Centre for Environmental Strategy

A review of the costs and benefits of demand response for Electricity in the UK

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Introduction to the paper

Background

- Policy issue –uncertainty on the economic case for DR and clarity required on the different costs and benefits;

Aims:

- Clarification - benefits and costs of DR;
- Explore the economic case (and establish important variables).

DR definition:

- Broadly adopted definition of Albadi and El-Saadany (2008)

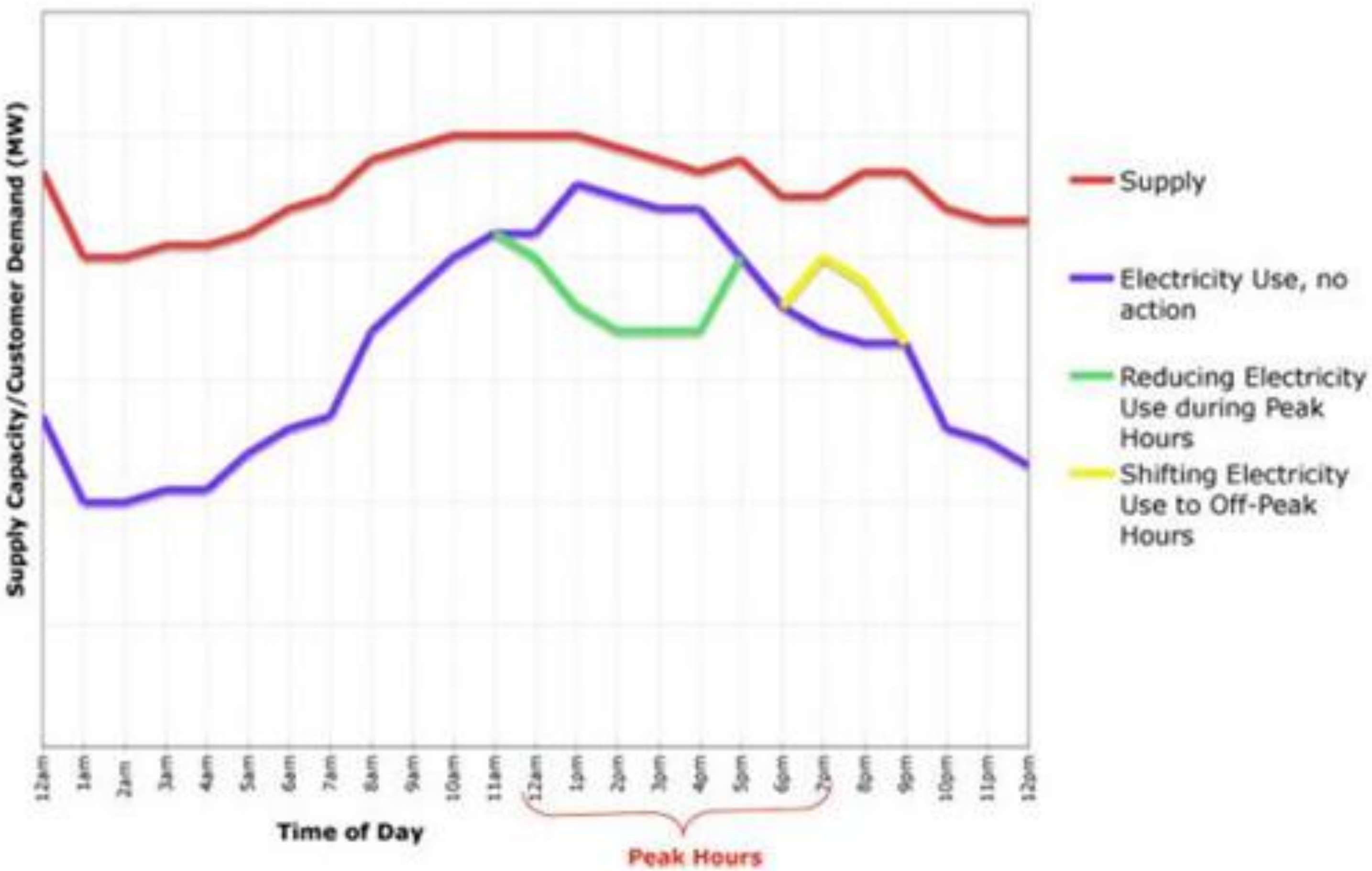
Demand response

Energy conservation

www.recyclereminders.com 2012

Demand response

Peak shifting



Green solutions magazine 2012

Method

- Theoretical framework - guided by DOE (2006);
- Quantitative estimates are established from five of the most relevant UK papers and reports, on particular forms of DR and their costs and benefits; some modelling is also conducted.
- Clarification of whether DR benefits are likely to result in welfare gain, assuming benefits outweigh costs.

Categorisation of benefits

DR benefits identified from literature:

- Benefits from relative and absolute reductions in electricity;
- Benefits from short run marginal cost savings (from shifts in peak);
- Benefits from displacement of new plant investment from peak shifts or from using DR to respond to emergencies;
- Benefits from DR for use in providing standby reserve and balancing for wind;
- Benefits to distributed power systems;
- Benefits in terms of reduced transmission network; &
- Benefits in terms of distribution network investment efficiency and reduced losses.

Categorisation of costs

Type of cost		Cost	Quantification
Participant costs	Initial costs	Enabling technology investment	Yes
		Establishing response plan or strategy	No
	Event specific costs	Comfort/inconvienience costs	No
		Reduced amenity/lost business	No
		Rescheduling costs (e.g. overtime pay)	No
		Onsite generator fuel and maintenance costs	No
System costs	Initial costs	Metering/communication system upgrades	Yes
		Utility equipment or software costs, billing system upgrades	Partial
		Consumer education	Partial
	Ongoing programme costs	Programme administration/managment	Partial
		Marketing/recruitment	Partial
		Payments to participating customers	Partial
		Programme evaluation	No
		Metering/communication	Yes

Table 2: Different cost categories for implementation and operation of a DSM system (DOE 2006)

Participation and response

Review Study	Results		
Martinez et al (2010)	**Likely aggregate level energy savings by feedback type (based on previous experience from studies and modelling)**		
	Feedback type	**Overall savings (given participation rates and average household values)**	
	Enhanced billing - opt out	2%	
	Real time feedback -opt out	4%	
	Real time feedback plus - opt out	6%	
Farugui et al (2010)	**Feedback type**	**Average energy savings**	**Overall savings (given participation rates and average household values)**
	Direct feedback by in home display (equiv. To real time feedback)	7%	-
	Direct feedback by in home display combined with prepayment (pay as you go type)	14%	-
Farugui and Sergici (2010)	**Findings on drops in peak demand from different tarfiff types**		
	Tarrif type	**Drop in peak demand for those that participate**	
	time-of-use	3-6%	
	time-of-use + technology	21-30%	
	critical peak pricing	13-20%	
	critical peak pricing+technology	27-44%	

Table 3: Findings from review studies on participation and levels of DR

Electricity savings the UK could expect

Martinez et al (2010)	**Feedback type**	**Overall savings (given participation rates and average household values)**
	Real time feedback -opt out	4%

- Opt out, relevant to UK context.

Peak shifts that the UK might expect and indicators of participant costs

	Findings on drops in peak household demand from different tarfiff types	
Farugui and Sergici (2010)	**Tarrif type**	**Drop in peak demand for those that participate**
	time-of-use	3-6%
	time-of-use + technology	21-30%
	critical peak pricing	13-20%
	critical peak pricing+technology	27-44%

[1]Feedback plus translates to real-time information to the resolution of appliances (as opposed to overall electricity use).

- Technology and structure - important

Results table for this study

Form of DR benefit or cost		Benefit/Cost	Time period	Units	Domestic/ non domestic	Estimate of benefits/cost		Mt CO_2 (electricity)	Potential to contribute to economic welfare	Study
Reductions in energy demand *(2.2)*	Benefits	Reductions in electricity *(energy savings)*	Average annual	Present value Millions of £	Domestic	157		0.87	low	DECC and Ofgem (2011a and 2011b)
					Non domestic	34		0.25		
		Reductions in electicity *(CO_2 savings)*	Average annual	Present value Millions of £	Domestic	19		" "	Yes	
					Non domestic	4.2		0.25		
Peak demand shift *(2.3, 2.4, 2.8 and 2.9)*		Short run marginal cost savings *(from shiting peak demand using TOU)*	Average annual	Present value Millions of £	Domestic	6.1		n.v	Yes	
					Non domestic	1.4		n.v		
		Displacing new plant investment *(Avoided investment from TOU)*	Average annual	Present value Millions of £	Domestic	33		n.v	Yes	
					Non domestic	1.0		n.v		
		CO_2 reductions assocated with TOU demand shifts	Average annual	Present value Millions of £	Domestic	2.4		n.v	Yes	
					Non domestic	0.9		n.v		
		Reduced transmission and distribution network investment *(avoided investment from TOU)*	Average annual	Present value Millions of £	Domestic	1.5		n.v	Yes	
					Non domestic	0.1		n.v		
Energy reduction and peak demand shift *(2.9)*		Reduced losses as a result of the introduction of smart meters *(electricity and gas)*	Average annual	Present value Millions of £	Domestic	22		n.v	Yes	
					Non domestic	5		n.v		
Not DR related		Other non DR benefits resulting from smart metering *(electricity and gas)*	Average annual	Present value Millions of £	Domestic	445		n.a	Yes	
					Non domestic	26		n.a		
'stand by' reserve for emergencies/unforeseen events		Estimated value of avoiding all customer interuptions and customer minutes lost for the UK	Estimated value for the year 2008-2009	Millions of £ for the year	Both	Avoided customer interuptions	Avoided customer minutes lost	n.a	Yes	Estimated based on modelling by authors
						155 (if all avoided)	229 (if all avoided)			
Balancing for wind *(2.6)*		Benefits from balancing for wind *(value of energy and CO_2)as a result of smart appliances*	Value per unit in 2025	Euro/kW DSM	Domestic	lower price scenario[1]	upper price scenario[1]	2	Yes	Seebach et al (2009)
						80	130			
Balancing for a change in system managment philosophy *(2.9)*		Reduced distribution network investment *(from a change to a smart corrective smart electricity system)*	Average annual (for the twenty years)	Present value Millions of £	Both	25-500		n.v	Yes	Strbac et al (2010)
Smart metering (electricity and gas)	System Costs	Capital costs, installation costs, O&M costs, IT costs, the cost of capital, energy costs from smart meter consumed energy, meter reading costs, disposal costs, Legal, marketing and organisational costs	Average annual	Present value Millions of £	Domestic	538		n.a	-	DECC and Ofgem (2011a and 2011b)
					Non domestic	30				
Smart appliances	Participant cost	Cost of the actual appliances and additional electricity use	Value per unit in 2025	Euro/kW DSM	Domestic	lower scenario	upper scenario	n.a	-	Seebach et al (2009)
						10	30			

Table 3: Summary table of potential costs and benefits of DR

Key DR benefits versus relevant key costs (average annual values)

- Electricity savings – 2.8% reduction in annual electricity demand (household and SME base)– results in £157m of benefits (average annual terms).
- Peak load shifting – 1.3% shift in peak electricity demand across household and SME non-domestic base: Displacement of plant investment: £34m

  Short run marginal cost savings: £7.5m
- Smart metering cost– Average annual cost £567m;
- Non-DR benefits and DR benefits come to £758m;

Key DR benefits (annual values) versus key costs

Balancing for wind - via introduction of smart appliances. Two years were assessed 2010 and 2025. Benefits are estimated to be significantly above costs in 2025. (lower price scenario)

- 256m euros of benefits (in terms of energy and CO_2 reductions);
- Compared with an estimated 32m euro in smart appliance costs.

Key DR benefits versus relevant key costs (average annual values)

- Reduced distribution network investment resulting from a change in operation management philosophy

- Estimated average annual benefits £25m - £500m depending on penetration of electric vehicles and heat pumps and decisions on distribution network reinforcement.

- Such a change in system may however entail organisational costs beyond key enabling technology costs already mentioned and quantified.

Summary of key benefits and costs

Benefits

- Consumer electricity savings;
- Peak load shifting – displacing new investment and reducing wholesale prices;
- Balancing for wind.
- Reduced distribution network investment – via change in management philosophy;

Costs

- Smart metering infrastructure; and
- Smart appliances.

Conclusion

The study:

- Illustrates the relative scale of different costs and benefits (given assumptions); &
- Allows the economic case for the different types of DR to be explored;

The findings:

- Financial benefits to individuals - often small;
- Benefits to the UK as a whole – can be substantial.
- There appears to be a reasonable economic case for DR for electricity in the UK;
- Economic case - depends on ensuring participation;

Conclusion

Participation - shaped by:

- Participant costs;
- Sharing of benefits;
- Non financial motivations;

Important variables:

- Tariff structures;
- Institutional environment;
- Technology and its implementation;

Thank you for listening