the project is to understand successful and cost-efficient demand-side participation from a customer and consumer perspective (household, industry, commercial and public sectors). This will include experience provided through the LCNF trials (e.g. tariffs, remote control of appliances, technologies such as micro-generation, electric vehicles etc.) and other similar initiatives in the UK and elsewhere. For households, this will include any particular issues for the fuel poor and potential distributional impacts.
- **Commercial** - Practical realisation of demand-side services - given different roles and requirements in the value chain. Issues likely to include: the nature of commercial agreements, the role of third parties (DNOs, ESCOs, aggregators), the kind of information-sharing likely to be necessary between parties etc. – drawing from practical experiences of the LCNF Trials and other experience in the UK and elsewhere.
- **Regulatory** – near and longer term regulatory factors that impact upon development of an active electricity demand-side for Great Britain – including current agreements between market actors, statutory codes, incentives in price controls, settlement, and third-party requirements. This will include experiences within the LCNF trials, and also feed into future considerations for price controls, RIIO and other thinking on innovation incentives.
- **Public Policy Issues** – likely economic value and potential contribution of the demand side to: cost-efficiency across the electricity sector; security of supply; carbon-emission reductions. Business models, approaches and incentives for integrating the demand side into the electricity market, including its interactions with Electricity Market Reform, smart meter roll-out and energy efficiency schemes such as the CRC Energy Efficiency Mechanism, Green Deal and Energy Company Obligation.

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

Papers published in the first year of the project are:

Paper 1 - GB Electricity Demand in 2010 - baseline data and context. Published October 2011.

Paper 2 - GB Electricity Demand 2010 and 2025 – Initial Brattle Electricity Demand-Side Model: Scope for demand reduction and flexible response
Published February 2012.

Paper 3 -What demand-side services could GB customers offer in 2010?
Industry paper - final paper published September 2012.
Household paper published May 2012.

Paper 4 -What demand-side services can provide value to the electricity sector?
Published June 2012.

Papers published in the second year of the project to date are:

Paper 5 -The electricity demand-side and wider policy developments
Published November 2012.

All papers are available from our website at:
http://www.sustainabilityfirst.org.uk/gbelec_documents.html

Our subsequent papers in Year 2 will be:

Paper 6 –What demand-side services does distributed generation bring to the electricity system?

Paper 7 – Evolution of commercial arrangements for more active customer & consumer involvement in the electricity demand-side.

Paper 8 – Electricity demand and consumer issues.

Future topics for Year 3 papers are likely to include:

- Active I&C Customers
- Active Household and Micro-business Customers
- Longer-Term Demand-Side Innovation and Realisation

Sustainability First
November 2012

Paper 5: The electricity demand-side and wider energy policy developments.

GB Electricity Demand – *realising the resource*

Paper 5

The electricity demand-side and wider policy developments

The Executive summary of this paper outlines the key impacts of the various policies on the demand side and makes recommendations for modifications to policy where we judge that is needed. These recommendations are those of Sustainability First alone. They do not imply endorsement or agreement by our Sponsor Group or by Smart Demand Forum members.

The remainder of the paper discusses the broad energy policy impacts on demand response and demand reduction and the impacts of individual policies.

The electricity demand-side and wider energy policy developments

Preface

Introduction

Executive Summary – pages 15 - 27

1. **Broad policy effects on the demand side**

    1.1 Climate Change targets
    1.2 Renewables targets
    1.3 Heat strategy
    1.4 Impacts of policies on electricity prices

2. **Electricity supply-side – EU ETS and EMR (Electricity Market Reform).**

    2.1 EU ETS cap
    2.2 Carbon price floor
    2.3 EMR – FIT CfDs
    2.4 EMR – Capacity Agreements
    2.5 EMR – Emissions Performance Standards
    2.6 DECC Electricity System Policy Assessment
    2.7 DECC Electricity Demand Reduction Assessment
    2.8 Ofgem Review of Cash-Out prices

3. **Network regulation and innovation**

    3.1 Distribution Price Control Review 5 (DPCR 5)
    3.2 DPCR 5 –LCNF
    3.3 DPCR 5 – IFI
    3.4 RIIO – ED1

4. **Green Deal and Energy Company Obligation**

    4.1 Green Deal
    4.2 Energy Company Obligation (ECO)
    4.3 Likely impact of GD and ECO on electricity demand reduction
    4.4 Is there a need for additional policies for electricity demand reduction?

5. Incentives for renewable electricity and heat

    5.1 Feed-In Tariffs
    5.2 Renewable Heat Incentive and Renewable Premium Payment
    5.3 Renewable Electricity and Heat Pumps – impacts on Distribution Networks
    5.4 Equity and fairness in charging for connection

6. **Smart meters**
7. **Ofgem smarter markets programme**
8. **Climate change levy and climate change agreements**
9. **CRC energy efficiency scheme**
10. **EU Draft Energy Efficiency Directive**
11. **EU Eco-Design Framework Directive**
12. **Electric vehicles policy**

Annex 1 – Draft Energy Bill

Introduction

This paper explores the interactions of policy and regulation with the demand side. It examines whether the various energy policy initiatives :

- Align well in terms of delivering electricity demand-reduction and demand response.
- Risk unforeseen consequences for the electricity demand-side - and if so - how to resolve.
- Impact in particular on certain customer or consumer groups from an electricity demand-side perspective.
- Provide an adequate and cost-effective framework for realising the electricity demand-side – including required investment - and if not, why not, and what might need to be done.

A great many energy policy initiatives and measures are now in train, designed to develop a secure, affordable and low carbon UK energy economy. The policy landscape will impact on current and future costs, benefits and values for demand response, demand reduction, flexibility, and longer-term electricity demand growth.

GB electricity demand through to 2020 will be shaped by UK and EU policies for:

- Power sector decarbonisation.
- Decarbonisation of heat.
- Energy efficiency.
- Energy affordability.
- Electrification of end-uses (notably transport and heat).

What are the factors likely to encourage demand response and demand reduction that policy / regulation could influence ?

- Product appliance features – ability to be remotely switched off; timers etc.
- Product standards – more efficient = less usage overall and less load at peaks if that appliance tends to get used at peaks.
- More substantial potentially flexible demand (e.g. electric vehicles) – which might be encouraged via incentives.
- Tariffs/retail offerings that get customers to shift demand (need to avoid any regulatory barriers to such packages and also need smart meters to offer them (unless direct load control)).
- Payments for demand response from networks, SO etc.
- Customers having their own on-site generation to use instead of networked electricity (incentives to have on-site such as FITs).

- More cost-reflective electricity prices that make customers more interested in reducing or shifting use.

It was agreed at the Smart Demand Forum meeting on 25 April 2012 that it will not be practicable to evaluate all of the policies that could impact upon the electricity demand side. Rather, the aim is to identify priority policy areas.

The key criteria to determine priority for Paper 5 are :

- Potential for significant impact on development of demand reduction and demand response in the next few years.
- Policy decisions likely to be made in the next year (through to summer 2013).
- Materiality of demand response or reduction, likely to result from the policy.

Based on these criteria, this paper therefore considers the following policies with respect to electricity demand reduction and demand response :

- Policy targets and strategy– carbon, renewables, heat.
- The role of price.
- Smart meters.
- Supply-side policies - including Electricity Market Reform.
- Green Deal and Energy Company Obligation.
- Microgeneration and heat (to a limited extent as they will be further covered in Paper 6).
- CRC energy efficiency mechanism.
- Ofgem's Smarter Markets Strategy.
- EU Draft Energy Efficiency Directive.
- EU Eco-Design Framework Directive.
- Electric vehicles policies.

Executive summary

Key policy issues

Based on our analysis of the various policies that are impacting and/or will impact on the electricity demand side over the period to 2020, we have identified the following key policy issues for electricity demand reduction and demand response.

- The role of more cost-reflective prices as a signal – both to actors in the electricity value chain and to end consumers via retail prices.
- The extent to which DNOs or other market actors are incentivised for demand reduction.
- The importance of product standards – for households and the commercial sector especially.
- Electric heat and lighting are key areas for early action to reduce demand.
- The relative importance of demand reduction and demand side response in short term
- Do we need any more incentives for demand reduction ? There are various policies in place already – are we using them effectively ?

In the remainder of this summary, we provide an assessment of these key issues and the other policy areas that have an impact on the demand side and make a number of recommendations.

We will consider the consumer and customer implications of policies for demand response and demand reduction more fully in Paper 8.

Overall impact of policy on demand response and demand reduction

Overall the range of energy policies currently in place or being developed over the next few years, will provide some incentives for demand response and demand reduction. The carbon, renewables and heat targets, which underpin UK energy policy, in combination with expectation of rising retail prices, should, in principle, incentivise both electricity demand reduction and electricity demand response – especially given the wish for economic delivery of targets.

On this basis, we would conclude that it would seem premature to adopt explicit GB goals or targets for electricity demand-side measures - unless or until it becomes more evident that today's measures and incentives cannot deliver in practice.

However, even where cost-efficient, electricity demand-side solutions may not necessarily happen of their own accord - for all of the well-understood reasons linked to inertia, market failure and split incentives[2] - unless there is a more concerted and explicit policy focus on electricity demand-side solutions. Measures targeted at reducing certain end-uses of electricity could make a material impact on electricity system costs today – in advance of

[2] It's not just about the money : taking the hassle out of energy saving. Gill Owen. Sustainability First. March 2011.

ToU tariffs , but, barriers include poorly targeted incentives and fragmented benefits in value chain.

We therefore make the following broad recommendations :

- The government should actively promote electricity-specific demand-side measures - so that cost-efficient measures are not over-looked because of their somewhat dispersed nature and relatively modest capital spend.
- Existing demand-side incentives (Green Deal, ECO etc) should be used to promote cost-efficient electricity demand reduction in a targeted way (e.g. for more efficient lighting schemes in all sectors).
- For demand side response, it will be important that the technical and commercial dependencies between existing schemes and proposals for a new capacity market, are well-understood and effectively addressed, including ways to introduce more price discovery / visibility for DSR value throughout the market.
- DECC and Ofgem need to join up the many reviews and policies currently in hand to promote the electricity demand-side. Priority areas for action need to be clearly identified and sequenced.

We therefore do not see a need at present for any major additional policy initiatives to incentivise the demand side. However, there are a number of existing policies that could be modified to more effectively incentivise the demand side and we outline the changes that we recommend below.

Electricity Demand Reduction

We have also reached a further broad conclusion on electricity demand reduction. This is that whilst all electricity demand reduction can presently deliver broadly the same value to most consumers (i.e. whilst these consumers are on flat tariffs, saving a kw at night delivers the same bill reduction as saving a kw between 5-7 pm) - not all demand reduction has the same value for the electricity system. As with demand response, reducing electricity demand at particular times of day is likely to deliver more wholesale / upstream value than at other times of day. For example, reducing lighting-use between 5-7 pm in winter (through more efficient lighting), will provide more value to the electricity system than improving the efficiency of electric hot water heating overnight in summer. There is therefore a need for a better understanding of which costs can be avoided in the electricity system when – and specifically from which end-use demand reduction measures.

Broad policy effects

The broad policy effects on the demand side come in two areas : targets and strategy; the impacts of policies on electricity prices.

Role of targets and strategy

The UK's carbon targets and the plans for realising them suggest substantially greater use of electricity post 2020 than today, for transport and heating and substantial quantities of intermittent generation on the system. Therefore the opportunities for, and need for, greater demand response and demand reduction will increase.

The renewables target is driving policies to support renewable electricity (e.g. feed-in tariffs and the renewables obligation) and renewable heat (the renewable heat incentive), which will in turn create a need for demand side solutions (to manage intermittency and additional loads) and provide opportunities to reduce demand and provide flexibility.

The heat strategy will from the 2020s onward aim to drive greater use of electricity for heating. This will therefore increase the need for electricity demand response and demand reduction in order to manage (practically and cost effectively) and where possible minimise, the need for more generating and network capacity.

Impacts of policies on electricity prices

Policies that impact on electricity prices are :

- Policies which increase wholesale and/or retail prices generally – EU ETS (in the long run - too weak currently) ; Carbon Price Support ; CCL, CRC, Energy Company Obligation, the Renewables Obligation, feed in tariffs, smart meter roll-out. - and therefore should increase the value available from both DSR and DR.

- Policies which increase wholesale prices at peak – e.g. Cash Out Review - which should encourage DSR (and possibly demand reduction).

- Policies which 'stabilise / smooth' revenues – (EMR : FIT CfDs, Capacity Mechanism) to electricity generators. These mechanisms are likely to suppress / smooth volatile wholesale prices.

- Policies that increase network costs (distribution and transmission) due to : increases in electricity demand, more wind on the system, new demands from distributed generation, heat pumps, electric vehicles etc , will increase the potential for demand reduction and demand response in two ways. Firstly by making the networks more interested in demand side measures to defer or avoid capital investment where cost effective and sufficiently reliable. Secondly, by increasing the interest amongst customers in reducing demand or participating in demand side initiatives.

In summary we see the price effects as follows :

- **Demand Reduction -** Rising wholesale and network costs and environmental policies will increase electricity prices over the short to medium term and thus should increase the incentive for demand reduction. In the longer term (post 2025), wholesale electricity prices may fall due to low carbon generating plant increasingly setting average wholesale prices (i.e. instead of higher fossil prices) although it remains to be seen what will be the trend for network costs. If average wholesale or retail prices were to fall in the long term this could arguably disincentivise electricity demand reduction over the longer term.

- **Demand-Side Response -** Value will increase in the future as both Balancing and Capacity Costs increase – and networks will seek to find a way to reward location-specific DSR solutions.

Specific policies – likely impact on the demand side and recommendations for change

Product standards

Mandatory standards for energy efficiency of electricity using products could be one of the most effective means of reducing electricity demand. The EU Ecodesign Framework Directive aims to improve the energy efficiency of energy-using and related products. Initial estimates by the Commission calculated that the first 13 measures (including standby; lighting; electric motors; domestic refrigerators, dishwashers, washing machines; television; air conditioners) would lead to annual savings of 366 TWh by 2020[3] (2009 baseline). The largest savings were expected from electric motors, street and office lighting and standby.

However, there are concerns regarding the successful implementation of the existing EU Ecodesign Framework directive, highlighted in Green Alliance's recent report 'Cutting Britain's energy bill – making the most of product efficiency standards'[4]. Key points of concern:

- Implementation of the Directive is beset by delays – e.g. within the UK only 13 out of 25 products in the first tranche of eligible products have so far had regulations applied to them.
- Additionally, consumer uptake of efficient appliances is not occurring at the expected rate – which will further impact on expected carbon savings.

Recommendation : The main changes to the existing Ecodesign framework directive which would make it more conducive to demand reduction would involve:

- Bringing forward its impact – the sooner the Directive is implemented, the sooner demand reduction savings will commence. This is the most urgent need.
- Promoting consumer take up of efficient appliances.

[3] http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/files/brochure_ecodesign_en.pdf
[4] http://www.green-alliance.org.uk/grea_p.aspx?id=6623

- Completing the first work programme, including more product families in 2012-14.
- Prioritising those products which, from a UK perspective, are likely to achieve greatest cost-savings in the electricity system.
- Enhancing market surveillance.

Green Deal and Energy Company Obligation

How far will the Energy Company Obligation (ECO) and Green Deal (GD) incentivise electricity savings ? Much of the focus of these policies will be on reducing energy use from space heating (through insulation and improved heating systems) so the main near-to-medium term impact will be on gas rather than electricity use. This means there is little prospect of the schemes being used to support lighting improvements at least in the household sector. Efficient lighting is eligible as a measure under Commercial Green Deal, which will also generally have a degree of flexibility in the measures that can be assisted - the assessor report can take into account actual consumption data from the building/company.

However, there could be potential for these schemes to tackle electric on-peak heating – assisting households and small businesses using on-peak electric heating to switch to off-peak electric heating (new generation storage heaters) or heat pumps[5]. Clearly there could also be a possible role here for the Renewable Heat Incentive.

Around 500,000 households use on peak electric heating as their main heating source and many more use it for supplementary heating. Electric on-peak heating may be used by many small businesses although we do not have data on this. Switching these customers to electric storage heating or heat pumps could be a useful means of reducing peak demand. It would also be important to install adequate insulation in these properties to make the heating systems cost effective and affordable for the occupants.

Recommendation : It therefore seems important that the Green Deal and ECO have a clear focus on tackling the on-peak electric heating issue and to incentivise efficient lighting. By so doing, the Green Deal and ECO schemes could play a more explicit near-term role in reducing electricity demand at highest cost periods in the electricity system overall, in the next 5-10 year period, before ToU retail tariffs become widely available to the vast majority of retail customers as a load-shifting or demand reduction incentive.

Distribution network regulation

Electricity distribution networks (DNOs) are incentivised to examine demand side alternatives, following a regulatory change made under DPCR5 (April 2010 - 2015). This was the equalisation of incentives between operating costs (opex) and capital costs (capex). One of main rationales for this change was to ensure that the price control does not reduce the incentive on DNOs to adopt solutions that do not involve investment in network assets such as demand-side management or contracting with distributed generation to manage

[5] Our Papers 2 & 3 found that up to ~7% of commercial electricity end-use and ~7% of household end-use is for on-peak electric heat.

constraints. To date very limited use has been made of DSR as an alternative to network upgrading, because there are few areas where there are significant distribution network constraints. However, this is likely to change with increasing adoption of solar PV, electric vehicles and heat pumps which will contribute to the need to upgrade at more locations and thus create opportunities for demand response and demand reduction. The equalisation of incentives should therefore lead to increasing adoption of demand side solutions where they are more cost effective than reinforcing the network. However, demand side solutions will also need to be as reliable as network upgrading – i.e. the networks will need to be confident that the demand side response or demand reduction will be delivered when required, and sustained.

DNOs are also similarly incentivised for cost-effective electricity demand reduction (as well as DSR) under LCNF and IFI (see sections 3.2 and 3.3).

However, it is arguable that, whilst there are no regulatory barriers to DNOs using demand side solutions, their effective use may still be limited as this is new territory for many DNOs. As part of the ED1 process these issues are currently under review.

Recommendation : continue to keep under active review during the ED1 process whether DNOs need any more specific encouragement to undertake demand side solutions.

Is there a need for any additional policies for electricity demand reduction ?

A key question is whether electricity demand reduction should only be incentivised if it is 'cost-efficient' (i.e. will cost less over a given period than the investment alternative) - but faces other barriers / market failures. From a purely economic point of view only cost-effective demand reduction will make sense, but there may be public policy reasons to support demand reduction that is not cost effective – e.g. for social (tackling fuel poverty) or environmental (carbon reduction) purposes.

There may be some further measures that could be considered specifically to encourage electricity demand reduction. For example :

- Capital allowances for more efficient products / appliances.
- Intervention in either the electricity wholesale markets or network sectors.

Some NGOs and others are advocating an electricity demand reduction measure 'equivalent' to the FIT CfD - an energy efficiency feed-in tariff (EE FIT). However, there is a need to consider carefully the rationale for an energy efficiency FiT, given the range of other policies in place to support demand reduction. If the existing policies are not likely to incentivise the desired amount of electricity demand reduction (either what is cost effective and/or what is required to meet other policy goals) it might be more sensible to adapt or modify one or more existing policies (e.g. Green Deal, ECO, CRC etc) than to introduce yet another new policy.

Product standards are likely to deliver key areas of demand reduction in lighting and refrigeration across economic sectors by the 2020s. The main rationale for new measures (such as an EE FiT) therefore could be to accelerate 'normal' rates of stock-turn-over and so

bring forward the savings that will eventually anyway accrue from improved product standards. However, given the range of policies already directed at domestic sector demand reduction and de-carbonisation (GD, ECO, RHI, FIT and product standards) and given that smart meters will not be fully rolled out in the domestic sector until 2019 (nor are there likely to be ToU tariffs at scale), there would seem little merit in further additional policies targeted to the domestic sector for demand reduction or for demand response in advance of 2019.

Recommendation : we do not at present see a clear rationale for an energy efficiency FiT to achieve cost-efficient electricity demand reduction. The priority should be to make the existing suite of energy demand-side policies more effective and more targeted to explicit electricity end-uses – especially for lighting efficiency and for on-peak electric heat - as we recommend under the specific policies covered in this paper. However, this is an issue that should be kept under review.

Incentivising Demand Response in the GB electricity market

The need for new policies to incentivise demand side response in the short term is limited because :

- DSR values are relatively low (likely to increase towards 2030s) and half-hourly settlement is needed (early 2020s at earliest) to get ToU tariffs and therefore DSR at scale.

- DSR is already active in the Balancing Mechanism and DNOs are already incentivised to consider DSR to avoid network reinforcement investment.

- Creation of 'equivalence' for DSR (distributed generation and non-generation alternatives) in the Capacity Mechanism is already proposed.

- FIT CfDs – will incentivise low-carbon plant bringing greater intermittency and lack of flexibility and so potentially increases the value of DSR. The key question is over what *timescales* those values may crystallise.

- In addition to DECC's Electricity System Policy, other current initiatives should in due course help to bring DSR measures together in a more coherent framework : Ofgem Smarter Markets Strategy; Ofgem Cash Out Review ; Universal smart meters by 2019 ; Smart Meter Customer Engagement policy ; LCNF projects ; DECC / Ofgem Smart Grid Forum; Elexon review of half-hourly settlement.

In the US, federal legislation[6] requires a national assessment of demand response potential by FERC, a national action plan, and a proposal for implementation. Similar amendments were proposed for the draft EU Energy Efficiency Directive - but rejected by member states.

[6] Energy Independence and Security Act 2007

Assuming the next steps which DECC identifies in its Electricity System Policy Assessment are taken forward, many of today's obstacles and barriers to facilitating DSR may be addressed – so enabling development of a more coherent market framework for demand-side participation. However, together with Ofgem, DECC needs to formulate some clear priorities and timescales for the actions DECC has identified. Most notably, the technical and commercial dependencies of current schemes (including the proposed capacity market) need greater clarity – including ways to introduce more price discovery / visibility for DSR value throughout the market.

Recommendation : we do not consider that further incentives for DSR are required in the short term, but this should be kept under review.

Feed in tariffs (FITs) and RHI

FITs are having an impact on the electricity demand side through :

- Creating the scope for households and businesses with low carbon generation to use less grid supplied electricity at certain times of the day and/or overall.
- Creating the scope for customers to contribute generation into the electricity distribution system, which could reduce the need for investment in more remote generation and/or distribution or transmission capacity (and/or provide balancing services at times of low wind output).
- Creating impacts on the local distribution network in terms of power quality and/or the need for investment in local upgrading. There is no recognition in the FIT rate of location or time of day of export.

The RHI and RHPP will have an impact on the electricity demand side through their support for air and ground source heat pumps. Where heat pumps are installed in properties that previously used other fuels for heating, this will represent a significant increase in electricity demand. Heat pumps can create impacts on the local distribution network in terms of power quality and/or the need for investment in local upgrading.

Electric storage heaters do not qualify for the RHI/RHPP because they are not classified as 'Renewable'. However storage heaters (e.g. as an alternative to the on-peak electric heating being used as a main heat source by 500,000 households) could contribute significantly to self-balancing with PV and cost-savings in the electricity system.

Recommendation : whilst the RHI is not appropriate for storage heaters, consideration should be given, through the Green Deal, to incentivising 'new generation' electric storage heaters alongside better thermal insulation to replace on-peak electric heating for households where a heat pump would not be a suitable option (see section on Green Deal).

Renewable electricity and heat pumps – impacts on distribution networks

Distributed generation can provide benefits to distribution networks by reducing losses, reducing the need for investment in transmission and distribution (closer to the point of use) and/or to delay the need for investment. However, heat Pumps, EVs and solar PV can cause the need for network reinforcement or upgrading in two ways : additional peak load / capacity; power quality. A single small scale installation (e.g. solar PV) is likely to have a negligible impact but if there is a 'cluster', then the network may have to be upgraded. Any equipment with power electronics can create power quality problems for the networks. The larger the equipment, the bigger the impact. Manufacturers can change the design of the appliance to deal with power quality, and latest EU standards would make most equipment generally compliant. These issues are currently under discussion in the UK between ENA and BEAMA.

Currently multiple (e.g. PV on a street of houses) or larger installations have to get approval from the DNO before they can connect. Single installations below 3.6 kW merely need to notify the DNO that they have connected. Developers of systems above 3.68 kW can be required to pay a proportion of the cost if their connection will cause the need for reinforcement or upgrading or other work. Developers of systems below 3.68 kW do not currently face any such charges. So if a number of people independently in a street install PV and reinforcement is needed, the cost will be socialised across the whole customer base. Use of system charges (for replacement and maintenance) are also charged to developers of above 3.68 kW - these charges are levied on the electricity supplier who may pass them through.

The impacts of the measures being incentivised by the RHI and FITs on the networks raises important issues of equity and fairness. Should customers be charged a connection cost where their heat pump, electric vehicle charging point or PV, causes the need for re-inforcement or upgrading ? The arguments for charging include :

- These customers should pay their share of upgrading or reinforcement costs, rather than customers in general, because they are imposing the costs on the network – such charges are therefore efficient.
- Customers installing these technologies tend to be better off on average than the generality of customers and therefore it would be more socially equitable for them to pay rather than the costs being passed through to all customers.
- These customers will in many cases already have received subsidies (paid for by other customers or taxpayers) towards the costs of these technologies so it is not fair that they should receive further subsidy.

The arguments against include :

- These customers are "doing their bit" for the climate change and renewable energy targets and as 'first-movers' should not be penalised.
- These customers will have to invest substantial sums of money in the technologies - a charge of this sort could discourage investment.
- Other electrical appliances can also cause problems for networks (e.g. electric showers) so why should low carbon technologies be singled out in this way ?

There are a number of options for dealing with reinforcement and upgrading :

- "Socialise" the costs - i.e. cover the costs in the revenue raised from the generality of consumers in the DNO's area.
- Introduce a threshold – against which either to re-charge / socialise costs of reinforcement.
- Separate out the reinforcement required for *network capacity* from reinforcements required for *power quality* and treat them differently.

The DECC/Ofgem Smart Grids Forum has been considering these issues and to date seems to be coming to the following conclusion : "Until full smart meter roll out in 2019, it may be impractical to target upstream reinforcement costs at existing domestic customers who increase demand or generation. Consequently, costs associated with this may have to be socialised. It was noted that if costs are socialised, the incentive for individual customers to enter into DSR arrangements as an alternative means of capacity reinforcement may be reduced. This assumption is being revisited in light of the impact that installing equipment with poor power factors can have on the LV network. DNOs may wish to charge domestic customers if they install equipment which is below a certain standard."[7].

Recommendation : The Smart Grids Forum approach seems sensible for the immediate future but should be kept under review.

Smart meters policy

Smart meters should facilitate demand response (through half-hourly data, and opportunities for ToU and load management tariffs and through the provision of information to customers) and also encourage demand reduction through improved consumption feedback. However, until smart meters are fully rolled out (2019), followed (possibly) by universal half-hourly settlement some time later, their potential to facilitate the development of a demand response market in the household sector may be limited, because it may not be worth retailers or others developing DSR products to a limited market. The exception to this may be for those households with EVs, PV or heat pumps. In terms of demand reduction smart meters may be able to influence this on an individual household basis pre 2019. Clearly smart meters should have an impact on electricity end-use in the commercial and industrial sectors earlier as the roll-out to those sectors will be completed earlier, (this should then incentivise half-hourly settlement and appropriate tariff options for those customers).

Smarter markets work programme

In July 2012 Ofgem published its initial smarter markets work programme based on the outcome of the consultation.[8] This outlined four priority areas of work :

[7] Smart Grids Forum. Work Stream 6. First report. Identifying potential barriers to smart grid implementation and laying out possible future direction for developing solutions. August 2012
[8] Ofgem. Promoting smarter markets : a work programme. Ofgem, July 2012

- **Change of supplier** – a fast, reliable and cost-effective process
- **Electricity settlement** arrangements that use smart metering data in an accurate, timely and cost-effective way, to facilitate product innovation and efficient use. An open letter from Ofgem early in 2013 will set out how reform should be progressed.
- **Demand-side response** – a market environment that supports the efficient, system-wide use of demand-side response. Ofgem will publish a consultation document early in 2013 that considers the potential of existing arrangements to support efficient system-wide use of DSR.
- **Consumer empowerment and protection** – regulatory arrangements that empower and protect consumers to participate effectively in smarter retail energy markets, recognising the opportunities and risks involved.

The Ofgem smarter markets work programme will thus have some important impacts on the development of demand reduction and demand response.

Climate Change Levy (CCL) and Climate Change Agreements (CCAs)

Sectors which have had umbrella agreements under the CCA have achieved significant improvements in energy efficiency since the beginning of the scheme. Since the future CCA targets will only apply to emissions not included within the EU ETS, CCL/ CCA will continue to drive demand reduction within industry. CCL drives demand reduction not just in electricity but also in gas and other fuels. The CCL and CCA do not encourage or impact DSR.

Recommendation:

There is potential to focus the CCL & CCA on electricity demand reduction and demand side response by:

- Including specific electricity saving targets for CCA parties,
- Exploring a potential focus on improving efficiencies in lighting, on-peak electric heating and motors, three areas which we know contribute significantly to peak electric load.

CRC Energy Efficiency Scheme

The CRC Energy Efficiency scheme does not focus specifically on electricity, however, it is expected to encourage electricity demand reduction by :

- requiring organisations to record their energy use, including electricity, it aims to raise awareness in organisations which previously did not monitor consumption.
- providing a financial incentive, through the £12/tCO2 charge for emissions from energy, including electricity, consumed.

- providing a competitive reputational element, through the CRC Performance League Table.

The scheme does not specifically address the issue of electricity demand side response, as there is no time-of-use consideration given to the emissions from electricity consumed by eligible organisations.

Recommendation : Changes that might make the policy more conducive to electricity demand response or demand reduction:

For Demand Reduction:

- Separating out emissions from electricity explicitly would drive electricity demand reduction.
- Stronger financial incentives.
- Revenue recycling would improve the credibility of the scheme, badly damaged by the removal of the revenue recycling element, which is now widely seen as 'yet another tax' by industry.

For Demand Side Response: The scheme does not set out to address DSR, and to rework the scheme so that it could include DSR could lead to the scheme being unworkably complicated, as it would need to take into account emissions saved by Demand Side Response in electricity, which is very complex.

Electric vehicles policy

The carbon and renewables targets envisage significant decarbonisation of transport over the next few decades and a key means of achieving this will be through uptake of electric (plug in) vehicles. The Government's Plug-In Vehicle Infrastructure Strategy is supporting development of recharging infrastructure and providing some grants for electric cars and vans.

Plug-In vehicles represent a significant load at domestic level and given the length of time over which a car may be stationary outside a property, provides an obvious load which could be shifted to avoid increasing demand at peak periods. Control of recharging times will aid network operators to avoid local overloading from vehicle clusters, and to defer investment in reinforcement. It could also potentially assist with balancing variable or inflexible generation (e.g. renewable). Plug-in vehicles could also enable Vehicle to Grid (V2G) and/or Vehicle to Home (V2H) energy flow with bi-directional charging and potentially become reserve stores at local level.

Aside from the Government strategy, key issues in respect of electric vehicles' impacts on networks are being dealt with by the ENA, working with the electric vehicle industry. A key requirement is to ensure appropriate standards for charging and interoperability. Vehicle manufacturers need to be involved in the development of these standards to ensure their products are suitably enabled for demand response. The ENA have an initiative to require installers to notify the network operators of plug-in vehicle charge units and heat pump

installations. This will provide a better understanding of total demand from these technologies.

There has been a comparatively low take up of vehicles when compared to the installation of charging points across the country. While it is likely EV drivers will predominantly charge at home, there must also be a reasonable public infrastructure if consumers are to have the confidence to purchase the vehicles. Key to take up is ensuring the customers are aware of the availability and location of charging points. This should facilitate longer journeys and remove a key barrier - "range anxiety".

While we may not see a significant level of vehicle take up nationally in the next 5 years, we are more likely to see localised clusters emerging. Therefore demand response options for plug-in vehicles need to be developed to enable the flexibility to cope with and anticipate clusters of vehicles.

Recommendation: The adoption of dedicated charging infrastructure for domestic properties should be incentivised. Current take up of this is low and in the interest of industry's long-term aims for demand response the provision of this infrastructure is key to enabling 'smarter' charging practices. The costs of these installations need to remain low in order to facilitate this take up and industry and government should focus on encouraging this as well as providing clear consumer advice on the longer-term benefits associated with adopting dedicated home charging.

The visibility of where infrastructure is being installed should be made through appropriate notification procedures which correspond with existing frameworks already established in the market in order to ensure the process remains as simple and low cost as possible.

Interaction of Demand Reduction and Demand Response

A further important area where it will be helpful to understand more, is on the potential interaction between Demand Response and Demand Reduction over time – including impact on relative cost savings. Now that more electricity end-use data (empirical and modelled) is becoming available (EST, Element Energy study for Ofgem), Brattle will incorporate this new material into an update of the joint Sustainability First / Brattle electricity end-use model as a start-point for considering interactions of DSR and demand reduction, including economic impacts.[9]

[9] More discussion of issues around interaction of DSR and demand reduction in section 2.6 & 2.7 below - on DECC Electricity Demand Reduction Assessment.

1. Broad policy effects on the demand side

The broad policy effects on the demand side come in two areas : targets and strategy; the impacts of policies on electricity prices. In respect of targets there are - climate change targets, renewables targets and the heat strategy.

1.1 Climate change targets

The Carbon Plan, published in December 2011, sets out the Government's plans for achieving the emissions reductions committed to in the first four carbon budgets, consistent with meeting the 2050 target to reduce the UK's greenhouse gas emissions by at least 80% below base year levels. To achieve these targets the plans for different sectors are :

- In 2009, 37% of UK emissions were produced from heating and powering homes and other buildings. By 2050, all buildings will need to have an emissions footprint close to zero. Buildings will need to become better insulated, use more energy-efficient products and obtain their heating from low carbon sources. Through the Renewable Heat Incentive (RHI) and Renewable Heat Premium Payment, over 130,000 low carbon heat installations are expected to be carried out by 2020. During the 2020s, the mass deployment of low carbon heat would need to begin to meet the targets. By 2027, if the scenarios set out in this plan are realised, emissions from buildings should be between 24% and 39% lower than 2009 levels.

- Industry makes up nearly a quarter of the UK's total emissions. Over 80% of these emissions originate from generating heat for industrial processes such as manufacturing steel and ceramics, and the remainder from chemical reactions in processes such as cement production. By 2050, the Government expects industry to have achieved reductions of up to 70% from 2009 levels. By 2027, if the scenarios set out in the plan are realised, emissions from industry should be between 20% and 24% lower than 2009 levels.

- The power sector accounts for 27% of UK total emissions. By 2050, emissions from the power sector need to be close to zero. The scenarios modelled in the plan show that by 2030 new nuclear could contribute 10–20 GW; fossil fuel generation with CCS up to 10 GW; renewable electricity between 35 and 50 GW (all depending on assumptions about costs and build rates). If these scenarios are realized by the end of the fourth budget period, emissions from electricity generation could be between 75% and 84% lower than 2009 levels.

- Domestic transport emissions make up nearly a quarter of UK emissions. By 2050, domestic transport will need to substantially reduce its emissions. By 2027, if the scenarios set out in the plan are realised, emissions from transport should be between 17% and 28% lower than 2009 levels.

These carbon targets and the plans for realising them thus suggest substantially greater use of electricity than today for transport and heating and substantial quantities of intermittent generation on the system. Therefore the opportunities for and need for greater demand response and demand reduction will increase.

1.2 Renewables targets

The EU 2009 Renewable Energy Directive sets a target for the UK to achieve 15% of its energy consumption from renewable sources by 2020. This compares to 3% in 2009. The Government's ambition (endorsed by the Climate Change Committee) is to have 30% of electricity from renewable sources by 2020 (it was 7% in 2010). This target is therefore driving policies to support renewable electricity (e.g. feed-in tariffs and the renewables obligation[10]) and renewable heat (the renewable heat incentive).

1.3 Heat strategy

The Government's vision and strategy for decarbonising heat is:

- To 2020 – complete and prepare: The Government's focus for both buildings and industry will be on energy efficiency, saving emissions and preparing the way to achieve the maximum efficiency from low carbon heat sources. At the same time, the Government will work with business to prepare the market, drive early deployment, innovation and build supply chains for low carbon heat technologies, helping to bring down costs ahead of large scale roll-out. Key policy measures are the Green Deal, ECO, building standards for new buildings, RHPP and RHI, CRC, EU TS and climate change agreements for business sector.

- The 2020s and 2030s – mass deployment: The Government's expectation is that the next two decades will see the growth of low carbon heat to mass market levels in buildings, and greater fuel switching to low carbon heat sources such as biomass in industry. The Government's focus will be on creating market frameworks.

- The long term – finalising: From the 2030s, the Government's focus will increasingly shift to helping business and consumers tackle the more challenging areas. This includes the roll-out of low carbon heating in more difficult to reach buildings, and technologies that require more innovation, such as biomass for high temperature processes and industrial CCS.

Heating networks - Opportunities to 2020 include: establishing schemes in the cores of major urban centres where high-density housing (especially new build) provides sufficient heat loads to make heating networks economical, and where building-level technologies are less suitable due to lack of space. This will include electrically-heated high-rise buildings[11] and social housing; extending existing heat networks to customers from the private sector; and making use of existing CHP plants and heat recovered from industrial sites and thermal power plants.

[10] Under the draft Energy Bill, the Renewables Obligation transitions to FIT CfDs from 2017. Beyond 2020, no formal or binding target for Renewable energy has been adopted.
[11] Individual gas supplies not permitted to high-rise homes..

The heat strategy will therefore, from the 2020s onwards aim to drive greater use of electricity for heating. This will therefore increase the need for electricity demand response and demand reduction in order to manage (practically and cost effectively) and where possible minimise, the substantially increased need for more generating and network capacity.

1.4 Impacts of policies on electricity prices

A key factor that will influence the realisation of demand response and demand reduction potential are how the costs in the various parts of the electricity supply chain - wholesale, capacity, balancing (i.e. reserve), networks - feed through into prices throughout the chain (including retail). Prices are important because they provide information about the relative values of supply-side versus demand-side actions, measures and services in different parts of the electricity market / electricity system.

Successful demand-side schemes do exist in the GB market (e.g. STOR), but they are currently limited to certain parts of the market and thus there is limited scope to compare the relative cost-effectiveness of demand-side measures against the alternative supply-side actions (i.e. generation and/or network investment). **Impacts of policy on wholesale costs and prices.**

The supply-side policy measures described in section 2 below could have three, potentially different, impacts on wholesale prices and hence on potential savings available from DSR and Demand Reduction.

- **Measures which increase prices generally –** these should increase value / cost-savings available from both DSR and DR. EU ETS in the long run (but too weak currently) ; Carbon Price Support ; CCL, CRC etc ; general expectation of higher wholesale electricity prices in the near-to-medium term, due, for example, to new capital investment, fossil prices etc.

- **Measures which increase prices at *peak* –** these should encourage DSR (and possibly also some demand reduction in the long-run). Cash Out Review.

- **Measures which 'stabilise / smooth' revenues available to market actors** – to promote both low-carbon plant (EMR : FIT CfDs) and reliable capacity (Capacity Mechanism). These mechanisms are likely to *suppress* / *smooth* volatile wholesale prices. The capacity mechanism is being designed to 'factor-in' DSR as an 'equivalent' source of capacity – so that DSR can also access a steady, 'insurance-type' earnings stream (along with other non-generation technologies) – and in return price signals associated with shortage of reliable plant will in effect be 'capped'[12].

[12] A counter-veiling short-run measure is for *short run* price signals of system stress to be made *sharper* via the Ofgem Cash-Out Review.

Impacts of policy on retail prices

The overall impact which these measures may have on retail prices – either separately or in combination - is not altogether certain.

- Measures where carbon intensity is reflected in downstream / retail prices are likely to stimulate demand reduction generally – and also, in time, DSR for half-hourly settled customers, for whom peak-related fossil-prices may become increasingly visible.

- The FIT CfD for low-carbon plant will create new fixed costs for suppliers who will be expected to pass the costs to end-customers in higher retail prices, tempered by retail competition (just as for the RO now). In theory, interest in electricity demand reduction should therefore be stimulated by these higher retail prices. Modelling for the EMR impact assessment anticipates reducing average wholesale prices *in the long-run* due to high volumes of low-carbon electricity setting *average* wholesale prices. If this long-run trend reflects into retail prices, it may, in turn, reduce the retail-price stimulus for electricity demand reduction.

- The government does not expect the capacity mechanism to have a significant impact on end-prices.

- In the long-run, with widespread smart metering *plus* half-hourly settlement (and / or new load-profiles), it should become easier for retailers to stimulate both DSR and cost-efficient demand reduction by reflecting more directly in retail prices :

    - The higher economic values associated with sources of flexibility n the electricity system on a minute by minute basis.

    - Half-hourly, daily or seasonal changes in wholesale prices – i.e. peak-related costs.

    - The anticipated growing differential between *average* wholesale prices - and prices at periods of 'system stress' (i.e. peak and / or low-wind).

Impacts of policy on network costs and prices

Network costs (distribution and transmission) are expected to increase over the next ten years and beyond due to :

- the need for general upgrading,

- increases in electricity demand,

- the costs of incorporating more wind on the system (mainly impacting transmission costs),

- costs of ensuring distribution networks can cope with new demands from distributed generation, heat pumps, electric vehicles etc.

Thus network costs are likely to increase the potential for demand reduction and demand response in two ways. Firstly by making the networks themselves more interested in demand side measures as a means of deferring or avoiding capital investment where they are both cost effective and sufficiently reliable. Secondly, by increasing the interest amongst customers in reducing demand or participating in demand side initiatives as a means of reducing the end-prices they pay for electricity.

Impacts of other policies on electricity prices

A number of other policies will tend to raise electricity retail prices over the coming years. These include the Energy Company Obligation, the Renewables Obligation, feed in tariffs, smart meter roll-out.

Combined effects of policies on electricity prices

The combined effect of the policies outlined above will therefore lead to increasing electricity prices over the short to medium term. So for demand reduction and DSR :

- **Demand Reduction -** Rising wholesale and network costs and environmental policies will increase overall electricity prices over the short to medium term and thus should produce a continuing generalised incentive for demand reduction. Daily or seasonal variation in wholesale costs will not reflect in retail tariffs to any serious extent however, until universal smart meters, half-hourly settlement and / or new load profiles – so enabling ToU retail tariffs capable of incentivising cost-efficient demand reduction. In the longer term (post 2025), average wholesale electricity prices may fall due to low carbon generating plant increasingly setting average wholesale prices (i.e. instead of higher fossil prices) although it remains to be seen what will be the trend for network costs. If average wholesale or retail prices were to fall in the long term this could arguably disincentivise general electricity demand reduction over the longer term (but reduction at peak may still be valuable).

- **Demand-Side Response** - Other than in the Balancing Market, DSR has limited realisable value today. Value will increase in the future as both Balancing, Capacity and Wholesale costs increase – and as networks find a way to reward location-specific DSR solutions. Retail prices and tariffs will need to reflect higher wholesale / upstream costs to customers at times of system stress or peak. Again, this is unlikely at scale until universal smart meters, half-hourly settlement and / or new load profiles – which will enable ToU and dynamic load-control tariffs designed to incentivise DSR among retail customers.

2. Electricity Supply-Side – EU ETS and EMR

2.1 EU ETS Cap

The EU ETS cap and trade scheme was designed as a long-term instrument to dis-advantage carbon-emitting technologies through higher prices – and in turn to incentivise investment in lower-carbon plant and electricity efficiency. The EU cap is fixed at 20% to 2020 against a 1990 baseline. EUAs (permits) have been allocated / auctioned on an EU-wide basis against that cap-level. Without political agreement and / or a new EU Directive[13], there is no available mechanism to tighten the cap or retire allowances.

The carbon price is persistently low - < euros 10 /tonne CO2 in 2012 – due to lower than expected carbon emissions since the cap was fixed – (combination of the economic downturn across Europe and replacement of coal with gas plant). This has led to a glut of EUAs (emissions permits) - and low carbon prices and hence limited incentive for lower carbon plant or energy saving.

UK unilateral action to introduce a carbon price floor to create a higher carbon price for the UK, may mean that the UK will decarbonise more quickly than the rate implied by the UK share of the EU ETS cap. The UK may therefore require fewer EUAs than assumed at the start of Phase II. In turn, this will mean that there is an excess of EUAs available in EU carbon markets - and so suppress the carbon price[14].

The carbon price interacts with demand response and demand reduction due to its in impact on wholesale and retail electricity prices. A low carbon price may dampen the incentive to consumers for both demand reduction and demand response.

The UK Government has tried to encourage the EU to adopt a tighter EU ETS cap of 30% by 2020 to provide a stronger carbon price signal[15]. Other options might be backloading auctions for EUAs in Phase 3 (from 20123) or to set aside' EUAs – but that may have less certainty than a tighter cap. The EU has not reached agreement to date.

A 30% cap may hasten the demise of inefficient and unabated fossil plant – and may increase low-carbon plant running at the margin. Fossil prices would be higher (assuming a tighter cap pushes up the carbon price) than today – and so increase the value of DSR at peak. In the long-run, higher low-carbon prices may support a downward long-term trend in average (low-carbon) wholesale prices – but with high peak-related and flexibility costs – so DSR values may increase. Any carbon savings associated with DSR are likely to decline into the long term.

[13] Or secondary legislation

[14] Generators in other member states may therefore obtain allowances at lower prices than otherwise. In turn, this may give electricity price advantages to the competitors of UK intensive-users of electricity – with their lower prices having been met by UK electricity customers.

[15] Ideally to move to a 30% cap by 2020 (or shortly thereafter).

2.2 Carbon Price Floor

The aim of the carbon price floor is to provide greater forward certainty in the UK about the cost of carbon. Announced in Budget 2011 and legislated initially in the Finance Act 2011, (with some further provisions in the Finance Bill 2012, to be implemented via secondary legislation[16]).

The carbon price floor acts as a 'top-up' tax to the market price of EU ETS allowances (EUAs). The tax is on fossil fuels used for power-generation in the UK, which varies subject to the carbon content of the fuel burned. Creating a tax-inclusive carbon price, introduces a 'floor' on the EUA price. If the EUA price exceeds the floor, the tax (CPF) is zero. If the EUA price is *below* the floor-price (as now), then the tax makes up the difference.

Carbon-price support rates are set two years in advance. Budget 2012 set carbon price support rates for 2014-15 which were equivalent to £9.55/tCO2. The carbon price floor from April 2013 will take the total tax-inclusive carbon price payable by UK emitters to around £15.70/tCO2 and follows a straight line to £30/tCO2 in 2020, rising to £70/tCO2 in 2030 (real 2009 prices).

As with the EU ETS, this policy will have an impact on demand response and demand reduction insofar as it impacts upon wholesale and retail electricity prices.
Higher retail prices should help to encourage both Demand Response and Demand Reduction, but note that the Energy and Climate Change Committee recently said[17] :

'We can see two potential reasons for introducing a Carbon Price Floor : (1) raising revenue; and (2) helping to achieve low-carbon generation more quickly in the UK than in the rest of the EU by creating certainty for investors. However, we are concerned that the mechanism would not reduce emissions overall, because reductions made in the UK would be soaked up in the rest of the EU (para 143).

'The Carbon Price Floor is unlikely to convince other member states to adopt a minimum price of carbon. Unilateral action by member states in sectors covered by EU Emissions Trading System will cause intra-EU carbon leakage. It is unlikely to reduce emissions in the EU. However, it will increase relative costs in the UK and reduce the overall efficiency of EU ETS. We agree that the shift to a low-carbon economy is vitally important, but we believe that targeted support for low-carbon technologies through feed-in tariffs would be a more effective way of achieving it' (para 146).

As for the EU ETS, the key issue in respect of this policy's potential impact on demand response and demand reduction therefore will be how effective it is in raising electricity prices and thus making demand response and demand reduction more cost effective.

[16] Relate to lower CPS CCL-rates to be applied to 'good-quality' CHP ; plant fitted with CCS etc.
[17] The EU Emissions Trading Scheme. Tenth Report of Session 2010-12. HC1476. Published 26 January 2012.

2.3 Electricity Market Reform – FIT CfDs (Feed-In Tariffs with Contracts for Difference).

FIT CfDs are new long-term contracts designed to provide increased revenue certainty and stability to investors in low-carbon generation[18] - renewables, nuclear and CCS-equipped plant – with the aim of reducing risk and therefore financing costs.
They are expected to be available to low carbon generators from 2014 and to replace the present Renewables Obligation arrangements from 2017.

FIT CfDs aim to remove long-term exposure for a generator to electricity price volatility, by stabilising returns at a fixed level – known as a 'strike price'. Generators receive revenue from selling their electricity into the market as usual (with the aim of ensuring efficient running via exposure to short-term market signals). In addition, when the market price is *below* the strike price, they receive a 'top-up' payment, for the additional amount up to the strike price. When the market price is *above* the strike price, the generator pays back any difference. Strike-price setting will be central in assuring an adequate return for a generator and also value for customers. From 2017, it is expected that some post-2020 contracts will be let via auctions[19] (i.e. most likely for wind, initially).

To provide investor certainty, the CfD legal framework and payment model will have a set of regulations which will act like a contract (final payment model and contract counter-party yet to be decided). A FIT CfD cannot be changed retrospectively, (at least in principle), to provide investor certainty. The Levy Control Framework, introduced by HMT in 2010, will also impact both the volumes and technologies supported by FIT CfDs - including auction timing and outcomes[20]. Detailed proposals are set out in the draft FIT CfD Operational Framework, and will be implemented through secondary legislation and changes to codes and licences. Many important issues yet to be resolved – expected autumn 2012 – including contract counterparty and payment arrangements.

How policy interacts with or impacts demand response and / or demand reduction

- **Demand Response –** FIT CfDs will incentivise plant-types which will bring greater intermittency and lack of flexibility to the electricity system and **therefore** potentially increase the value of DSR (i.e. may increase value to extent that additional interventions for DSR become unnecessary). The key question is in trying to understand when those values will crystallise.

[18] Most likely for plant over 5 MW. Small scale fixed Feed-In Tariffs will continue to be an option for plant <5MW.
[19] initially technology specific and technology neutral from 2020.
[20] Since 2010, DECC has sought to control the combined total cost to consumers of the Renewables Obligation, Feed-In Tariffs, and the Warm Home Discount scheme through the Levy Control Framework. This framework sets a cap on the cost of these policies during each spending review period, and has been set at £11.8bn over the four years to 2014-15. HMT and DECC have initially agreed the level of acceptable headroom above the cap at 20% - after which DECC has to rapidly agree changes to bring the policy back into line with the agreed profile. NAO report. The government's long-term plans to deliver secure, low-carbon and affordable electricity. June 2012. Para 4.11.

- **Demand Reduction .** In the short term, support via FIT CfDs will add to wholesale and retail electricity prices – due to the levy arrangements – and so make electricity demand reduction more cost-effective. In the long-term - FIT CfDs may arguably *reduce* the potential cost-savings of demand reduction, if significant volumes of low carbon generation on the system lead to lower long-term wholesale electricity prices on average (and also, subsequently, in retail prices).

What changes might make the policy more conducive to :

- **Demand Response** – A far better understanding as to *when* the greater volumes of intermittency and nuclear will start to make DSR a cost-efficient alternative to peaking plant. That will give a better idea as to whether there is any real urgency and / or need to intervene in the market to produce more DSR solutions ahead of them being economic – e.g. whether one might wish to consider some kind of DSR 'goal' or even a target.

- **Demand Reduction –** In the near term there is a debate about whether an 'equivalent' incentive for electricity demand reduction may be needed - to reduce the amount of (more expensive) low-carbon plant which might otherwise be incentivised by FIT CfDs. (see discussion in Key Policy Issues above).

2.4 Electricity Market Reform – Capacity Agreements (in a Capacity Market).

Capacity agreements will be for 'reliable capacity' to meet electricity demand, to insure against risk of inadequate reliable capacity due to : plant closures, insufficient new-build ; intermittency (wind - by 2020, up to one-quarter of installed generation may be wind.) ; inflexibility (nuclear). They are thus designed to address 'resource adequacy' – to ensure sufficient reliable and diverse capacity to meet demand (mostly mid-merit), for example during cold, still anti-cyclonic periods where demand is high and wind generation low.

The capacity market will sit alongside the existing market structure, providing fixed payments in return for capacity to be available in periods of system stress. These will remunerate reliable peak plant (chiefly gas) which is otherwise likely to be faced with fewer annual running hours in a low-carbon electricity system[21]. In effect, providers of reliable capacity exchange volatile revenues in the wholesale market for a more steady, predictable revenue flow. The capacity market will only be run if needed. The need for and timing of a first capacity auction will be determined by ministers, based on advice by the system operator and other experts including Ofgem[22].

The draft Energy Bill includes powers for the Secretary of State to design and introduce a Capacity market and to confer functions on National Grid to enable delivery. Detailed design

[21] The aim is to ensure that gas mid-merit plant can adequately recover its fixed and operational costs over fewer running hours in the future. So, to avoid reliance for recovery of fixed-costs on extremely high and volatile short-term prices at times of acute system shortage resulting from insufficient investment – and which (especially in winter) could prove contentious in practice. See Q.348. National Grid oral evidence to HoC ECC Select Committee – Pre-legislative Scrutiny of draft Energy Bill. 26 June 2012 : '..**essentially mid-merit rather than base-load in the first instance'**.

[22] Ofgem to produce its first annual Capacity Assessment in September 2012 (as required by Energy Act 2011).

of the Capacity Market will not be set out in primary legislation, but implemented through secondary legislation, Codes and Licenses, allowing some future flexibility to reflect an evolving market.

The first capacity auction could be run by the system operator as early as 2014 if needed – for capacity to be in place by 2018-19 (by 2015-16 if necessary).
The proposed mechanism is expected to work as follows :

- A forecast made of future peak demand - made as part of the capacity assessment provided to Government by Ofgem, the system operator or other technical experts.
- Ministers will decide the total amount of capacity needed for security of supply.
- Total amount of capacity needed for security of supply to be contracted through a competitive central auction run by the system operator for delivery 4-5 years ahead[23]. Auctions open to existing and to new plant.
- A commitment that the capacity market will support both generation and demand-side forms of capacity : DSR and storage *'playing a fair and equivalent role alongside generation'*.
- Successful bidders will enter into capacity agreements – committing to provide electricity when needed in a specific delivery year – in return for a predictable payment to cover costs of the capacity. Failure to provide capacity as contracted will incur penalties.
- Costs of capacity payments to be met by electricity suppliers on a shared basis (in the delivery year). Suppliers will benefit from lower and less volatile short-term prices in return. (Details of contract counter-party and payment model yet to be resolved).
- The capacity market works alongside the electricity market –does not replace it.
- DECC estimate that the capacity market should have limited impact on bills.

Stage of development / implementation of policy

Initial proposals are being refined through consultation. Much design detail is yet to be resolved – including interaction with the balancing and wholesale markets and FIT CfDs. Emerging design choices to be published by end-2012. Design should be completed by March including for how DSR is expected to participate. Formal consultation on full detailed design later in 2013.

Some key issues being considered – yet to be resolved – and also important for demand-side participation, include :

- How to provide adequate reliable capacity at minimum cost to customers - which also minimises risks, including to wider energy policy goals.
- How to determine the volume of capacity to contract for – and whether that should be driven by an enduring 'reliability standard' (e.g. risk of interruption due to capacity shortfall on no more than x days per annum).
- **Likely to reward volume – rather than flexibility.** On the assumption that market already incentivises flexibility (e.g. via Balancing Mechanism).
- Linkage between Capacity Market, Balancing Services, Cash-Out prices - technical, commercial inter-actions.

[23] may be less for first auction

- Lead-times from auction to delivery – likely to be 4-5 years (but may vary, subject to whether existing or new capacity).
- Duration of capacity agreements – one or more years ? Different length for different types of capacity. Tradeability of contracts in secondary market ?
- Pre-qualification requirements to participate in auction. Also depends on penalty regime.
- Treatment of low-carbon capacity incentivised by FIT CfDs. Unlikely that low-carbon plant in receipt of administered FIT CfD will be able to participate in capacity market - they are anyway incentivised to run/be available.
- How to determine revenue payable for capacity – e.g. pay-as-bid etc.
- Penalty regime – yet to be decided but a need to balance effective sanction to ensure delivery - against undue risk to capacity providers for non-delivery[24].

Where policy interacts with or impacts demand response and / or demand reduction

Demand Response

Current thinking from DECC and others

- DSR definition for capacity market – 'Active reduction in demand from the national transmission system at a particular time which can be monitored and verified'.
- Can be achieved by time-shifting demand or using distributed generation.
- Potential for cost-effective DSR in delivering security of supply to be recognised ; fully responsive firm demand could mitigate need for Capacity.
- DSR – not a core business consideration for many businesses.

A number of possible models to take forward the role of DSR in the GB capacity market are under initial consideration :

(1) **Generic** (i.e. full equivalence of DSR with generation in capacity market). May be 'simplest' – but perhaps unlikely to stimulate significant DSR activity – and raises many issues.
(2) **Possible Banded Trial** – SO to offer several demand reduction banded 'products' each with different parameters in an initial Trial e.g. Duration and maximum number of interruptions on a 5-year trial.
(3) **Indirect Participation** – DSR does not participate directly in either primary or secondary capacity auctions – so receives no capacity payments. However, DSR providers contract bi-laterally with suppliers – and are rewarded for reducing demand in system stress ; suppliers reduce share of load – and therefore pay lower capacity payments – and share the benefit with the DSR provider (and customer?).

[24] Penalty regime could be administered, market-based or hybrid model. A hybrid 'physically-backed' reliability market model would possibly combine physical checks that capacity available with market-based incentives – aiming to reduce the risk of non-delivery, and at the same time offering capacity providers some predictability in their exposure to potential penalties.

A Trial seems to be currently viewed by DECC as an active route to helping to stimulate DSR in the capacity market – while offering learning, risk mitigation and visibility to SO. First Banded Trial auction could take place as early as in 2017 – for delivery in 2018 – with last Banded Trial in 2021. (Some capacity for DSR in secondary auctions could also be available from 2017). The other alternatives are likely to happen to some extent anyway.

DSR issues :

- Participation of non-generation technologies and approaches – DSR, interconnected capacity and storage.
- 'Verifiable DSR' - a particular challenge : how to set and verify reliable baselines.
- Secondary trading of agreements / secondary capacity auctions - secondary trading and secondary auctions believed to provide opportunities for technologies with shorter lead-times, such as DSR. Capacity agreements secured via the central primary auction will be tradeable - to allow capacity providers to manage their risk. Actors in secondary markets would also need to meet any pre-qualification criteria. Secondary capacity auctions – designed to augment secondary trading. Some 'same delivery-year' auction capacity may also be held back.
- Since the Energy White Paper in July 2011, changed projections in the Impact Assessment (nuclear life-extensions, lower fossil prices, more efficient CCGTs) mean that energy costs may be lower than projected a year ago – and so may have a knock-on impact on the cost effectiveness of DSR as an alternative.
- If a capacity mechanism succeeds in removing price volatility and smoothes peak prices – that could also reduce the cost savings available to customers from DSR.
- **Basis by which suppliers are to share costs of the capacity market is yet to be decided. One option put forward by DECC is on basis of a supplier's peak load (however that would be defined) – to provide incentives for suppliers to reduce their share of peak load and therefore their requirements for capacity, with the aim of ensuring that capacity is used more efficiently**. The implications of such an approach to charging suppliers may need consideration in terms of how this could impact on suppliers individually. This is because a supplier's contribution towards the costs of the capacity mechanism would depend on their existing customer base (e.g. by volume of industrial, commercial, household load). [25]

Demand Reduction

Capacity mechanism does not explicitly look at Electricity Demand Reduction. However, there is an initial debate on whether an EE FIT might be administered – PJM-like – by the system operator – via the Capacity Market[26].

[25] Electricity Market Reform. Annex C. Capacity Market. Design and Implementation Update. 22 May 2012. para 80.

[26] See Q.348. National Grid oral evidence to HoC ECC Select Committee – Pre-legislative Scrutiny of draft Energy Bill. 26 June 2012.

In the USA, electricity demand reduction products are procured in the capacity market (e.g. PJM) as 'equivalent' to 'base-load' plant. For GB, plant likely to be incentivized by a capacity mechanism, may be 'mid-

Lower than expected demand due to the recession may lead to : earlier generating plant closures ; reduced investment in new generating plant depending on investors' expectations of future electricity prices.

What changes (if any) might make the policy more conducive to -

- **Demand Response** – the kind of 'firm capacity' sought in the capacity market to meet long anti-cyclonic periods might not be at all well-suited to either DSR or back-up generation – though it could perhaps be well suited to CHP and other forms of thermal storage and to self-balancing through storage heaters, water tanks etc. Would need to find practical ways for small customers – i.e. with thermal storage – to access the capacity markets.
- **Demand Reduction** – some initial discussion on merits of whether National Grid might possibly run-a PJM-type market via the Capacity Market[27].

2.5 Electricity Market Reform – Emissions Performance Standard (EPS)

The EPS (included in the current Energy Bill) will be a regulatory measure which provides a back-stop to limit emissions from unabated new fossil power stations.

The EPS will be set as an annual limit, equivalent to 450gCO2/ kWh at base-load and will be 'grand-fathered' for each consented new plant at 450gCO2/kWh limit until 2045 – but that limit could be subject to review. Any review would not be retrospective, once a plant has been consented. The EPS is likely to be administered by the Environment Agency.

The EPS will have long-term price effects because it will push up fossil-generation prices through enforced emissions abatement. In particular, long-term will force coal and gas-CCS – so high cost. So its impact on demand response and demand reduction could be :

- **Demand Response –** short–term little effect, because not much impact on availability of flexible CCGT. Longer term will push-up cost of flexible plant (flexibility expensive with CCS – needs to run base-load to recover costs). So should make DSR values higher in the long-run.
- **Demand Reduction –** short term may have limited impact (because much CCGT already consented to 2045 at 450gCO2/kWh). Long-term may also have little impact, because once de-carbonised, average long-run wholesale prices should start to flatten or even reduce.

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merit' plant. This perhaps raises questions as to how any demand reduction in GB might be viewed as 'equivalent' to mid-merit plant.
Note: we expect our Paper 7 to include a section on PJM.
[27] Ditto.

2.6 Electricity System Policy Assessment

In 2011, DECC embarked on an Electricity System Policy assessment, to evaluate the impact of current market and other reforms on the wider management of the electricity system, largely to mitigate the challenges and risks to the electricity system beyond 2020. The assessment considers the impact and timescales of future changes in generation and demand, the potential for non-generation approaches, including interconnection, storage and demand-side responses, as part of the development of a smarter grid system. Pre-2020, the electricity system is judged capable of meeting the challenges of a changing electricity market. Inter al, the review seeks to answer whether there is a need for Government to take any additional action to facilitate future low-carbon generation and to meet electricity demand in the most secure and affordable way, with the most efficient use of assets.

DECC published its review document : **'Electricity System: Assessment of Future Challenges'** on 9 August 2012. In support of the assessment, DECC also published three background consultancy studies. Key points from each study are summarised in the Box below. However, some headline findings from the Imperial modelling include:

- Regardless of the future generation mix, there is value in non-generation balancing technologies in all pathways – which could lead to reduction in overall system costs.
- The value of alternative balancing options increases significantly beyond 2030 – but more marginal before 2030.
- The generation mix (i.e. penetration rates of high variable and / or high inflexible generation) and rates of increase in load – and variation in that demand – are crucial for the value of balancing technologies.
- A number of key sensitivities impact on results : level of electrification of heat and transport ; daily and seasonal load-profiles ; levels of DSR (flexibility) in Europe ; the European generation mix ; assumption that energy self-sufficiency is a goal (especially important with regards to I/Cs).
- The main issue for DSR is customer up-take of tariffs. Even with low penetration (e.g. up to 10% uptake) there are considerable benefits for the system across all pathways modelled - suggesting that DSR should be pursued whatever the scenario.

Demand Side Response – by confirming that DSR can bring long-term value to the electricity system, the Electricity System Policy document offers a clear signal that policies to develop DSR are worthwhile.

DECC Electricity System Policy Assessment – Next Steps

The DECC assessment identifies a number of next steps. Many of these are relevant to the practical development and delivery of electricity demand response into the 2020's, as follows[28].

Market arrangements : DECC will work to ensure that DSR and electricity storage can play a fair and equivalent role in the capacity market ; seek to ensure that EMR (electricity market

[28] DECC. Electricity System: Assessment of Future Challenges – Summary. Pp 10-11.

reform) is implemented in a way that allows the development of flexible solutions to generation challenges ; publish a Gas Generation Strategy in autumn 2012 to ensure that the UK continues to attract investment in gas generation and infrastructure ; revise DECC's in-house system model to incorporate transmission and distribution constraints, refine modelling of balancing technologies and real-time balancing activities.

Technology development : DECC will undertake an assessment as to whether there is a need for Government to do more to support the development of key balancing technologies. Areas to be considered may include :

- **Low carbon technologies** - working with key organisations to support the development of the technologies likely to impact significantly and cost-effectively on : the demand for electricity ; the infrastructure required for their deployment, and : ensuring that these technologies incorporate the functionality to support demand side response initiatives.
- **Customer Engagement** - studies to investigate further, how consumers can be best engaged to respond to demand side response initiatives, by using opportunities from other engagement initiatives, like the smart meters engagement strategy.
- **Storage -** working to understand how effective commercial arrangements for storage could be developed ; the barriers to cost-effective storage options, and, whether there is a role for Government to remove unnecessary regulatory barriers.
- **DSR incentives** - considering what incentives may be required, and are appropriate, across the supply chain in order to encourage more DSR.
- **Heat recovery -** explore further how through the use of heat networks, the recovery and distribution of excess and wasted heat might minimise the impact of decarbonising heating on the electricity sector. DECC will publish policy proposals on low-carbon heat in March 2013.

Networks development : DECC proposes to work with Ofgem and the DECC/Ofgem Smart Grid Forum to investigate in further detail what could be done to encourage, and remove any barriers to, the development of these interactions and associated development in commercial frameworks. This is expected to include :

- **Network investment** - work with stakeholders in the industry to develop a model that can be used during the RIIO-ED1 process to inform the nature and timing of distribution network investments.
- **Distributed generation -** further work to understand the impact of increasing levels of DG on the electricity system including the roles and responsibilities of the SO and DNO.
- **Transmission network impacts** - work with stakeholders to analyse potential transmission network impacts of longer term developments in the electricity system and the potential network solutions.
- **Interconnection** - development of an evidence base and analysis on the impact on GB under different interconnection scenarios including further exploration of the most appropriate way of developing UK interconnection capacity.

Sustainability and Climate Resilience - Government to work with industry and other stakeholders to commission analysis and research to fill evidence gaps on the impact of the new technologies and supporting infrastructure - in order to identify a sustainable mix of technologies for future UK power needs. DECC will also continue to work with industry and civil society to manage the risks around access to the physical resources required by some

low-carbon technologies. DECC will work with Defra, the Environment Agency and energy companies under the National Adaptation Plan to ensure energy infrastructure is adapted to a changing climate.

DECC Electricity System Policy Assessment – and further development of policies and measures.

Assuming the next steps which DECC identifies above are taken forward in a concerted way over the next five years or so, many of today's obstacles and barriers to facilitating DSR may be addressed – so enabling development of a more coherent market framework for demand-side participation. In practical terms however, together with Ofgem, DECC needs to formulate some clear priorities and timescales for the actions DECC has identified.

Policy Development for DSR

Our initial conclusions on policy development for DSR are :

- Some value is already available to DSR providers for offering DSR in GB today (both Balancing & peak-avoidance (TRIADs)).

- Larger half-hourly customers already engage in DSR schemes – System Balancing ; DNOs (toe-in-water) ; TRIADs ; Capacity market (in future).

- The technical and commercial dependencies of current schemes (including the proposed capacity market) need greater clarity – including ways to introduce more price discovery / visibility for DSR value throughout the market.

- Sources of flexible / shiftable / controllable load are somewhat limited at current highest-cost periods in GB electricity system.

- Commercial and household on-peak electric heat – are perhaps somewhat overlooked as potentially shiftable load today. May be scope to shift to overnight charging (e.g. 'new-generation' storage heating – but better insulation important).

- For retailers *today*, there is little commercial incentive to promote DSR schemes *at scale* to households (or other non half-hourly settled customers) - unless and until : smart meter roll-out completes ; new customer load profiles developed (e.g. an 'avoided winter evening peak' profile; and / or cost-efficient half-hourly settlement for small customers.

- In addition to the Electricity System Policy, other current initiatives should in due course help to bring DSR measures together in a more coherent framework : Ofgem Smarter Markets Strategy; Ofgem Cash Out Review ; Universal smart meters by 2019 ; Smart Meter Customer Engagement policy ; LCNF projects ; DECC / Ofgem Smart Grid Forum; Elexon review of half-hourly settlement.

- System flexibility requirements – & hence DSR value(s) – are unlikely to significantly increase before the mid-2020's . More flexible / controllable load will be needed in 2020's (i.e. EVs, electric heat, DG). But if this load does not materialise, electricity system costs may simply go up.

- GB starts from a base of rather modest flexible load (& possibly even more so – if policies succeed for electricity demand reduction). So, a watchful eye will be needed on success (or not) of policies & measures designed to promote new sources of flexible / controllable electrical load.

In the US, federal legislation[29] requires a national assessment of demand response potential by FERC, a national action plan, and a proposal for implementation. Similar amendments were proposed for the draft EU Energy Efficiency Directive - but rejected by member states.

In the light of the many DSR initiatives in GB today, including DECC's Electricity System Assessment, our tentative conclusion is that further policy interventions for GB DSR are presently unlikely to be necessary.

Rather, DECC should take full account of the many reviews and policy measures currently in hand both to promote DSR and to address the barriers, and, as noted above, in tandem with Ofgem, identify priority action areas in sequence against a timeline.

Demand Reduction – In considering system balancing needs and flexibility into the future, neither the DECC Electricity System Policy review, will in due course also need to take account of the potential impact of savings from electricity demand reduction in GB to 2030 (e.g. from product standards or other measures). In a separate exercise, DECC recently published a paper for their Electricity Demand Reduction Assessment (McKinsey for DECC. July 2012). These two exercises currently seem to be conducted separately, in parallel. At some point the work streams will need bringing together.
Brattle (London office Serena Hesmondhalgh) will therefore now build on the earlier GB electricity end-use model developed for Sustainability First – and incorporate data and findings from new reports commissioned by DECC and Ofgem – now becoming available – and inter al, will assess the potential interactions and combined impacts, including economic impacts, of measures for GB electricity demand reduction and demand response combined.

[29] Energy Independence and Security Act 2007

DECC Electricity System Policy Assessment

In support of their Electricity System Policy Assessment, DECC commissioned three background studies from consultants. These were also published by DECC in August 2012 alongside their own assessment [1]. Key points on system balancing identified by each of the three studies are noted in the Box below.

1. Understanding the Balancing Challenge. Imperial College & Nera Economic Consulting.

This is a Whole Systems Analysis to 2050. It models the electricity system to 2050 under a range of different generation and demand scenarios – in particular with snapshots at 2040 and 2050. The aim is to attempt to quantify the potential size of the balancing challenge and the value of alternative balancing technologies, and to understand when the electricity system might start to experience significant cost-savings from widespread deployment of these alternative technologies. The study notes the limitations imposed by the 'sheer number of uncertainties' looking 40 years ahead, making the model complex, and the results somewhat difficult to generalise. Some high-level pointers are that :

- Regardless of the future generation mix, there is value in non-generation balancing technologies in all pathways – which could lead to reduction in overall system costs.
- The value of alternative balancing options increases significantly beyond 2030 – but more marginal before 2030.
- The generation mix (i.e. penetration rates of high variable and / or high inflexible generation) and rates of increase in load – and variation in that demand – are crucial for the value of balancing technologies.
- A number of key sensitivities impact on results : level of electrification of heat and transport ; daily and seasonal load-profiles ; levels of DSR (flexibility) in Europe ; the European generation mix ; assumption that energy self-sufficiency is a goal (especially important with regards to I/Cs).
- The main issue for DSR is customer up-take of tariffs. Even with low penetration (e.g. up to 10% uptake) there are considerable benefits for the system across all pathways modelled - suggesting that DSR should be pursued whatever the scenario.
- The model also assesses different impacts of Interconnection and Storage.

2. DECC Electricity System Analysis – future system benefits from selected DSR scenarios. Redpoint Energy, Baringa & Element Energy.

Redpoint Energy, Baringa and Element Energy modelled the benefits associated with different household / domestic demand-side response (DSR) tariffs up to 2030. This exercise sought to estimate the potential benefits of DSR under different take-up scenarios. The analysis considered four DSR tariffs (static Time of Use, Critical Peak Pricing, and two Load Control Tariffs) combined with estimates of the take-up of DSR tariffs and consumer response (load shifting) as a result of the tariff – against sensitivities of different levels of electrification of heat and transport The model sought to calculate the potential savings of generation capital expenditure, generation operational expenditure (including carbon) and distribution network savings – associated with the different DSR tariffs modelled. The analysis looked at the benefits – but did not evaluate any of the costs related either to implementing DSR in practice, nor costs associated with the different tariffs (infrastructure, IT, consumer loss of utility, advertising etc).

The study found that there could be significant system gross benefits from static time-of-use tariffs (range £60-200m pa by 2025-30) – and potentially greater savings associated with the more dynamic tariffs (up to £500m in 2030 relative to the model baseline). The majority of benefits from domestic DSR are linked to avoided building of additional generation capacity and avoiding the need to re-inforce the distribution network – i.e linked to peak reduction. The Dynamic Load Control tariff produced greater generation opex savings (£40-160 m in 2030) because it flattens the overall load-profile, rather than just reducing the peak real-time DSR benefit.

In a central scenario with increased electrification of heat and transport, by around 2025, dynamic tariffs begin to show a material incremental benefit over static time-of-use tariffs in the model. At an average per customer annual saving, annual wholesale market cost-savings for suppliers, (chiefly from avoided capex but also energy) ranged from £7 (SToU) to £34 (Dynamic Load Control). If savings / benefits are attributed only to those customers who take up a DSR tariff, individual customer-savings on end-bills of up to £90 p.a. were estimated.

The study noted a need for further exploration of :

- Uptake rates of low-carbon heat and transport.
- Uptake of DSR tariffs, including consumer responses to prices.
- Consumer acceptance of automation – and a greater understanding of the likely associated costs of shifting load to other time-periods.
- The knock-on economic impact of shifting household load into peak periods for commercial load.

3. Demand Side Response in the Domestic Sector – a literature review of major trials. Frontier Economics & Sustainability First.

This is a meta-study with an economic focus to assess key findings and key lessons for policy from a selection of major international household DSR trials. It evaluates how domestic customers have responded to major DSR trials and the generic lessons to arise from these trials. The review also looked at approaches by other sectors (rail, gas, water, telecomms) to handling peak demand. In particular, the review finds that :

- Domestic customers do shift their load in response to both economic and non-economic incentives – even if this is accompanied by only basic information. Responsiveness increases with more information.
- Automation delivers the most sustained household load-shifting.
- Consumers do not necessarily respond better to tariffs with the highest differential between peak- and off-peak prices.
- Longer peak periods seem to be associated with lower peak demand reductions.
- Consumers are generally positive towards DSR initiatives. They accept direct load control as long as it does not reduce their comfort and they can over-ride it.

The study identifies the following priority areas for further work on domestic DSR in GB:

- DSR and low-income and vulnerable consumers in the UK.
- Consumer behaviour and attitudes in relation to existing ToU & Economy 7 Tariffs.
- Persistence of DSR.
- Appliance use and behaviour patterns.
- Response to price differentials.
- Customers uptake of low-carbon technologies – including customer flexibility in their use of such technologies.
- Practical testing of wind-related dynamic pricing and load control.
- Identifying ways to collate findings and disseminate lessons from current trials on a systematic and regular basis.

2.7 DECC Electricity Demand Reduction Assessment

General demand-side policies, measures and interventions for energy demand reduction - including the Green Deal, the ECO, the CRC Energy Efficiency Scheme can, in principle at least, also incentivise electricity demand reduction in a variety of ways.
The new Energy Efficiency Deployment Office (EEDO) has been set up to improve co-ordination and delivery across the many demand-side policies and initiatives. EEDO called for evidence on energy efficiency in February 2012, as a prior step to an Energy Efficiency Strategy, expected in November 2012. The Government will also set out plans later this year for UK implementation of the new Energy Efficiency Directive, (being adopted now).
As discussed in sections 2.1 to 2.5 above, supply-side policies also entail incentives and price signals, some of which may also support electricity demand reduction - via approaches to carbon pricing and also (to varying degree) via development of new market incentives, including cash-out reform.

In July 2011, as a part of its Electricity Market Reform (EMR) programme, DECC initiated an Electricity Demand Reduction assessment to consider the scope for further initiatives to deliver permanent reductions in electricity demand[30]. The original goals of the exercise were to assess :

- **Potential** – what permanent end-use reduction in electricity demand could be made in the UK? Understanding the current landscape, including what initiatives have been successful and why.
- **Barriers** – what is limiting electricity demand reduction ? What barriers do companies face ? How much are current policies supporting this – and where are the gaps ?
- **Preferred policy approach** – What changes could be made through EMR ? (e.g. electricity efficiency incentives ?). Could existing efficiency policies be improved ? International experience ?

In July 2012, DECC published a draft paper 'Capturing the full electricity efficiency potential of the UK'[31]. Initial conclusions are that :

- There is significant *technical* potential to further reduce electricity demand.
- Existing policies are not expected to capture all of the identified potential. In 2020 the abatement potential is estimated at ~115 TWh - of which ~60% is expected to be captured by current policy. By 2030, there is expected to be ~155 TWh of demand reduction potential – (~40% of total expected demand) – of which current policy is expected to cover around ~54 TWh or ~35% of total demand.
- There is scope for additional policy to drive further demand reduction.

The 155 TWh technical potential identified by 2030, splits (very roughly) 50:50 between the residential sector – and the commercial and industry sectors. Main opportunities for reduction identified are :

[30] 'We will undertake an assessment over the coming year to determine whether DECC should take further steps to improve the support and incentives for the efficient use of electricity' (EMR White Paper. July 2011. p.13).
[31] Draft report for DECC developed by Mckinsey. July 2012.

- Residential – efficiency of electrically heated homes, appliances and lighting.
- Commercial – building insulation, HVAC and lighting.
- Industrial – motors and pumps.

A range of current policies are found to impact on electricity demand – and are expected to uncover some of this potential – but not all. Barriers to take-up across all sectors were identified as: perceived investment risk and uncertainty, agency issues and pay-back periods. While most potential seems to be in the residential sector – three-quarters of that potential is thought likely to be achieved anyway through present policy. Much of the unexploited potential *not already adequately captured by current policy or measures* may be in the commercial and industry sectors[32] .

These findings from the Mckinsey assessment carried out for DECC, are broadly supportive of conclusions already drawn by Sustainability First in our Papers 1-4. DECC will publish a final Electricity Demand Reduction analysis report later this year.

The initial DECC assessment does not yet address the policy questions raised by some parties and which were the original catalyst for the assessment. Namely, that EMR incentivises the low-carbon supply-side through FIT CfDs - but fails to recognise an equivalent need at a system wide level to incentivise electricity demand reduction. DECC indicates that it will return to policy development and evaluation of potential policy approaches to uncovering the remaining technical potential for electricity demand reduction 'later this year'.

The development and evaluation of policy options will include consideration of : opportunities within EMR ; the wider Energy Efficiency Strategy ; and draw on international reviews. It will also consider 'cross-cutting' issues – including base-lining demand, measurement and verification, and 'additionality'. There will be a consultation later this year on potential policy approaches, including any legislative implications.

[32]Capturing the full electricity efficiency potential of the UK. Draft Report for DECC by Mckinsey. July 2012. Slide 33.

How DECC's Electricity Demand Reduction assessment interacts with or impacts on demand response and / or demand reduction

Demand reduction from a market actor viewpoint - From a market actor view-point, not all end-use electricity demand reduction is 'equal'. The economic value of electricity demand reduction is time-of-day and time-of-year related, just as for DSR. For example, from permanent destruction of peak-lighting load or shifting on-peak heat to overnight - and so enabling peak-related costs-savings (avoided capex and opex) to market actors through the full electricity-system value-chain. By contrast, some electricity demand reduction measures may achieve relatively modest cost-savings for market actors in the overall electricity system, if at all (e.g. product standards to reduce overnight standby of electronic goods).

Demand reduction from a customer point of view – By contrast, *as of today*, from a non half-hourly customer view point, measures for electricity demand reduction are likely to result in lower bills, *regardless of what time of day the electricity demand reduction occurs or from which appliance* – and so for the vast majority of customers today, electricity demand reduction offers a standard per-unit cost- saving[33]. In the long-run, with more wide-spread uptake of ToU tariffs and more cost-reflection in retail tariffs, customers are more likely to be incentivised to take explicit steps to permanently reduce their electricity end-use at those times of day when electricity system costs are highest.
Also for the long-term, if low-carbon electricity displays very significant wholesale price differentials between peak (and / or low-wind periods) – and all other times of the day - then reducing load (or shifting it) should also offer even more value to a customer.

Policy Development for Electricity Demand Reduction

Some initial conclusions on Policy Development for Electricity Demand Reduction are :

- In future, we will need a better understanding of *which costs* are avoided in the electricity system *when* - from different end-use demand reduction measures. So, *when* does the cost-saving occur ? How much reduction likely ?

- Eventually, ToU tariffs should also promote cost-efficient *demand reduction*. In practice, this kind of cost-reflection to most customers may still be some way off, because widespread ToU tariffs are likely to require new load profiles (e.g. for 'avoided winter evening peak') - and / or half-hourly settlement.

- **But, in *today's* retail world, *cost-efficient* electricity demand reduction will need**: carefully targeted incentives; clear priorities for measures (i.e. what to tackle when / first) ; & willing customers (smart should help).

- As noted, there are already many 'general' energy efficiency incentives – including for electricity demand reduction : e.g. DNO price control (including LCNF), CRC, ECO, Green Deal. Also, supply-side measures which push up wholesale prices e.g. EU ETS, Carbon Price Floor.

[33] This is not the case for those customers who are already half-hourly settled and / or already on a time of use tariff.

- **When DECC considers later this year whether GB needs any additional electricity efficiency incentives,** our initial inclination is to look first at whether *current* incentives can be made to work in a more concerted and targeted way. So, for example, to look *explicitly* at how to deliver more efficient lighting (commercial, household) ; how to shift on-peak electric heat.

- Measures targeted at reducing certain end-uses of electricity could make a material impact on electricity system costs *today* – in advance of ToU tariffs . But, barriers include (1) poorly targeted incentives (2) fragmented benefits in value chain - and (3) on the face of it, a rather unglamorous in policy.

Demand reduction and carbon – demand reduction also has a carbon benefit. However, the carbon benefit is likely to vary (just as for DSR), according to which generation is displaced and / or runs as a result of the changed half-hourly load profiles from that efficiency or product saving.

Demand Side Response - was 'out of scope' for the DECC Electricity Demand Reduction Assessment.

Interaction of Electricity Demand Reduction and Electricity Demand Response

As noted in the section on Electricity System Policy above, the interaction between electricity demand reduction and demand response in terms of the impact on system flexibility is not well-understood, either today or in the future – particularly at high-cost and or peak periods. The interaction of demand reduction and DSR may be quite complex.

Much is likely to depend on how permanent reductions in electricity end-use might impact the half-hourly load-shape. If demand reduction also reduces peak-load, then that *may* reduce the potential saving available from other sources DSR. If specific demand-reduction makes no difference to the shape of peak-load, then a potential cost-saving by flexible DSR from another source at peak would still exist (albeit possibly somewhat less than if there had been no demand reduction).

Conversely, if a customer reduces their bill by shifting load to lower cost periods, they may feel less interest in measures to reduce electricity demand, unless prices become sufficiently high that they wish to make additional savings. **Illustration – Northern Ireland Powershift Pilot.** NI Powershift customers used less electricity at winter evening peak – but consumed slightly more electricity overall.

In practice, the combination of these many different effects are difficult to foresee.
It will therefore be helpful to understand more about how policies which achieve overall *reductions* in electricity demand might impact on potential for DSR – i.e. on the possible cost-savings associated with (1) load-shifting at high-priced periods or (2) incentivising usage at low-price periods.

Brattle will therefore now build on the earlier GB electricity end-use model developed for our Sustainability First GB Electricity Demand project – and incorporate new material and data

from the recent reports commissioned by DECC and Ofgem, including the EST (household) and Ofgem Element Energy study (commercial-users) . Brattle will assess the potential interactions and combined impacts, including economic impacts, of measures for GB electricity demand reduction and demand response combined.

2.8 Ofgem Significant Code Review of Cash-Out Prices

Ofgem decided in March 2012 to conduct a 'holistic' Significant Code Review[34] of arrangements for deriving electricity cash-out prices. If a market actor either generates or consumes more or less electricity than they have contracted for, they are exposed to the imbalance price – or 'cash-out' – for the difference. The aim of the imbalance price is to create (1) a strong short-term price signal to generators and to suppliers to balance themselves bilaterally – and (2) to provide a longer-term price signal for cost-efficient plant investment[35].

Cash-out prices are important from a customer perspective because they impact the price paid for energy – and the incentive on market actors to invest in generating plant. However, cash-out pricing arrangements are complex. Ofgem has a long-standing concern that the detailed rules for calculation of cash-out prices may not correctly signal the value of flexibility and peaking plant in the market. Specific concerns are that they do not :

- Fully reflect scarcity value at times of system stress – (i.e. may not be sufficiently high).
- Provide the right incentives for demand-response
- Be sufficiently predictable or transparent – important for investment decisions.

Ofgem wishes to see imbalance price signals provide incentives to market actors to balance their positions without the need for interventions by the system operator, and to reflect the value of peak energy.

Ofgem has therefore initiated a cash-out review with the aim of providing: better signals for investment (and so increase security of supply) ; plus development of a 'reference price' for market-based penalties (i.e. EMR FIT CfDs, Capacity Mechanism).

Alignment is therefore needed between imbalance prices and :
- Wholesale markets – to ensure correct signals for investment, plant closures etc.
- A Capacity Mechanism – The capacity mechanism seeks to incentivise 'reliable capacity' – (i.e. probably mid-merit capacity – but not to incentivise short-run flexibility).
- DSR Development – imbalance prices are a benchmark against which to judge the cost-efficiency of flexibility provided by DSR against generation alternatives.

[34] Ofgem. March 2012. Open Letter. Ofgem Decision to launch a Significant Code Review (SCR) of the electricity cash-out arrangements.

[35] The system operator is responsible for maintaining a balance between supply and demand at all times. Electricity generators and suppliers have incentives to balance their own positions through bi-lateral contracting and trading, leaving the system operator to resolve the remaining imbalance. The cash-out price acts as a penalty on market actors for failure to be in balance at all times.

The review is expected to last 12-15 months. Changes to Codes and Licences would then follow. Ofgem is very mindful of the strong interaction with the Capacity Mechanism design - and believes that the cash-out review may inform the capacity mechanism design process.

How policy interacts with or impacts demand response and / or demand reduction

Ofgem is concerned that cash-out may not currently provide the right incentives for DSR. If DSR is to become an important source of flexibility in the electricity system, imbalance prices will be the benchmark against which competition between DSR and generation alternatives should be judged. Cash-out prices have no immediate impact on demand reduction, but have a longer-term interaction with average wholesale prices – and therefore may influence demand reduction.

Suppliers told us that the current Imbalance pricing calculation incentivises them to over-contract for generation (i.e. go 'long'), In effect, the risk of being under-contracted by an equivalent amount attracts a greater penalty - and so being under-contracted represents an asymmetric risk due to severe penalties – which in turn reduces suppliers' interest in exploring DSR alternatives.

Changes that might make the policy more conducive to demand response include :

- New approaches to imbalance pricing that would ensure an 'equivalent' incentive as between generation and DSR alternatives.
- Sharper imbalance price signals which better reflect the value of short-term scarcity - would improve the avoided-cost value available from DSR.

3. Network regulation and innovation

In Paper 4[36] we found that savings at low voltage were potentially higher than at other voltages. This led us to query whether appropriate incentives were in place to deliver demand-side savings at lower voltages : both electricity demand reduction and electricity demand response.

3.1 Distribution Price Control Review 5 (DPCR5)

A key change made to the regulation of the DNOs under DPCR5 (from April 2010) was the equalisation of incentives between different types of expenditure – i.e. operating costs (opex) and capital costs (capex). Previously, DNOs were not incentivised to minimise total lifetime costs as they were sometimes better off adopting a capex solution rather than a cheaper opex solution due to the way that the different expenditures were treated. One of main rationales for making this change was to ensure that the price control does not reduce the incentive on DNOs to adopt solutions that do not involve investment in network assets such as demand-side management or contracting with distributed generation to manage constraints.

This change in DPCR5 thus means that if a DNO chooses a DSR solution to dealing with local network constraints rather than upgrading the network, it will be subject to the same incentives (including the sharing mechanism, whereby DNOs get to keep 50% of any savings in costs whilst the other 50% is shared with customers.

To date very limited use has been made of DSR solutions as an alternative to network upgrading, due to the fact that there are few areas where there are significant network constraints and hence few opportunities to compare these options. However, this is likely to change with increasing adoption of solar PV, electric vehicles and heat pumps which will contribute to the need for upgrading at more locations and thus create opportunities for demand response and/or demand response solutions instead. The LCNF and IFI (details below) have also been provided under DPCR 5 to enable the DNOs to research and trial demand side solutions.

This equalization of incentives should therefore lead to increasing adoption of demand side solutions where they are more cost effective than reinforcing the network. However, the cost effectiveness of demand side solutions will be influenced by a number of factors and it is also important to note that demand side solutions will also need to be as reliable as network upgrading solutions – i.e. the networks will need to be confident that the demand side response or demand reduction will be delivered when required. The factors that will affect the extent to which the networks will adopt demand side solutions as an alternative to investment thus include :

- The full costs (from the customer's perspective) of demand side solutions – including transaction and opportunity costs and incidental or consequential costs – these will impact on customer willingness to engage.

[36] Sustainability First. GB Electricity Demand Project. Paper 4. What Demand-Side Services Can Provide Value to the Electricity Sector ?' . p. 78. June 2012.

- Whether customers are willing to engage in demand side solutions (which will include non cost factors) – and what incentives they might need to do so.
- The reliability or "firmness" – e.g. will customers deliver reductions in demand when needed (or accept automation and not override it at key times) – and the ease with which networks are able to demonstrate 'measurement' and 'controllability' to satisfy regulator requirements (especially for LCNF).
- The costs of delivery – for example, if DNOs have to partner with others (e.g. electricity retailers or aggregators) to deliver the solutions this means that a number of actors may be seeking to share any savings – is there sufficient value to go around ?
- The practicality of delivery where multiple actors are involved – which will include any regulatory or commercial issues.
- Any wider cost-savings or value associated with *system-wide* benefits of demand reduction (capital, affordability, carbon) do not accrue to the DNO. DNOs have no reason to deliver these wider benefits which do not directly benefit their business – but could, potentially, benefit others.

3.2 DPCR 5 - LCNF

As part of Distribution Price Control Review 5 (DPCR5) Ofgem created a £500 million Low Carbon Network (LCN) Fund to encourage the DNOs to use the period to 31 March 2015 to try out new technologies, operating practices and commercial arrangements. The learning from these trials and demonstration projects will help DNOs understand how they can play their role in the transition to a low carbon economy whilst maintaining security of supply and providing value for customers.
There are two tiers of funding available under the LCN Fund. The First Tier is designed to enable DNOs to recover a proportion of expenditure incurred on small scale projects. Under the Second Tier of the LCN Fund, Ofgem facilitates an annual competition for an allocation of up to £64million to help fund a small number of flagship projects. In the first year, 4 projects were awarded Second Tier funding totalling £63.6million through the annual competition and 11 projects were registered under the First Tier. These projects involve the DNOs partnering with suppliers, generators, technology providers and other parties to explore how networks can facilitate the take up of low carbon and energy saving initiatives such as electric vehicles, heat pumps, micro and local generation and demand side management, as well as investigating the opportunities that smart meter roll out provide to network companies.

3.3 DPCR 5 - Innovation funding incentive (IFI)

Also in DPCR5 Ofgem have continued the Innovation Funding Incentive (IFI) that it introduced in 2005 to encourage the DNOs to conduct technical research and development. This fund allows each DNO to spend up to 0.5 per cent of allowed revenues on these activities- a total sum of around £20m per year under DPCR5. The IFI operates alongside the low carbon networks fund (LCN fund). The IFI funds technical R&D whilst the LCNF funds trials on the distribution network focussed on low carbon initiatives. This IFI is intended to incentivise technical research and development on demand side solutions as well as more traditional network investment.

3.4 RIIO - ED1

A key objective of the new electricity distribution price control from 2015 (RIIO-ED1, 2015-22) will be to ensure that DNOs accommodate low carbon technologies (such as heat pumps, photovoltaics) in a timely and cost effective way. Distribution networks are not designed to accommodate large volumes of these technologies so their take-up could be an important driver of investment needs over the ED1 period. However there is uncertainty over how fast and where the take up of low carbon technologies will be. One challenge for RIIO-ED1 will be to strike a balance between ensuring that network capacity is in place to accommodate low carbon technologies and ensuring that customers do not pay for redundant assets.

Smart grid technology and associated contractual arrangements with customers and generators may offer a more cost effective way of providing the flexible network required. As noted above at the last review (DPCR5) Ofgem equalised incentives for different types of expenditure and also created the Low Carbon Networks (LCN) Fund which is funding trials of both smart technology and demand side response. DECC and Ofgem have also established the Smart Grids Forum (SGF). Work Stream 6 aims to understand what drives the value of smarter solutions and addressing regulator and commercial barriers to their adoption.

As part of the RIIO-ED1 review in order to ensure the timely and cost effective connection of low carbon technologies, Ofgem says it may need to consider the following issues:

- The approach the DNOs use in developing their business plans – particularly the timeframe, scenario analysis and methodology to evaluate different investment strategies.
- The outputs it will require the DNOs to deliver, particularly relating to connections, network reliability and environmental objectives and whether it is appropriate to establish output targets for dates beyond the end of the ED1 period.
- Barriers to the DNOs adopting commercial arrangements to manage demand and generation output (demand side response) and incentives and uncertainty mechanisms.

The connection of low carbon technologies spans several of the six primary output categories in the RIIO framework . Ofgem therefore has set up an overarching “flexibility and capacity” working group to focus on this issue, which has started work in advance of work on the related primary outputs. This working group will inform the development of the associated outputs and ensure coordination between them.

4. Green Deal and Energy Company Obligation

4.1 Green Deal

The Green Deal is set to commence in October 2012 with a fuller roll-out in 2013. It will provide loans, issued by Green Deal Providers for energy efficiency measures, repayable over up to 25 years as an addition to the electricity bill. Interest rates are expected to be around 6-8%. A key feature of the Green Deal is that the debt would remain with the property and be passed onto new occupiers when they take over the payment of the bills. There is no prescribed list of measures that can or cannot be funded under the Green Deal. This should allow sufficient flexibility to fund a wide range of measures that can help to reduce energy bills – in particular, aimed at heating and insulation improvements.

4.2 Energy Company Obligation (ECO)

The **Energy Company Obligation (ECO)** will require the main energy suppliers in the UK to fund measures that reduce the amount of carbon produced and the fuel bills in household customers' homes. The scheme will launch in autumn 2012, along with the Green Deal. There are two elements of the ECO: carbon saving and affordable warmth.

- **Carbon saving ECO** will work alongside the Green Deal to provide additional support for more expensive energy efficiency solutions (for example, in older properties with solid walls or off the gas network). This is expected to particularly focus on solid wall insulation.
- **Affordable warmth ECO** is designed to provide support to low income and vulnerable households. Any measure which improves the thermal performance of a property and reduces the cost of a customer's fuel bills could be eligible for affordable warmth ECO support. Energy suppliers are expected to deliver primarily new heating systems and basic insulation measures, such as cavity wall and loft insulation, under the affordable warmth obligation.

4.3 Likely impact of GD and ECO on electricity demand reduction

How far will the Energy Company Obligation (ECO) and Green Deal (GD) incentivise electricity demand reduction ? Much of the focus of these policies will be on reducing energy use from space heating (through insulation and improved heating systems) so the main impact will be on gas rather than electricity use. This means there is little prospect of the schemes being used to support lighting improvements at least in the household sector. Efficient lighting is eligible as a measure under Commercial Green Deal, which will also generally have a degree of flexibility in the measures that can be assisted - the assessor report can take into account actual consumption data from the building/company.

However, there could be potential for Green Deal and ECO to tackle electric on-peak heating – assisting households and small businesses using on-peak electric heating to switch to off-peak electric heating (new generation storage heaters) or heat pumps. Clearly there would also be a role here for the Renewable Heat Incentive.

Around 500,000 households rely on electric on peak heating as their main heating source and many more use it for supplementary heating. Electric on-peak heating may also be used by many small businesses although we do not have data on this. Switching these customers to electric storage heating or heat pumps could be a useful means of reducing peak demand. It would also be important to install adequate insulation in these properties to make thee heating systems cost effective and affordable for the occupants.

It would therefore seems important that the Green Deal and ECO have some focus on tackling the on-peak electric heating issue incentivise efficient lighting.

4.4 Is there a need for any additional policies for electricity demand reduction ?

There may be some further measures that could be considered specifically to encourage electricity demand reduction. For example, via measures such as :

- Capital allowances for more efficient products / appliances.
- Intervention in either the electricity wholesale markets or network sectors.

Some NGOs and others are advocating an electricity demand reduction measure 'equivalent' to the FIT CfD, possibly administered by National Grid along-side the FIT CfD process - in effect, an energy efficiency feed-in tariff (EE FIT). To date there is little detailed GB work on how such a mechanism would work – nor how in practice it might relate to the EMR proposals[37].

An EE FIT could be funded via a flat p/kWh levy on customers (less you use, less you pay). In effect, this would be a 'top-down' *system-wide* electricity demand reduction scheme. A key question is whether it would assume that *all* demand reduction has an equal value – regardless of time-of-day impact, location etc. Some alternative approaches under discussion for an EE FIT incentive include :

- Run alongside the FIT CfD mechanism.
- Run via the Capacity Market (as per PJM and ISO New England)[38].

[37] The European Commission produced a number of background papers on an Energy Efficiency FIT in 2009-10. Also, Green Alliance paper .

[38] Two electricity markets in the US – PJM and ISO-NE (both covering states in the eastern part of the US) conduct forward capacity auctions that permit a wide range of demand side resources to compete with those on the supply side to meet resource adequacy requirements. Demand side resources involved include energy efficiency measures to deliver demand reduction; shifting demand between times of day; distributed generation.

On this, see Q.348. National Grid oral evidence to HoC ECC Select Committee – Pre-legislative Scrutiny of draft Energy Bill. 26 June 2012.
In the USA, electricity demand reduction products are procured in the capacity market (e.g. PJM) as 'equivalent' to 'base-load' plant. For GB, plant likely to be incentivized by a capacity mechanism, may be 'mid-merit' plant. This may perhaps raise questions as to how any demand reduction in GB might be viewed as 'equivalent' to mid-merit plant.

- Run as an Obligation on all Utilities – including DNOs – via a White Certificate Scheme which would allow third-party providers – Suppliers, Aggregators, ESCOS.

However, there is a need to consider carefully the rationale for an energy efficiency FiT, given the range of other policies in place to support demand reduction. If the existing policies are not likely to incentivise the desired amount of electricity demand reduction (either what is cost effective and/or what is required to meet other policy goals) it might be more sensible to adapt or modify one or more existing policies than to introduce yet another new policy.

Product standards are likely to deliver key areas of demand reduction in lighting and refrigeration across economic sectors. The main rationale for new measures (such as an EE FiT) therefore could be to accelerate 'normal' rates of stock-turn-over and so bring forward the savings that will eventually anyway accrue from improved product standards.

How far will the Energy Company Obligation (ECO) and Green Deal (GD) incentivise electricity savings ? Much of the focus of these policies will be on reducing energy use from space heating (through insulation and improved heating systems) so the main near-to-medium term impact will be on gas rather than electricity use. This means there is little prospect of the schemes being used to support lighting improvements at least in the household sector. Efficient lighting is eligible as a measure under Commercial Green Deal, which will also generally have a degree of flexibility in the measures that can be assisted - the assessor report can take into account actual consumption data from the building/company.

However, there could be potential for these schemes to tackle electric on-peak heating – assisting households and small businesses using on-peak electric heating to switch to off-peak electric heating (new generation storage heaters) or heat pumps[39]. Clearly there could also be a role here for the Renewable Heat Incentive.

Around 500,000 households use on peak electric heating as their main heating source and many more use it for supplementary heating. Electric on-peak heating may be used by many small businesses although we do not have data on this. Switching these customers to electric storage heating or heat pumps could be a useful means of reducing peak demand. It would also be important to install adequate insulation in these properties to make the heating systems cost effective and affordable for the occupants.

It therefore seems important that the Green Deal and ECO have some focus on tackling the on-peak electric heating issue and incentivise efficient lighting.

[39] Our Papers 2 & 3 found that up to ~7% of commercial electricity end-use and ~7% of household end-use is for on-peak electric heat.

5. Incentives for renewable electricity and heat

5.1 Feed in tariffs

The Feed-in Tariffs (FITs) scheme was introduced on 1 April 2010, under the Energy Act 2008 to encourage small-scale (less than 5MW) low-carbon electricity generation, by organisations, businesses, communities and households. FITs provide a guaranteed payment from an electricity supplier for the electricity generated and used as well as a guaranteed payment for unused electricity exported back to the grid (3.2p/kwh). FIT rates for generation ranged from 5p-45p/kwh (depending upon size and type of technology) in the first year, but have been reduced for some technologies for those installing microgeneration since April 2012. Rates currently range from 5p-21p/kwh. Those installing low carbon electricity generation also benefit from having to buy less electricity from a supplier. Technologies qualifying for FITs include solar PV, wind, anaerobic digestion, hydro and domestic scale (less than 2KW) CHP.

According to the EST a typical domestic solar PV electricity system with an installation size of 3kWp could provide the customer with :

- £530 a year from the Generation Tariff.
- £40 a year from the Export Tariff.
- £100 a year reduction of current electricity bills.

368,000 PV installations (and 2800 wind and 500 micro-CHP) were registered under the FITs scheme from its start in April 2010 to the end of August 2012, with 1.3 GW of PV capacity. £102 million in FITs payments were due to generators in the quarter 1 April – 30 June 2012. FITs therefore represent a cost for electricity suppliers that is passed on (in electricity prices) to all customers.

FITs are having an impact on the electricity demand side through :

- Creating the scope for households and businesses with low carbon generation to use less grid supplied electricity at certain times of the day and/or overall (i.e. demand response and/or demand reduction).
- Creating the scope for customers to contribute generation into the electricity distribution system, which could reduce the need for investment in other more remote generation and/or distribution or transmission capacity (and/or provide balancing services at times of low wind output).
- Creating impacts on the local distribution network in terms of power quality and/or the need for investment in local upgrading (see section below). FITs are paid at a universal rate (depending upon technology) and therefore there is no recognition in the FIT rate of location or time of day of export.

5.2 Renewable Heat Incentive and Renewable Premium Payment

The Renewable Heat Incentive, is designed to encourage the installation of renewable heat equipment such as solar thermal technologies, biomass boilers and heat pumps.

The Renewable Heat Incentive (RHI) tariffs for non-domestic installations in the industrial, business and public sector were introduced in July 2011. From October 2012, RHI tariffs for domestic properties will become available.

Around £15 million was provided for households (to support up to 25,000 installations) through the RHI Premium Payment (RHPP) from July 2011. In return for the payments, participants have to provide feedback on how the equipment performs in practice. £3 million was set aside for social housing providers. RHI premium payments range from £300 for solar thermal to £1250 for ground source heat pumps.

The RHI and RHPP will have an impact on the electricity demand side through their support for air and ground source heat pumps. Where heat pumps are installed in properties that previously used other fuels for heating, this will represent a significant increase in electricity demand. Heat pumps can create impacts on the local distribution network in terms of power quality and/or the need for investment in local upgrading.

Electric storage heaters do not qualify for the RHI/RHPP because they are not classified as 'Renewable'. However storage heaters (e.g. as an alternative to the on-peak electric heating being used as a main heat source by 500,000 households) could contribute significantly to (1) self-balancing w PV and (2) capital and operational cost-savings in the electricity system.

5.3 Renewable electricity and heat pumps – impacts on distribution networks

Heat Pumps, EVs and solar PV potentially create **two** problems that might cause the need for network re-inforcement or upgrading at certain locations : additional peak load / capacity; power quality.

Any equipment with power electronics can create power quality problems for the networks. The larger the equipment, the bigger the impact. The technical problem is called Source Impedence – and can create 'flicker'.

Manufacturers can change the design of the appliance to deal with the power quality issue, and latest EU standards would make most equipment ??<75 amps generally compliant. These power quality issues and the implications for network investment are currently under discussion in the UK between ENA and BEAMA.

Distributed generation can provide benefits to distribution networks by reducing losses, reducing the need for investment in transmission and distribution (by being sited closer to the point of use) and/or to delay the need for investment. DG can also pose challenges to DNOs depending upon: the generation technology, the voltage level it is connected to, the size of the plant and the type of network (urban or rural). A single installation of small scale DG (e.g.

solar PV on someone's roof) is likely to have a negligible impact but if there are many, in particular if there is a 'cluster', then the cumulative effect can be significant and may mean the network has to be upgraded.

Currently multiple installations (e.g. where a social landlord is installing PV on a street of houses) or larger installations have to get approval from the DNO before they can connect (pre-connection notifications). This system is mandated by the Electricity Safety, Quality and Continuity Regulations 2002. Single installations below 3.6 kW do not need permission but merely need to notify the DNO that they have connected.

Developers of systems above 3.68 kW can be required to pay a connection charge if their connection will cause the need for reinforcement or upgrading or other work. Typically non-domestic customers are charged for direct costs of connection and "shallowish" charges of local reinforcement (i.e. not extending far up the network). The principle is that of the "last straw", i.e. if you can connect within the capacity of the local substation, you will not be charged, but if reinforcement is needed you will be charged a proportion of the additional cost.

Developers of systems below 3.68 kW do not currently face any such charges. So an installer responsible for a row of installations in a street is required to seek approval from the DNO and could face cost of reinforcement, but, if each house makes a separate notification they would not be charged any costs of reinforcement. This also means that if a number of people independently in a street install PV and reinforcement is needed, the cost will fall on the DNO and therefore be socialised across the whole customer base.

Use of system charges (for ongoing replacement and maintenance) will also be charged to developers of above 3.68 kW, although these charges are levied on the electricity supplier rather than directly (but the supplier may pass them through and itemise them on the bill).

Non-domestic customers (other than small businesses) will have a specific connection agreement that specifies the maximum demand permitted (which links into the DUoS price). Domestic customers are governed by the National Terms of Connection, which do not specify what is permitted demand. There is no notification process currently for heat pumps and the extent to which a heat pump could be installed consistent with the National Terms of Connection without clearance from the DNO is unclear. The Energy Networks Association is working up a notification process for heat pumps, however, this would be voluntary. A mandatory process might require customers to notify their intention to connect a Heat Pump via their registration for the RHI. The ENA is also proposing that since no heat pump has yet secured the right British Standard to guarantee that they do not interfere with neighbouring electricity supplies, all heat pump installations should require prior approval from the DNO. The latest ENA position is that HPs need to comply with latest EU standards –and then no additional connection charge to be made to the customer.

5.4 Equity and fairness in charging for connection

This raises important issues of equity and fairness in charging. Should customers who currently do not pay be charged a connection cost where their installation of a heat pump, electric vehicle charging point or PV, causes the need for network re-inforcement or upgrading - either for reasons of power quality management, or for increased load, or both ? The arguments for charging include :

- It is right that these customers should pay their share of upgrading or reinforcement costs, rather than customers in general, because they are imposing the costs on the network – such charges are therefore efficient.
- Customers installing these technologies tend to be better off on average than the generality of customers and therefore it would be more socially equitable for them to pay rather than the costs being passed through to all customers.
- These customers will in many cases already have received subsidies (paid for by other customers or taxpayers) towards the costs of these technologies so it is not fair that they should receive further subsidy.

The arguments against include :

- These customers are "doing their bit" for the country's climate change and renewable energy targets and as 'first-movers' should be supported / rewarded rather than penalised.
- These customers will have to invest substantial sums of money in the technologies - a charge of this sort could discourage investment.
- Other electrical appliances can also cause problems for distribution networks (e.g. electric showers) so why should low carbon technologies be singled out in this way ?

There are therefore a number of options for dealing with the costs of reinforcement and upgrading :

- "Socialise" the costs - i.e. cover the costs of upgrading in the revenue raised from the generality of consumers in the DNO's area.
- Introduce a threshold – against which either to re-charge / socialise costs of reinforcement (e.g. ?? <65 amps).
- Separate out the reinforcement required for *network capacity* from reinforcements required for *power quality* and treat them differently.

The DECC/Ofgem Smart Grids Forum has been considering these issues and to date seems to be coming to the following conclusion : "Until full smart meter roll out in 2019, it may be impractical to target upstream reinforcement costs at existing domestic customers who increase demand or generation. Consequently, costs associated with this may have to be socialised. It was noted that if costs are socialised, the incentive for individual customers to enter into DSR arrangements as an alternative means of capacity reinforcement may be reduced. This assumption is being revisited in light of the impact that installing equipment

with poor power factors can have on the LV network. DNOs may wish to charge domestic customers if they install equipment which is below a certain standard."[40].

This is an area that the Northern Powergrid CLNR project is also looking at.

[40] Smart Grids Forum. Work Stream 6. First report. Identifying potential barriers to smart grid implementation and laying out possible future direction for developing solutions. August 2012

6. Smart Meters

The Government will require all electricity and gas suppliers to complete the rollout of smart meters to their domestic and smaller non-domestic customers by 31 December 2019. This will impact approximately 30 million premises. Some smart meters are being installed by some suppliers at present during the "Foundation stage" through to 2014 when mass roll-out is scheduled to start. Suppliers are required to offer an in-home display (IHD) as part of any compliant smart meter installation during both the Foundation Stage and mass rollout.

Smart meters could help to facilitate demand response and demand reduction and therefore the policy design and implementation will be important. Consultation documents published in April 2012 set out Government proposals in a number of key areas.

Smart meter electricity technical specification (SMETS)

The technical specification for smart meters is considered to be broadly adequate for delivering the likely requirements for the electricity demand side. SMETS 2 is closer (near 100%) than SMETS 1 (around 90%). The one area that may not be required but is not presently covered is voltage surge protection.

Data access and consent

Smart meters will mean that much more data about electricity-use by all consumers will be collected on a regular basis. This could facilitate a range of demand response and demand reduction activities. However, a key challenge for the programme is balancing the requirements of suppliers and networks for data, with the concerns that consumer might have about who has access to their data. The current proposals are as follows:

Consumers will be able to access their own energy consumption data through their in-home display, through the connection of additional devices to the Home Area Network, or by requesting information from their supplier.

The proposed framework for supplier access to domestic consumers' energy consumption data would :

- Allow suppliers to access monthly (or less granular) energy consumption data, without customer consent, for billing and for the purposes of fulfilling any statutory requirement or licence obligation;
- Allow suppliers to access daily (or less granular) energy consumption data for any purpose except marketing, with clear opportunity for the customer to opt out; and
- Require that suppliers must receive explicit (opt-in) consent from the customer in order to access half-hourly energy consumption data, or to use energy consumption data for marketing purposes.

The Government can see the case for enabling the use of consumption data for the purposes of trials, and that in certain cases requiring customers to opt in to trials could distort results.

However, if half-hourly consumption data were to be used, then the Government's view is that consumers should have the opportunity to object (i.e. opt out), and that such trials should be approved by DECC or Ofgem, to give consumers reassurance.

The Government sees the case for distribution network operators to access half-hourly energy consumption data *without customer consent* for the purposes of developing and maintaining efficient, co-ordinated and economical systems for the distribution of electricity, *provided that* privacy concerns are appropriately addressed. It could be feasible for them to aggregate this data such that individual households could not be identified from it. Before such access to data is granted, the Government proposes that network operators should develop more detailed plans to explain what level of data would be accessed, for which purposes, and how privacy concerns would be addressed. Network operators would be encouraged to consider a full range of options, which might include anonymisation or aggregation of data, use of sampling and other approaches. Further work will be carried out on the approval process, including the roles of DECC and Ofgem. There is also the question of what access to energy consumption data network operators should have if plans for aggregation had not been approved. One option would be the same levels of data and consumer choice, as is proposed for suppliers – i.e. monthly consumption data. At this stage the DNOs do not feel that they have sufficient knowledge of what data they would require to be able to develop such plans.

Consumers will be able to give third parties (e.g. switching sites and energy services companies) permission to access their energy consumption data remotely via the Data and Communications Company (DCC).

Settlement

Electricity is currently settled on a half-hourly basis. Larger industrial customers already have half-hourly meter readings. For domestic and smaller industrial customers, half-hourly figures are estimated from annual consumption using typical consumer profiles provided by Elexon. The estimates can then be refined by reconciling them against actual meter readings. Smart metering could improve the accuracy of electricity settlement as actual half-hourly consumption data will be available for all customers. The industry is considering the case for moving to greater use of half-hourly meter readings for electricity settlement. There should be more of an incentive on suppliers than now to develop time-of-use tariffs if their actions to shift customers' load are recognised in the settlement process.

Some level of consumption data is required by suppliers to meet the existing licence condition (through the Balancing and Settlement Code) on settlement. However settlement of domestic customers does not currently require half-hourly data. The Government's view is that monthly energy consumption data will enable suppliers to meet their current licence obligations in relation to settlement, and that suppliers should be able to access this data from their customers for this purpose without customer consent. The Government's current

position is that if there is a move to more frequent settlement the position on use of half-hourly data for settlement purposes should be reviewed. [41]

Wholesale hedging

Wholesale hedging involves suppliers purchasing electricity in advance, based on forecasts of future demand, to spread risk and reduce exposure to high costs. There is currently no licence obligation on suppliers in relation to hedging. The Government proposes to give consumers the chance to object to their data being used for the purpose of wholesale hedging, as it is not something which suppliers are required to do. Under the proposed framework, suppliers would be able to access daily data for this purpose if they explained that they were doing so and allowed consumers to opt out.

Time of use tariffs

The Government feels it is unnecessary at this stage to enable half-hourly data to be collected from all customers to develop time-of-use tariffs, and recognises concerns raised by consumer groups about use of half-hourly data to target customers with time-of-use tariffs. Under the Government's proposed framework, suppliers would need explicit (opt-in) consent from the consumer in order to access their half-hourly consumption data for time-of-use purposes, or to use their consumption data to market products and services. However, if all domestic customers need to be settled on a half-hourly basis and there are wider moves to time-of-use tariffs, then the case for enabling access to half-hourly data could be reviewed.

Consumer engagement

Consumer engagement, information and feedback – will impact on customer receptiveness towards demand response offers (e.g., TOU tariffs) and how much demand reduction can be delivered. The Government's consultation on the Consumer Engagement Strategy acknowledges the role that tailored feedback and energy efficiency advice can have in supporting behaviour change. This might involve the provision of graphs and other information in bills about energy consumption and suggestions about how to reduce consumption. The proposed framework would enable suppliers to provide feedback on consumption and energy efficiency advice based on daily consumption data, *provided that consumers were given the opportunity to opt out of this, and suppliers would be required to obtain explicit (opt-in) consent in order to access half-hourly data for this purpose.*

The Government's current thinking is that consumer engagement should not just be left to suppliers to manage individually as this could result in messages not being consistent and coordinated, which could lead to potential confusion or inefficiencies. Given the important role third parties (e.g. charities, consumer groups, community organisations, local authorities, housing associations) could play in engaging consumers, there needs to be some mechanism for orchestrating this. Centralising some engagement activities under one delivery mechanism

[41] http://www.decc.gov.uk/assets/decc/11/consultation/smart-metering-imp-prog/4933-data-access-privacy-con-doc-smart-meter.pdf

would address this and allow for the possibility of an umbrella brand to position individual suppliers' roll-outs as part of a national programme.

Summary of smart meters' impact on demand reduction and demand response

Smart meters should facilitate demand response (through half-hourly data, and opportunities for ToU and load management tariffs and through the provision of information to customers) and also encourage demand reduction through improved consumption feedback. However, until smart meters are fully rolled out (2019), followed, potentially by universal half-hourly settlement some time later, their potential to facilitate the development of a demand response market in the household sector may be limited, because it may not be worth retailers or others developing DSR products to a limited market. The exception to this may be for those households with EVs, PV or heat pumps. In terms of demand reduction smart meters may be able to influence this on an individual household basis pre 2019. Clearly smart meters should have an impact on electricity end-use in the commercial and industrial sectors earlier as the roll-out to those sectors will be completed earlier.

7. **Ofgem smarter markets programme**

Smart metering will provide an opportunity for development of retail energy markets, innovation in tariffs (such as time-of-use), energy services and payment methods and more use of demand-side response. However, as well as potential benefits of smart metering, Ofgem also sees some potential risks for consumers - for example through increasing sophistication in tariffs.

Currently, different parts of the electricity market are governed by different regulatory frameworks. Each framework has different timescales for decisions, creating difficulties in coordinating policy. For example, wholesale prices are determined competitively, network charging methodologies are industry led, while distribution price controls are set by Ofgem. Market processes are set out in detailed industry codes with which licence holders must comply. Since market opening in the 1990s, these codes have been subject to hundreds of incremental changes through modification processes driven by market participants.

In Ofgem's view "There are various aspects of current market arrangements that are likely to constrain the benefits of a more active demand side, even with the roll-out of smart metering. These factors could affect the uptake of all demand-side response, including through time-of-use tariffs." (para 3.24 of smarter markets consultation)

Ofgem has therefore launched its Smarter Markets programme to design and deliver reforms to market rules, systems and processes. In terms of reforms, there are a number of options open to Ofgem. These range from changes to licences to approving industry-led code modifications. Under the Significant Code Review process Ofgem can facilitate complex and significant changes to a range of industry codes.

Retail market review

In Ofgem's view its Retail Market Review proposals are unlikely to deter suppliers from offering time-of-use tariffs. Suppliers would still be able to offer non-standard tariffs of fixed duration with prices that vary by time-of-use. This seems a reasonable conclusion at this stage and until smart meters are more fully rolled out it is likely that time of use tariff offers may be relatively limited in any case. However, Ofgem recognises that, in the medium term, it will need to review the impact of regulatory arrangements on the development of time-of-use tariffs. Relevant aspects of the regulatory framework are likely to include licence conditions on provision of consumption information to consumers, sales and marketing practices and tariff design.

Network charging

Ofgem's view is that existing network charging arrangements dampen incentives to both network operators and suppliers to use demand-side response. These arrangements are complex and vary according to the type of consumer. For a number of years, Ofgem has been encouraging network operators to make their charges more cost-reflective and transparent, in part to reward demand-side response and distributed generation where this brings network benefits. In April 2010, electricity distribution network operators implemented a Common Distribution Charging Methodology, which made significant progress towards more cost-reflective distribution charges. This could be important as a means of incentivising more demand response although it is also important to note that more cost reflective charging will create winners and losers.

System operator procurement rules

The System Operator has specific procurement rules that determine the types of services with which it can balance the system. For example, to provide Short-Term Operating Reserve, parties must make available a minimum volume of change in demand and a minimum delivery period. Demand-side response also needs to meet additional requirements to participate. Ofgem's view is that these rules may act as a barrier to increased use of demand-side response and it is considering whether there is scope to address this through the development of the System Operator incentive schemes from 2013.

Settlement arrangements

For the domestic and smaller non-domestic consumers, the current settlement arrangements break the link between suppliers costs and their customers' within-day changes in consumption. This is due to the extensive use of profiling and estimates. Enabling universal half-hourly settlement, at an individual customer level, could therefore make price signals to suppliers sharper and so increase the incentives for suppliers to use demand-side response. Variations in suppliers' unit costs over the course of the day could encourage them to use demand-side response to shift their customers consumption from higher-cost periods to lower-cost periods, thereby lowering their overall costs of supply. However, even if settlement were half-hourly, suppliers unit costs presently vary little over the course of the day. A number of factors influence the variation in suppliers costs throughout the day, including the effect of wholesale costs, cash out prices, network charging and System Operator costs. Wholesale costs are around 61 per cent of costs on average for all domestic and non-domestic electricity consumers. In 2011, however, wholesale prices differed on average by only 20 per cent between the most expensive and least expensive times of day. Wholesale prices are in part influenced by the costs which suppliers face if they do not balance supply and demand. Imbalance costs are also competitively determined through the cash out regime, but the framework itself is governed by the balancing and settlement code.

Smart metering provides an opportunity to improve significantly the quality of energy settlement by using accurate, frequent and timely gas and electricity consumption data. This is likely to enable a number of important changes in the market.

Using actual meter readings for each settlement period would improve the link between a supplier's customer billing revenue and its energy and distribution charge liabilities. This could be particularly beneficial for smaller suppliers or new entrants, who may be more exposed to differences between billed charges and industry costs. It would also allow suppliers and consumers to be credited for changes in consumption sooner than at present. This could remove a key barrier to offering new tariffs designed to incentivise consumers to shift electricity consumption to off-peak times.
Moving to imbalance charges that reflect actual consumption would incentivise suppliers to purchase energy to meet their customers actual demand, rather than an estimate based on estimated Load Profiles. Any resulting changes to suppliers energy purchasing decisions may reduce the residual balancing role of the System Operator and the overall cost of balancing. More accurate settlement would encourage suppliers to manage their imbalance exposure more effectively and support more efficient use of demand-side response. The latter would give suppliers the opportunity to reduce the wholesale prices they pay for electricity by allowing them to buy more off-peak if they can shift demand away from peak times.

Use of timely meter reading data in settlement could reduce financial uncertainty for suppliers caused by the existing reconciliation process. Currently, it may be several years before the final allocation of charges associated with a particular settlement period is reached. Removing the existing processes for estimating consumption and allocating energy costs could also reduce costs associated with the estimation, profiling and reconciliation of consumption data.

The rules that support electricity settlement arrangements are set out in the Balancing and Settlement Code (BSC). An electricity supplier can opt to settle any supply point on a half-hourly basis. However, there may be practical and financial disincentives to them doing so. For example, sites that move to the half-hourly market may face higher network charges due to the different charging methodologies that operate for non-half-hourly and half-hourly supply points. Half-hourly sites may also face additional charges for metering services to meet the requirement to submit more frequent meter readings.

Industry participants have already recognised the potential for smart metering to improve the accuracy of the gas and electricity settlement arrangements. Proposals are under development to mandate half-hourly settlement for larger non-domestic electricity consumers (Load Profiles 5-8), and, more generally, to remove barriers to the elective use of actual meter reading data for settlement purposes. In electricity, consideration is also being given to using smart meter data to improve the quality of profiling.

Key questions regarding settlement :

- Whether market participants have incentives to voluntarily move to using actual meter reading data in a full or timely manner.
- Whether it is in consumers' interests for actual meter reading data to be used in settlement arrangements.

If answer to first is no and second yes Ofgem would consider whether it would be appropriate to mandate settlement on actual data and when to introduce such a requirement. Options include: whenever a smart meter is fitted; once a critical mass of smart meters have been fitted; or by reference to related industry reforms. There may be a case for phasing in moves to more accurate settlement arrangements across different consumer groups. Different segments of the market are due to complete roll-out at different times: for example, all larger non-domestic consumers (Load Profiles 5-8) should have advanced gas and electricity meters by 6 April 2014.

There may be alternative approaches to mandating the use of actual meter readings for each settlement period that could deliver better outcomes, such as more sophisticated use of profiles.

The current settlement arrangements are likely to need to be largely retained for traditional meters during the transition to smart metering. There may be scope to use the data from smart meters to improve the quality of consumption estimates, for example by improving the quality of profiling and consumption estimation. In addition, profiling and estimation for consumers with traditional meters may become less accurate over time as the population of supply points decreases.

The use of actual meter reading data for settlement purposes will necessarily require access to a certain amount of consumption data. The DECC Programme is considering access to, and use of, smart metering data. Ofgem are discussing with DECC how data for settlement might be handled in a way that mitigates potential privacy concerns, such as through the use of aggregation.

Smarter markets work programme

In July 2012 Ofgem published its initial smarter markets work programme based on the outcome of the consultation.[42] This outlined four priority areas of work :

- **Change of supplier** – a fast, reliable and cost-effective change of supplier process, which will facilitate competition and build consumer confidence.
- **Electricity settlement** – settlement arrangements that use smart metering data to allocate energy in an accurate, timely and cost-effective way, which will facilitate product innovation and efficient use of energy. The first deliverable will be an open letter from Ofgem early in 2013 setting out how reform should be progressed and the role Ofgem will play.
- **Demand-side response** – a market environment that supports the efficient, system-wide use of demand-side response, which has the potential to reduce bills for consumers, enhance security of supply and contribute to sustainable development. The first deliverable will be a consultation document in Q1 2013 that considers the potential of existing arrangements to support efficient system-wide use of DSR.
- **Consumer empowerment and protection** – regulatory arrangements that empower and protect consumers to participate effectively in smarter retail energy markets, recognising the opportunities and risks involved.

The Ofgem smarter markets work programme will thus have some important impacts on the development of demand reduction and demand response.

[42] Ofgem. Promoting smarter markets : a work programme. Ofgem, July 2012

8. Climate Change Levy and Climate Change Agreements

The **Climate Change Levy** (CCL) is a tax on energy use in industry, commerce and the public sector. All revenue raised is recycled back to businesses through a 0.3% cut in employers' national insurance contributions, and support for energy efficiency and low carbon technologies. The current rate of CCL tax on electricity from 1st April 2012 is 0.509 pence per kWh[43]. The current rate for gas supplied within GB is 0.177 pence per kWh[44]. The CCL was introduced on 1st April 2001, to encourage businesses to become more energy efficient and reduce their greenhouse gas emissions.

The CCL applies to a range of fuels consumed: gas, electricity, petroleum and hydrocarbon gas in liquid form, coal, lignite and coke. It does not apply to fuel used by domestic customers, the transport sector, fuel used for producing other forms of energy (such as electricity), fuel used for non-energy purposes (e.g. used as raw materials by industrial processes), and energy used by registered charities for non-business use. Other exemptions to the CCL include:

- Electricity generated from new renewable energy (such as solar and wind power).
- Fuel used by 'good quality combined heat and power' schemes.
- Fuel used as a feedstock.
- Electricity used in electrolysis processes, such as the chlor-alkali process, or primary aluminium smelting.

Climate change Agreements

In recognition of the fact that energy-intensive industries would be significantly affected by the Climate Change Levy, DECC introduced the Climate Change Agreements, effectively a rebate scheme under which energy-intensive industries can obtain a discount of up to 65% on their CCL, provided they meet targets for improving their energy efficiency or reducing their carbon emissions.

Energy-intensive industries were initially defined as those detailed in Schedule 1 of the Pollution Prevention and Control (England & Wales) Regulations 2000[45], but in 2006 the qualifying criteria for sectors that could apply for a CCA was extended and the definition of 'energy intensive' expanded in line with the definition set out in the 2004 EU Energy Products directive. The new criteria include a measure of energy intensity and the industry import penetration rate (designed to stop carbon leakage). Sectors must either have an energy intensity of 3% or more (where energy costs are 3% or more of the production value for the sector) and an import penetration rate of 50%; or they must have an energy intensity of 10% or above. Energy-intensive industries include steel, chemicals, cement and industrial gases, as well as agricultural businesses such as poultry and pig raising.

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[43] http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_ShowContent&id=HMCE_PROD1_031183&propertyType=document

[44] As above

[45] http://www.legislation.gov.uk/uksi/2000/1973/contents/made

Climate Change Agreements set out the energy efficiency or carbon emission reductions targets that must be met for the reduction in CCL to be granted. CCAs have a two-tier structure, with agreements between the Secretary of State and sector or trade associations (umbrella agreements), and agreements between individual participants and the Secretary of State (underlying agreements). Targets are negotiated between sector associations and government, but it is the responsibility of the associations to distribute the target among their members.

There are currently 54 sector umbrella agreements in place, covering 10,000 facilities. Targets are set to cover all energy used by a unit, including any covered by the EU ETS, with a CCA mechanism in place to avoid double counting. Operators can meet their CCA targets either by taking direct action or by purchasing allowances from the UK ETS.

The Climate Change Levy and Climate Change Agreements were introduced in 2001, and have since undergone some revision and changes. Notably, as mentioned above, the definition of energy intensive was amended in line with the EU definitions (from 2004 EU Energy Products directive) to include consideration of exposure to international markets.

The other major change historically has been the change in the levy rate: the levy discount was originally set at 80%, and revised to 65% in April 2011. The 2011 autumn statement[46] announced that the CCL discount rate for electricity only will rise from 65% to 90% in 2013.

DECC is currently in the process of revising the CCA, and carried out a consultation exercise which finished in May 2012[47]. A number of changes to the CCA are proposed:

- Consolidating the baseline year across all sectors – taking 2008 as baseline year (currently there are different baseline years in place across different sectors).
- Requiring individual target units to comply with their targets, rather than requiring sectors to meet their targets (therefore improving poorer performers).
- Aligning CCA target periods with EU ETS reporting periods: this will simplify reporting.
- Closing the UK ETS. This will lead to administration savings for both government and CCA participants. CCA participants will have to pay government more directly, rather than trading within the UK ETS.
- Removing the need for the EU ETS overlap accounting mechanism. CCA targets will only apply to non-EU ETS emissions. This will remove the need for the costly and burdensome CCA-EU ETS double-counting avoidance mechanism currently in place.
- Consolidating Umbrella and Underlying agreements into one type of agreement – this will simplify administration.
- The Environment Agency will be the scheme administrator.

[46] http://cdn.hm-treasury.gov.uk/autumn_statement.pdf
[47] See DECC's response to the consultation, published July 2012: http://www.decc.gov.uk/en/content/cms/consultations/cca_simp_new/cca_simp_new.aspx

Where policy interacts with or impacts demand response and/or demand reduction

The CCL and CCA have had a historic impact on energy efficiency within industry. Sectors which have had umbrella agreements under the CCA have achieved significant improvements in energy efficiency / demand reduction since the beginning of the scheme. Since the future CCA targets will only apply to emissions not included within the EU ETS, CCL/ CCA will continue to drive demand reduction within industry. CCL drives demand reduction not just in electricity but across the board as it covers gas and other fuels.

The CCL and CCA do not encourage or impact DSR.

There is potential to focus the CCL & CCA on electricity demand reduction and demand side response by:

- Including specific electricity saving targets on CCA parties.
- Exploring a potential focus on improving efficiencies in lighting, on-peak electric heating and motors, three areas which we know contribute significantly to peak electric load.

9. CRC Energy Efficiency Scheme

The CRC Energy Efficiency Scheme (originally the Carbon Reduction Commitment), is a mandatory UK-wide trading scheme aimed at improving energy efficiency and cutting emissions in large public and private sector organisations (large non-energy intensive organisations). It is designed to drive emissions reductions in the target sectors by incentivising the uptake of cost-effective energy efficiency. The scheme requires businesses to report on and pay a tax on energy used, and ranks businesses in a performance league table which provides reputational incentive to improve their energy efficiency. The scheme is expected to deliver carbon savings of 21 MtCO2 by 2027.The scheme was introduced in April 2010 and is administered by the Environment Agency.

Organisations are required to fully participate in the scheme if they:

1) Have at least one half hourly electricity meter (HHM) settled on the half-hourly market.
2) Consumed at least 6,000MWh during the qualification period[48] through a HH meter (whether HH settled or not).

These organisations are required to report on their energy consumption[49] across a range of fuels, and buy allowances for their CO_2 emissions. In 2012 the price of allowances was set by government at £12/tCO_2.

Organisations which had at least one HHM consuming **less** than 6,000MWh in 2008 were required to make an information disclosure of their half hourly electricity consumption during 2008.

Energy already covered by EU ETS or CCA is exempt from CRC, but this exemption applies to energy covered by these schemes, not to the entire organisation, hence some organisations have to take part in both CRC and EU ETS or CCA.
The CRC scheme encourages energy demand reduction not only by introducing a financial incentive, but by requiring companies to keep track of their energy consumption, in many cases for the first time.

Under initial proposals for the CRC as set out in the 2007 Energy White Paper, there was to be a revenue-recycling element to the scheme, so that profits generated would be distributed to the participants. This element was later scrapped and the revenue from the CRC scheme will be used to support public finances (revenue is estimated to total £1bn a year by 2014-2015).At the same time government announced that the first sales of allowances would take place in 2012 instead of 2011. Participants would therefore be able to purchase allowances to cover their 2011/2012 emissions at the end of the 2011/2012 compliance year.

The Environment Agency published the CRC Performance League[50] at the end of each reporting period. The CRC Performance League Table ranks companies according to their performance on three metrics relating to:

[48] 2008 was the qualification period for the first CRC stage. For the second phase of the CRC scheme the qualification period is the 2010-2011 financial period.
[49] With some exceptions, e.g. energy supplied to domestic accommodation or for transport purposes is excluded.

- Their voluntary installation of AMRs to measure gas and electricity supply (Early Action Metric).
- The percentage change in CRC emissions of a participant (Absolute Metric).
- The percentage change in CRC emissions per unit of turnover or revenue expenditure (Growth Metric).

The Performance League Table also provides information on overall aggregated emissions (tonnes CO_2).

In the first year only the Early Action Metric applied. The first reporting period ended March 2011, and the first CRC Performance Table was published in November 2011.

Work is currently being undertaken to simplify the scheme, making it easier for organisations to participate. DECC and the devolved administrations ran a consultation on the proposed simplification plans (closed on18th June 2012).Some of the proposals included in the consultation include:

- Reducing the number of fuels covered by CRC from 29 to 4[51]. The four fuels would be: electricity, gas, gas oil (diesel) and kerosene.
- Removing the requirement on facilities covered by Climate Change Agreement or EU Emissions Trading System installations to purchase CRC allowances.
- Reducing the amount of reporting required by businesses.
- Adopting new emissions factors for the CRC which will align it with Greenhouse Gas reporting processes.

Where policy interacts with or impacts electricity demand response and/or demand reduction

The scheme does not focus specifically on electricity, however, it is expected to encourage electricity demand reduction as follows:

1) By requiring organisations to record their energy use, including electricity, it aims to raise awareness of energy and electricity consumption in organisations which previously did not monitor their consumption.
2) By providing a financial incentive, through the £12/tCO2 charge for emissions from energy, including electricity, consumed.
3) By providing a competitive reputational element, through the CRC Performance League Table.

In this way the scheme is expected to deliver carbon savings of 21 MtCO2 by 2027.

[50] The current CRC Performance League Table is available here: http://crc.environment-agency.gov.uk/pplt/web/plt/public/2010-11/CRCPerformanceLeagueTable20102011
[51] http://www.decc.gov.uk/en/content/cms/news/pn12_031/pn12_031.aspx

Demand Side Response

The scheme does not specifically address the issue of electricity demand side response, as there is no time-of-use consideration given to the emissions from electricity consumed by eligible organisations.

What changes (if any) might make the policy more conducive to electricity demand response or demand reduction:

For Demand Reduction:

1. Separating out emissions from electricity explicitly would drive electricity demand reduction.
2. Stronger financial incentives would lead to stronger action.
3. Revenue recycling would improve the credibility of the scheme, badly damaged by the removal of the revenue recycling element, which is now widely seen as 'yet another tax' by industry.

For Demand Side Response:
The scheme does not set out to address DSR, and to rework the scheme so that it could include DSR would lead to the scheme being unworkably complicated, as it would need to take into account emissions saved by Demand Side Response in electricity, which is very complex.

10. EU Draft Energy Efficiency Directive

The EU has an overall objective of achieving 20% primary energy savings by 2020[52].
The European Commission's latest estimations, which take into account the national energy efficiency objectives for 2020 that Member States have set in the context of the Europe 2020 strategy, suggest that the EU will achieve only half of the 20 % goal in 2020[53].

The draft Energy Efficiency directive is designed to replace two existing directives: the Cogeneration Directive (2004/8/EC, CHP directive) and the Energy Services Directive (2006/32/EC, ESD directive). These two directives will be repealed when the new Directive comes into force, with the exception of the objective to reduce final energy consumption of each member state by 9% by 2017. (Article 4(1) to (4) and Annexes I, III and IV to the ESD directive).

The draft Energy Efficiency directive will require Member States to take action in a number of areas, including setting **indicative national energy efficiency targets**, improving **energy efficiency in public buildings**, **purchasing by public bodies**, **energy auditing**, improving energy **metering and billing**, and making improvements in **energy transformation, transmission and distribution**. All these measures are designed to ensure that the EU meets its goal of 20% improvement in energy efficiency by 2020.

A very brief outline of the Energy Efficiency directive articles follows:

- Article 1 sets out the directive's **subject matter and scope** ('the directive establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20% headline target on energy efficiency'), Article 2 covers definitions.
- Setting **indicative national energy efficiency targets** (**Article 3**). Member States shall set indicative national energy efficiency targets, which take into account the EU's maximum energy consumption in 2020 (namely 1474 Mtoe primary energy or 1078 Mtoe final energy).
- **Exemplary role of public bodies' buildings (Article 4)**. From 1 January 2014, 3% of the total floor area of heated and/or cooled buildings owned and occupied by central government is to be renovated each year to meet at least the minimum energy performance requirements set by the MS concerned in application of Article 4 of Directive 2010/31/EU. (suggested previous wording was simply 3% of all government owned buildings – this has been significantly amended by the caveats **owned and occupied**, and **heated and/or cooled**).
- **Purchasing by public bodies (Article 5)**: 'MS shall ensure that central governments purchase only products, services and buildings with high-energy efficiency performance'.
- **Energy efficiency obligation schemes (Article 6).** 'Each MS shall set up an energy efficiency obligation scheme'.

[52] http://ec.europa.eu/clima/policies/package/index_en.htm
[53] Commission staff working paper - Impact Assessment accompanying the proposed Energy Efficiency Directive (SEC (2011) 277)
http://ec.europa.eu/energy/efficiency/eed/doc/2011_directive/sec_2011_0779_impact_assessment.pdf

- **Energy audits (Article 7)**. Member States shall promote the availability to all final customers of high quality energy audits which are cost-effective.
- **Metering (Article 8)**. The directive sets out that final customers for electricity (among other energy sources) be provided with individual meters that accurately reflect consumption and provide information on actual time of use.
- **Article 12 on Energy transformation, transmission and distribution** sets out requirements for Member States to ensure national energy regulatory authorities pay due regard to energy efficiency in operating the gas and electricity infrastructure. It also requires that Demand Side Response and aggregators of Demand Side Response be allowed to participate in balancing and other ancillary services without prejudice (more detail below).

The Energy Efficiency Directive was proposed by the European Commission in 2011 (22.06.2011), and referred to the Council of Ministers and the European Parliament under the co-decision mechanism. A compromise text was agreed in June 2012.

The European Parliament voted in favour of the energy Efficiency Directive on 11 September 2012, and the Council endorsed the directive on the 4th October 2012[54]. Now that the Council has approved the Directive, it will be published in the Official Journal and will enter into force 20 days after its publication in the Official Journal.

The directive has undergone significant amendments during the discussion process, undertaken during the Danish presidency of the EU, many of which were subsequently discarded. Overall the final draft directive is less stringent than initially proposed, as for example member states are now being required to introduce ***indicative*** national energy efficiency targets, not ***binding*** energy efficiency targets (Article 3).

How policy interacts with or impacts DSR and DR

Demand reduction

The Energy Efficiency directive is entirely focussed on achieving energy savings and will therefore have significant impact on demand reduction across the EU when implemented. Some of the key points which will lead to demand reduction include:

- The requirement for Member States to set **indicative national energy efficiency targets** (**Article 3**).

- On **public buildings setting an example**: the requirement, from 1 January 2014, for 3% annually of total floor area of heated and/or cooled buildings owned and occupied by MS' central government to be renovated to meet at least the minimum energy performance requirements set out by MS in application of Article 4 of the Directive 2010/31/EU (**Article 4**).

[54] See http://ec.europa.eu/energy/efficiency/eed/eed_en.htm

- On ensuring central governments purchase only products, services and buildings with high energy efficiency performance, in so far as this is consistent with cost-effectiveness, economical feasibility, wider sustainability, technical suitability, as well as sufficient competition (**Article 5**).

- Member States shall set up an **energy efficiency obligation scheme,** which shall ensure that obligated energy distributors and/or retail energy sales companies operating in the Member State territory achieve a cumulative end-use energy savings target by 31 December 2020 (**1.5% of annual energy sales to final customers**, by volume). These obligated parties will be designated by the Member State on the basis of non-discriminatory criteria (**Article 6**).

- The requirement on MS to promote the availability to final customers of high quality energy audits (which are cost effective and carried out in an independent manner, and implemented and supervised by independent authorities under national legislation) (**Article 7)**.

- On **energy metering and billing** (Article 8): Member States are required to ensure that:

    - Final customers for electricity (and others) are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and provide information on actual time of use (in so far as it technically possible, financially reasonable and proportionate in relation to the potential energy savings).
    - Where MS implement intelligent metering systems and roll out smart meters for gas and electricity (in accordance with directives 2009/72/EC and 2009/73/EC), they are required to: 1) ensure the metering systems provide information on actual time of use; 2) ensure the security of smart meters and data communication, 3) on request of the final customer, require meter operators to ensure that the meter can account for **electricity put into the grid from the final customer's premises,** 4) require appropriate advice and information to be given to customers at the time of installation of smart meter about their full potential with regard to monitoring of energy consumption.
    - **Billing:** where customers do not have smart meters, MS are required to ensure that by 1 January 2015 billing information is accurate and based on actual consumption, for all the sectors covered by this directive.

- On **customer information and empowering programme** (Article 8D): Member States shall take measures to promote and facilitate an efficient use of energy by small energy customers, including domestic customers.
- On **financing of energy efficiency** (**Article 15a):** MS shall facilitate the establishment of financing facilities or use of existing ones for energy efficiency improvement measures to maximise the benefits of multiple streams of financing.

Demand side response

Article 12 of the directive regards **Energy transformation, transmission and distribution,** and will impact on Demand Side Response in addition to demand reduction.
The following points have all been agreed by the EU trilogue (EU Commission, Council and Parliament), and are included in the final draft directive:

1) MS to ensure national energy regulators pay due regard to energy efficiency in operating the gas and electricity infrastructure. In particular ensure that tariffs and regulations incentivise grid operators to make available system services to network users, allowing them to implement energy efficiency improvement measures in the context of continuing deployment of smart grids.

2). By 30 June 2015 MS will have undertaken an assessment of the energy efficiency potential of their gas and electricity infrastructure, especially regarding transmission, distribution, load management and interoperability.

4). MS shall ensure removal of incentives in transmission & distribution tariffs which are detrimental to overall efficiency (including energy efficiency) of the electricity system, or those that might **hamper participation of demand response in balancing markets and ancillary services procurement.** Tariffs shall allow suppliers to improve consumer participation in system efficiency**, including demand response**, depending on national circumstances.

5). MS shall ensure that TSOs and DSOs guarantee the transmission & distribution of electricity from high-efficiency cogeneration provide priority or guaranteed access to the grid of electricity from high-efficiency cogeneration, and when dispatching electricity generating installations, provide priority dispatch of electricity from high efficiency cogeneration in so far as the secure operation of the national electricity system permits.

6). MS shall ensure that cogeneration can participate in balancing and other operational services. TSOs and DSOs shall ensure that such services are part of a transparent, non-discriminatory bidding process for balancing services and other operational services.

7). MS shall ensure that national energy regulatory authorities encourage demand side resources, e.g. DSR, to participate alongside supply in wholesale and retail markets. Subject to technical constraints inherent in managing networks, MS shall ensure that TSOs and DSOs, in meeting requirements for **balancing and ancillary services**, **treat demand response providers, including aggregators, in non-discriminatory manner** on the basis of their technical capabilities.

7b) Subject to technical constraints inherent in managing networks, MS shall promote DSR's access to balancing, reserve and other system services markets, inter alia by requiring national regulatory authorities (…) to define technical modalities for participation in these markets. Such specification shall include the participation of aggregators.

It is difficult at this stage to predict the impact that the Energy Efficiency directive will have on either electricity demand reduction or electricity demand side response in GB.

What changes might make the policy more conducive to DSR or DR

The final requirements of the draft Directive will be less stringent than the original text proposed by the Commission, and many of the amendments by the European Parliament. There was a general shift to less stringent wording e.g. from 'Member States will **ensure'** to 'Member States will **incentivise'**, and 'may' rather than 'shall'; as well as frequently preceding obligations with the caveat 'where this is technologically and economically feasible'.

Demand reduction

Specifically, some of the proposed amendments during the course of the discussion, which **did not make it through to the final text** and which would have strengthened the impact of the directive on demand reduction, include:

- **Article 3**: the requirement for member states to set **binding** – rather than indicative - national energy efficiency targets.

- **Article 8 on metering and billing.**
  - Regarding the requirement for all final customers to have a meter, this is caveated as follows: **in so far as is technically possible, financially reasonable and proportionate in relation to the potential energy savings.** The first two clauses 'technical possible, financially reasonable' are open to a range of interpretations by Members States when implementing the directive.
  - Additionally, one proposed amendment regarded smart metering functionality, and would have required minimum functionalities to '**enable communication of smart metering components with devices or gateways used within the home or building in the provision of energy saving and demand-side management services'.**

Demand Side Response

Article 12 of the directive concerns **Energy transformation, transmission and distribution**. A number of amendments were proposed during the course of the lengthy discussion process, which were not ultimately carried through to the final text[55]. These would have strengthened the impact of the directive on DSR. The following are some of the unsuccessful amendments, **not included in the final directive text:**

Paragraph 2) The deadline for the target 'MS will have undertaken an assessment of the energy efficiency potential of their gas and electricity infrastructure, especially regarding transmission, distribution, load management and interoperability' was to be **30 June 2013** rather than **30 June 2015.**

[55] Amendments are brought forward by the EU Council of Ministers and the Parliament. The Smart Energy Demand Coalition (SEDC, http://sedc-coalition.eu/) was active in lobbying for the directive to recognise the value of smart meters and demand response, and create a demand-response energy market in the EU.

Paragraph 4) In addition to requiring MS to 'ensure that network operators (…) are incentivised to improve (…) consumer participation in system efficiency, including demand response depending on national circumstances.' An amendment proposed '**MS may impose public service obligations relating to energy efficiency on undertakings operating in the electricity and gas sectors'.**

Paragraph 6) Proposed text allowed for **demand response aggregators** to be allowed to offer balancing and other operational services at the level of the TSO or DSO (subject to it being technologically feasible).

Paragraph 7). Regarding the requirement that '*MS promote DSR's access to balancing, reserve and other system services markets, inter alia by requiring national regulatory authorities (…) to define technical modalities for participation in these markets. Such specification shall include the participation of aggregators*.'
A significant amendment proposed an outline of what should be included in the **specifications for DSR participation in energy reserve markets**. This included points such as baseline measurement methodology, duration of demand response activation, timing of demand response activation, among others, and would have established some common rules in countries where DSR cannot at present participate in the balancing and reserve services.

Another unsuccessful amendment proposed an additional paragraph, **7c** ' *MS shall develop a demand response action plan, to include detailed information on how DSR resources, including smart grids, will be deployed and integrated into regional electricity markets, including tertiary reserves markets and capacity markets. The Commission will assess the DSR action plans'*[56].

The Energy Efficiency Directive will be transposed into legislation by Member States, including the UK, following its approval by the EU Council in October 2012. Implementation of the Directive will bring significant progress in both the demand reduction and demand side response arenas.

[56] This seems to mirror provisions in US legislation (Energy Independence and Security Act 2007) which requires a national assessment of demand response potential by FERC, a national action plan, and a proposal for implementation.

11. EU Eco Design Framework Directive

The EU Ecodesign Framework Directive has the aim of improving energy efficiency by targeting the design stage of energy-related products. The directive sets a framework for setting Community-wide Ecodesign requirements for energy-related products, with the aim of ensuring free movement of such products within the internal EU market. The directive covers all energy-related products, defined as:

- **Energy-using products (EUPs**), which use, generate, transfer or measure energy (electricity, gas, fossil fuel), such as boilers, computers, televisions, transformers, industrial fans, industrial furnaces etc; and
- **Other energy related products (ERPs**) which do not use energy but have an impact on energy and can therefore contribute to saving energy, such as windows, insulation material, shower heads, taps etc.

The Ecodesign framework directive foresees two types of **mandatory product requirements**:

- Specific requirements which set limit values such as **maximum energy consumption** or minimum quantities of recycled material.
- Generic requirements which do not set limit values. These may require for example that a product is 'energy efficient' or 'recyclable'.

It also envisages **voluntary agreements**, which are considered a priority alternative to mandatory requirements, if the industry voluntary agreements fulfil certain conditions, namely achieving the same as binding legislation in '*a more rapid and cost-effective manner*'[57].
The first working plan for 2009-2011 (adopted in 2008) established a list of ten product groups to be considered a priority for implementing measures. The 10 product groups are:

- Air-conditioning and ventilation systems.
- Electric and fossil-fuelled heating equipment.
- Food-preparing equipment.
- Industrial and laboratory furnaces and ovens.
- Machine tools.
- Network, data processing and data storing equipment.
- Refrigerating and freezing equipment.
- Sound and imaging equipment.
- Transformers.
- Water-using equipment.

As part of the current working plan, a number of independent preparatory studies on individual products areas have been commissioned. These assess current Best Available Technology (BAT), electricity consumption data, the potential for energy efficiency

[57] http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/files/brochure_ecodesign_en.pdf

improvements in product design, and report on modelling of potential savings and associated costs of rolling out such improvements across the market.
There are a number of completed preparatory studies available at present, including a report on refrigeration and freezing equipment prepared by BIO-IS[58]. This report assesses products including service cabinets, blast chillers (for chilling hot food quickly), cold rooms and chillers (for cooling water for air-conditioning units). BIO-IS have also produced a preparatory report on Industrial and Laboratory Furnaces and Ovens[59]**.**

Consumer awareness: The directive also sets out that in order to maximise environmental benefits from improved design it may be necessary to inform customers about the environmental characteristics and performance of energy-related products and on how to use products in an environmentally-friendly manner.

The directive is framed in the context of the EU's energy efficiency ambitions under the European Climate Change programme (ECC) and Sixth Community Environment Action Programme (Decision no 1600/2002/EC of EU parliament and of the Council).
The EU Eco-Design framework was originally set in place in 2005, but recast in 2009 at the Directive 2009/125/EC **establishing a framework for the setting of Ecodesign requirements for energy-related products (recast).**

A first working plan for 2009-2011 was published in 2008, which set out an indicative list of ten product groups covered in the working plan, as set out in the section above.
The effectiveness of the EU Ecodesign framework directive is currently being reviewed and assessed, and the Commission will decide by the end of 2012 if any amendment to the directive is required. In preparation of the review, an independent evaluation study was carried out[60].

A working plan for 2012-2014 is currently being discussed by the Commission in conjunction with member states and representatives of EU associations on the Consultation Forum.

UK Implementation

In the UK the EcoDesign directive is put into law by the Ecodesign for Energy Related Products Regulations (SI 2010 No 2617). Ecodesign regulations aim to improve the environmental performance of products by reducing the impact of a product's life-cycle on the environment. This is done through regulation or voluntary agreements.

[58] Preparatory study for Eco-Design. Refrigerating and freezing equipment, summary document. Final report by Bio-IS (May 2011)
http://www.ecofreezercom.org/doc_unprotected/BIO_ENTR%20Lot%201_summary%20document_16052011_final.pdf
[59] http://eco-furnace.org/open_docs/043122753%20Draft%20Task%201-5%20Rep%20final.pdf
[60] http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/review/index_en.htm

Where policy interacts with or impacts DSR and DR

Demand reduction

The EU Ecodesign framework directive is expected to have a significant impact on electricity demand reduction. By establishing new industry standards for a variety of energy-related products (be they energy-using products, or energy-related products such as e.g. windows, insulation) through mandatory requirements or voluntary agreements, significant energy reductions are expected.

Initial estimates by the commission calculated that the adoption of the first 13 measures within the EU Ecodesign directive would lead to **annual savings of 366 TWh electricity consumed by 2020**[61] (from a 2009 baseline). This is a very significant reduction in electricity demand – equivalent to 12% of total EU electricity consumption in 2009.
These thirteen measures include measures focussing on: standby, simple set top boxes, street & office lighting, domestic lighting, external power supplies, electric motors, circulators, domestic refrigerators, television, domestic dishwashers, domestic washing machines, fans, air conditioners and comfort fans. **The largest savings were expected from Ecodesign measures affecting electric motors** (135 TWh annual savings**), followed by street and office lighting** (38 TWh) and **standby** (35 TWh).These savings figures assumed all the measures to be adopted by 2012. It is not clear if all these measures have been adopted to date, however, the review of the directive currently underway by the Commission should clarify this.

However, there are some concerns regarding the implementation of the Ecodesign Framework directive, highlighted in Green Alliance's recent report 'Cutting Britain's energy bill – making the most of product efficiency standards'[62]. Key points of concern include:

- Delays to the implementation of the Directive – e.g. within the UK only 13 out of 25 products in the first tranche of eligible products have so far had regulations applied to them.
- Delays in consumer uptake efficient appliances, which is not occurring at the expected rate.

These delays will impact on the realisation of predicted carbon savings.

There is currently a draft Ecodesign working plan for 2012-2014[63] , which would include a raft of new measures **focussing on areas such as lighting and heating controls**, window products, construction products, steam boilers and smart meters. There is a proposal requiring a preparatory study on **Smart Meters** to be carried out. This would explore requirements relating to interoperability as well as features (e.g. requiring actual energy consumption of household appliances to be displayed on smart meters).

[61] http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/files/brochure_ecodesign_en.pdf
[62] http://www.green-alliance.org.uk/grea_p.aspx?id=6623
[63] http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/working-plan/index_en.htm

Demand side response

The directive does not specifically address Demand Side Response, and so is not expected to impact on DSR directly. If the working plan for 2012-2014 includes further research on smart meters, this may indirectly facilitate DSR in future.

The Ecodesign framework directive is ambitious, and its full implementation will drive significant electricity demand reduction. The main changes which would make the policy more conducive to demand reduction involve strengthening the directive and ensuring its on-time implementation:

- Bringing forward the impact of measures, by accelerating implementation – the sooner measures are introduced, the sooner demand reduction savings will be realised.
- Complete the first work programme, include more product families in 2012-14.
- Raising standards within product areas – requiring more significant/ more stringent Ecodesign requirements for selected product areas.
- Prioritising those products which, from a UK perspective, are likely to achieve greatest cost-savings in the electricity system.
- Enhance market surveillance.

12. Electric vehicles policy

Stage of Development and Implementation of policy

Climate change policy is a key driver, given the potential for electric vehicles to reduce greenhouse gas emissions in the transport sector. The existing European regulatory framework aims to achieve a 40% reduction in CO_2 emissions from new cars by 2020, based on a 2007 baseline. Plug-in Vehicles are also seen as offering the potential to ease the reliance on oil and improve energy security. Additional policy drivers for Plug-in Vehicles include UK obligations for improved air quality, especially in densely populated areas, and the Green Growth agenda which supports the roll-out of recharging infrastructure in the UK.

The Government published the Plug-In Vehicle Infrastructure Strategy, Making the Connection[64], in June 2011. This sets out the framework to remove market barriers and establish a recharging infrastructure, and the formation of the Plugged-In Places programme - £30 million matched funding for eight local pilot projects installing and trialling recharging infrastructure (domestic, public and private / commercial chargepoints). This initiative has enabled the private sector to make significant investment in recharging infrastructure. For example, by the end of 2012 one organisation expects to have a network in 100 towns and cities, providing 4,000 Plug-In Vehicle recharging bays. Other private sector organisations are developing chargepoint business models. Some pilots are also examining the impact Vehicle charging will have on the electricity network through the installation of Smart Meters and home chargepoints to assess the impact of clustering.

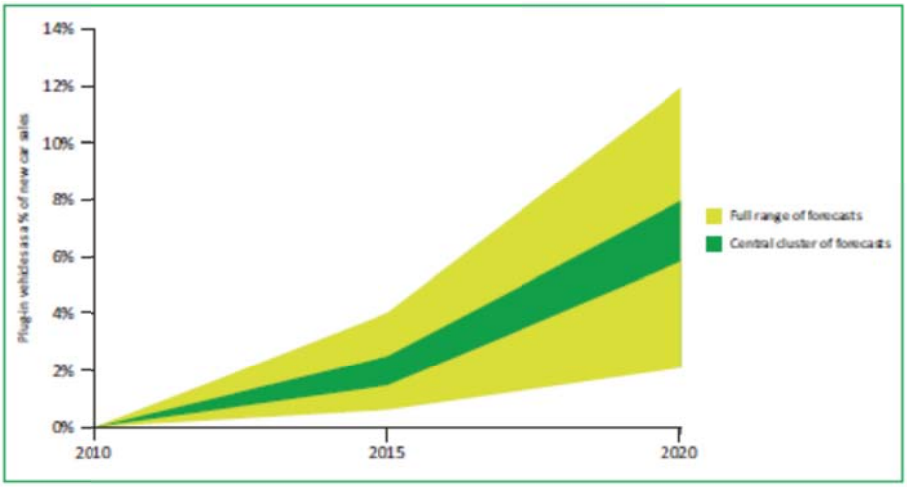
The Plug-In Vehicle Infrastructure Strategy also included £300million for the Plug-In Car Grant for eligible vehicles for consumers and businesses. This was launched in January 2011 and revised in January 2012 to include Plug-In Vans.

A number of proposals were made in the Plug-In Vehicle infrastructure strategy to remove existing barriers. These include the addition of infrastructure in the National Planning Policy Framework and a Permitted Development Right that removes the requirement from local authorities and owners of public car parks to apply for planning permission to install chargepoints. In addition the government made a commitment to encourage the adoption of plug-in vehicle infrastructure within voluntary standards, such as the Code for Sustainable Homes, supporting the adoption of infrastructure within new build developments. A commercial market for plug-in infrastructure is favoured by government rather than a regulated asset base, perhaps owned by local authorities and / or distribution networks, on the basis that a commercial market will be more responsive to consumers.

[64] June 2011, Making the Connection: The Plug-In Vehicle Infrastructure Strategy, Office for Low Emission Vehicles

Market development

It is difficult to project the potential take up of plug-in vehicles. The graph below, published in the Government's Plug-In Vehicle Infrastructure strategy outlines a range of assumptions for market growth. A wide range of factors will influence market growth, including consumer acceptance and oil prices.



Source: Graph based on selected plug-in vehicle uptake forecasts by Arup-Cenex, BCG, Berger, Cheuvreux, Deutsche Bank, Frost & Sullivan and McKinsey

Figure 1: Plug-in Vehicle market forecasts to 2012, Plug-In Vehicle Infrastructure Strategy, Making the Connection, June 2011

Installed Chargepoints	>6,000
Claims made through the Plug-in Car Grant	1,706
Claims made through the Plug-in Van Grant	99

Table 1: Market figures to end June 2012[65], Office for Low Emission Vehicles

A National Chargepoint Registry is to be launched later in 2012 which will provide visibility of all public recharging networks in the UK.

How Policy interacts with or impacts demand response.

The Plug-In Vehicle Infrastructure Strategy outlined two key areas of work for Industry to take forward:

- To specify how the back-office functions for vehicle recharging infrastructure will operate; and
- Develop recommendations on ways to facilitate recharging of vehicles at times that are cost effective.

[65] Of the estimated 6,000 chargepoints, 2200 have been delivered through the 8 plugged-in places initiatives, 70% of which are publically accessible. The remainder have been installed by private sector organisations and other local authorities.

Industry bodies BEAMA, ENA, Energy UK and SMMT came together to take this work forward[66]. The review focuses on domestic charging and the potential for demand response from end-use customers through plug-in vehicles. Similar potential will be available from workplace plug-in vehicle infrastructure. Less potential is foreseen from public infrastructure, as people need to recharge at a given time, and regardless of whether this is during peak electricity demand.

Based on evidence from pilots and trials across the UK, it is envisaged that the majority of private recharging will take place at home, over night - and will need to be incentivised to take place during periods of low demand to minimise the impact on peak demand and mitigate the need for network reinforcement investments.

Plug-In vehicles represent a significant load at domestic level and given the length of time over which a car may be stationary outside a property, provides an obvious load which could be shifted to fill troughs in demand. In the long run, plug-in vehicles could also enable Vehicle to Grid (V2G) and/or Vehicle to Home (V2H) energy flow, as bi-directional charging is facilitated. This means that in the longer-term, the vehicle could perhaps also become a reserve store at local level. However, for the time-being V2G and V2H is currently not viewed as viable or attractive to customers, given the comparatively low cost of electricity and current limited financial benefit of providing demand response, as opposed to the high cost of purchasing the vehicle.

Fully-advanced, and predominantly automated, demand response ability for plug-in vehicle recharging will aid network operators to avoid local electricity network overloading from vehicle clusters, and to defer investment in reinforcement. It could also potentially assist with balancing variable or inflexible generation (e.g. renewable) at national level. For the efficient operation of the electricity system some important considerations are:

- Knowing where and when Plug-In Vehicles are being recharged so that electricity demand can be accurately forecast. This will enable potential impacts on the networks to be assessed and suitable tariffs and infrastructure can be offered to customers.

- Fully understanding the most cost-effective time periods for recharging of Plug-In Vehicles and, where possible, reflecting these in customer incentives for vehicle charging, so that the effect on network and generation can be minimised.

- Enabling opportunities to encourage the recharging of Plug-In Vehicles during periods of lower CO_2 output, (eg in high-wind periods) therefore enhancing the environmental benefits.

- For owners of Plug-In Vehicles to understand the most cost-efficient method of recharging a vehicle to ensure the minimum network and system impacts of recharging.

[66] BEAMA, ENA, Energy UK and SMMT Response to Government's Plug-In Vehicle Infrastructure Strategy, June 2012, www.beama.org.uk

There are a number of options available for off-peak charging of plug-in vehicles. :

Timers: a well understood technology and a cost-effective solution in the short term. Various products are available including timers built into the vehicle as well as those connected to the outlet from which the vehicle is being recharged. Trials conducted as part of the Plugged-in Places programme have shown timers to be effective in shifting demand. As the move towards 'smart' charging progresses the need for further flexibility and dynamic charging cycles may require more advanced systems as noted below, but the timer will always be able to provide a simple and easy to apply measure for off-peak charging.

Tariffs: Some suppliers have already introduced Plug-In Vehicle electricity tariffs to encourage off-peak charging, as part of a home installation package. Any use of tariffs at scale would need to include the facility for staggered recharging times. Suppliers will need to remain cognisant of total Plug-In Vehicle running costs when set against the typical costs of domestic energy consumption.

In the long-run, simple controls may not provide the complex control functions needed to manage a more dynamic and distributed energy supply.

Home Automation: Technology enabling home automation can be used to manage recharging, and is already a familiar measure used today to control the use of heat and lighting appliances in the built environment. Home automation systems for plug-in vehicles could be standalone or form part of a wider home automation system. Discussions are taking place on computer and smart phone systems to link to a smart meter. This could be via a 'dongle' plugged into a laptop which provides customer access to their smart meter data along with the ability to interact with suitably enabled appliances, such as a plug-in vehicle, via computer or smart phone.

Smart Meters: could enable customers to choose a supplier and tariff to lower the cost of charging their plug-in vehicle and encourage demand response. One additional benefit of smart meters with regards to demand management for plug-in vehicles is in the visibility this could provide for DNOs in detecting new or significant loads being added to the network.

What changes might make the policy more conducive to demand response and demand reduction?

A key requirement is to ensure appropriate standards for charging are developed and interoperability maintained. Vehicle manufactures will need to be involved in the development of these standards to ensure their products are suitably enabled for demand response.

One of the key barriers to implementing demand response could be the lack of information about the purpose for which electricity is being used[67]. Network operators will wish to know where plug-in vehicles are being recharged and when. The adoption of dedicated recharging infrastructure in domestic properties has the potential to be linked to a smart meter, or home automation system. In the longer term this could also facilitate more advanced demand response, including potential for vehicle to grid or vehicle to home.

ENA have an initiative in development to require installers to notify the network operators of plug-in vehicle charge units and heat pump installations. This will provide a better understanding of total demand from these technologies.

Due to the comparatively low cost to recharge a plug-in vehicle in comparison to the high purchase price it is anticipated that suppliers will adopt innovative tariff offerings to encourage customers to recharge their vehicles off-peak.

The more advanced demand response capabilities highlighted in the overview of the BEAMA, ENA, Energy UK and SMMT paper would require both smart meters and smart grid technologies. Smart meters and their data/communication infrastructure will need the functionality to enable off-peak charging and to facilitate TOU and eventually dynamic tariffs. The BEAMA, ENA, Energy UK and SMMT paper therefore stresses that it will therefore be essential to ensure plug-in vehicle recharging infrastructure is interoperable and able to interact with the planned smart meter implementation.

In the longer term (10 or more years), fixed TOU tariffs and other simple measure such as timers, may have less role to play than more sophisticated, more dynamic demand response options. The Government's Plug-In Vehicle Infrastructure Strategy is being revised in 2013 and needs to take into account these requirements.

Concluding remark on EV charging : existing market barriers

With the majority of charging likely to take place at home over night, it is recognised that there is future potential to maximise the benefits of demand response from plug-in vehicle charging. Progress however needs to be made in a number of areas if we are to reach a point at which the more advanced applications can be applied.

[67] ENA, Energy UK, 2012, Smart Demand Response A discussion paper

The long-term industry objective is for dedicated charging systems at domestic level (mode 3[68]), motivated by the need for energy management in the home and demand response. For this to progress clear guidance needs to be provided to consumers on the benefits and application of such charging equipment, and the installation of mode 3 equipment should be incentivised. The decision to recharge off-peak will ultimately always come down to the consumer, but industry and government must be mindful of how demand response can be incentivised and encouraged through the adoption of different charging technologies.

The measures outlined above have focused on the domestic level, however a comparatively large take up of plug-in vehicles for fleets, for private or public use, is possible. This could lead to a significant number of vehicles being charged at one location, therefore the network requirements will need to be carefully considered along with measures to manage the charging cycles. Key to assessing the potential for demand response from this sector is the understanding of its infrastructure needs, how they will be charging and how they can be encouraged to optimise existing electrical infrastructures and installed charging assets.

There has been a comparatively low take up of vehicles when compared to the installation of chargepoints across the country. While it is likely EV drivers will predominantly charge at home, there must be sufficient public infrastructure if consumers are to have the confidence to invest in this new technology. Key to take up is ensuring customers are aware of the availability and location of charging assets and the ability to easily access these. Facilitating longer journeys should also help to remove a key barrier – "range anxiety".

Finally, while we may not see a significant level of vehicle take up nationally in the next five years, we are more likely in the shorter term to see localised clusters emerging. Therefore demand response measures for plug-in vehicles needs to be developed to cope with and anticipate clusters of vehicles.

[68] BEAMA Guide to Electric Vehicle Infrastructure, May 2012,

Annex 1 - Energy Bill

The Government proposes to reform the current electricity market arrangements and put in place new processes and mechanisms capable of supporting the delivery of high capital-cost low-carbon generation at scale[69].

Timetable - A draft Energy Bill to reform the GB electricity market was published for pre-legislative scrutiny on 22 May 2012. Pre-legislative scrutiny is being conducted by the House of Commons Energy and Climate Change Select Committee in a six-week window to July 2012. The Bill is likely to be introduced into Parliament in late 2012. The Bill is expected to spend most of 2013 in Parliament, with Royal Assent towards the end of 2013.

The process for developing secondary legislation will begin in summer 2013, and consultation to take place at the end of 2013. Government proposes to publish their consultation responses and lay statutory instruments in early 2014. Secondary legislation is likely to come into force around mid-2014.

Content - The draft Bill puts forward measures for electricity market reform.

From the perspective of view of the GB Electricity Demand project there are two core measures: [70]

(1) **Feed-in-Tariffs with Contracts for Difference** - to create new long-term incentives for low-carbon (designed to replace the Renewables Obligation from 2017) and
(2) **A new Capacity Mechanism** - to ensure that sufficient *reliable* capacity is available.

These mechanisms will be supported by :
(3) **The Carbon Price Floor** – a tax to underpin the carbon price in the EU Emissions Trading Scheme.
(4) **An Emissions Performance Standard** – a new regulatory measure to provide a back-stop to limit emissions from unabated power stations.

Institutional Arrangements - **Government** will set out overall policy directions and key parameters (for capacity auctions ; initial administrative price-setting for low-carbon

[69] Large-scale de-carbonisation of the UK power generation sector to 50gCO2/kWh by 2030 (from 560gCO2/kWh in 2010) is the main means identified by both Government and the Committee on Climate Change to meet the UK's legally binding carbon target of reducing carbon emissions against a 1990 base-line by 80% by 2050. Current design of the GB electricity market, structured around competition in short-run costs, does not adequately support investment in new low-carbon generation - characterised by high up-front investment and low running-costs.

[70] Measures introduced in the draft Bill are : Contracts for Difference – long-term instruments to provide stable and predictable incentives for companies to invest in low-carbon generation; Investment Instruments – long-term instruments to enable early investment in advance of the CfD regime coming into force; Capacity Market – to ensure the security of electricity supply; Conflicts of Interest and Contingency Arrangements – to ensure the institution which will deliver these schemes is fit for purpose; Renewables Transitional – transition arrangements for investments under the renewables obligation scheme, and Emissions Performance Standard – to limit carbon dioxide emissions from new fossil fuel power stations.

investments - and later on, for low-carbon auctions). Every 5 years, government will publish a Delivery Plan – the first in 2013.

The System Operator will :
(1) administer the two new market mechanisms and
(2) provide evidence and analysis to inform the Government's decisions.
The system operator will not comment on the government's objectives or policy. A Panel of Technical Experts will scrutinise the System Operator's anlaysis to make sure that it is up-to-date and objective. Further details of the respective roles of the Government, the System Operator and Ofgem will be set out in autumn 2012, and in secondary legislation in 2013-14. Ofgem will continue to regulate the SO and ensure value for money.

Customer Savings - The Energy Bill Impact Assessment indicates that as a result of the measures proposed in the Bill, household electricity bills are estimated, on average, to be 4% lower to 2030, than without reform (so an increase of £100 in average household bills to 2030 with reform - instead of a possible BAU increase of £200 without reform). Average bills for business and energy intensive industries are are also expected to be lower than otherwise (~2.8% lower).

Outstanding Issues – a good deal of material was published on 22 May together with the draft Energy Bill. However, some important areas of policy - plus very many detailed technical design issues - still require clarification and resolution. Final decisions on these many matters may yet take quite some time[71]. There is widespread support for the general objectives of the Bill in creating a stable and long-term investment framework for low-carbon. Nevertheless, there remains considerable debate on the chosen mechanisms, including their detailed design, and also some concern that the level of complexity and uncertainty may, in the short-term, lead to a slow-down in low-carbon investment.

[71] Some key outstanding issues include : likely impact on investment of the Levy Control Framework ; contract counterparty arrangements for FIT CfDs (and associated payment models) ; CfD strike-price setting ; effectiveness of FIT CfDs for both of Renewables and CCS ; PPAs for some generators ; pre-Royal Assent, the use of Financial Instruments to support investments; the detailed design of a capacity agreement – including detailed understanding of where and how DSR might become actively involved ; EPS exemptions for security of supply.

Sustainability *First*

Sustainability *First* was set up to develop new approaches to sustainability. Its primary focus is on policy and solutions within the UK, but draws on experiences and initiatives both within and outside the UK.

Sustainability *First* develops implementable ideas in a number of key policy areas – notably, energy, water and waste - where it can make a difference. It undertakes research; publishes policy and discussion papers; organises high level seminars and other events. Sustainability First is a registered charity.

Sustainability *First*'s trustees are: Ted Cantle (Chair); Phil Barton (Secretary); Trevor Pugh (Treasurer); Sara Bell; John Hobson; Derek Lickorish; Derek Osborn; David Sigsworth. Its projects are developed by the trustees and a number of associates and consultants.

Sustainability *First's* Director is Judith Ward.

Sustainability *First*'s associate is: Gill Owen.
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