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Business participation in Demand Response: a review of potential barriers

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- \* The I&C Sector
- Neoclassical economics: hidden costs and risk
- Behavioural economics: bounded rationality and statusquo-bias
- Social practice insights
- Conclusion

### The I & C sector

- \* I & C sector provided 2.7 GW of DSR in 2016 (National Grid, 2017a)
- \* Potential 9.8 GW by 2020 (ADE, 2016)
- The industrial sector provided 54% of all demand side flexibility (National Grid, 2017b)
- The commercial and public sector provided 29% of all demand side flexibility (National Gridb, 2017)
- \* Non-domestic buildings account for 30% of peak demand
- \* Demand-led DSR potential: between 1.2 and 4.4 GW (Element Energy, 2012)
- \* Generation DSR potential: another 1-4 GW

#### The I & C sector



- Consume electricity for productive processes
- Energy costs represent 8% of overall costs (CCC, 2017)
- Advanced control systems
- Constraints: e.g. criticality of productive processes

- Consume electricity for building-related purposes: lighting, HVAC, catering and refrigeration, computing.
- Energy costs represent 0.5% of overall costs (CCC, 2017)
- Limited control systems
- Constraints: perceived impact on business

#### The commercial and public sector





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#### DSR costs

- Initial cost cost of investing in enabling technology and establishing a response plan
- Activation costs costs incurred when responding to a DSR request
- Initial costs in the commercial sector are high e.g.
   capital cost
- \* Activation costs in industry £80 £ 400 per MWh
- \* Activation costs in commercial premises £15 per MWh

Source: Charles River Associates, 2017

## Other initial costs: hidden costs

Type of hidden costs	Examples of hidden costs				
Hidden production costs	<ul> <li>Searching for suitable equipment</li> <li>Overhead costs to allow equipment installation</li> </ul>				
Market transaction costs	<ul> <li>Gathering information to allow initial decision</li> <li>Choosing aggregator</li> <li>Negotiating and managing contracts</li> <li>Complying with administrative requirements</li> </ul>				
Organisational transaction costs	<ul> <li>Internally championing DSR</li> <li>Coordinating various departments' contributions</li> </ul>				

Based on Sorrell et al, 2004

## Organisational TCs

"The onsite energy manager thinks DSR looks interesting and could provide revenue. They have to speak to the estates team, who will look at the asset register. Then they have to get in touch with the finance guys to ask whether they can go ahead; ... Then they have to consult with the clinicians, who are acutely concerned about any break in supply..."

Julie Braidwood, Crown Commercial Services Energyst 2016, p. 21

#### Risk

Risk to core business

- \* DSR an unfamiliar concept
- Automation

Uncertainty of financial returns

- Auctions
- One year contracts
- Changes in policy context



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# Bounded rationality

- Rational but facing limitations in terms of their attention capacity and knowledge.
- Resorting to rules of thumb to find satisfactory rather than optimal solutions
- Most relevant for marginal issues during the initial stages of decision-making process

## Energy as a marginal issue

Proportion of large companies with both capacity and ambition to reduce energy consumption is 44%.

Source: BEIS, Building Energy Survey, 2016 Table 3.3: Percentage of energy consumed by organisation size, energy management resource and energy management ambition, 2014–15

Organisation size         Energy management ambition         Specialist energy manager         Non- specialist energy manager         No energy management         Don't know         Total           All         Active         35%         18%         3%         -         56%           All         Passive         14%         12%         8%         -         34%           None         1%         1%         3%         -         66%           Not asked         0%         -         -         4%         49           Total         50%         31%         15%         4%         100%           Large         Active         44%         20%         2%         -         65%           None         0%         0%         3%         -         49%           None         0%         0%         3%         -         49%           None         0%         -         -         8%         8%         100%           SME         Passive         14%         17%         15%         -         46%           None         3%         2%         4%         -         9%           Not asked         -         -		Energy management ambition	Energy management resource (%)				
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#### Bounded rationality and DSR

Low Carbon London - interviews

- Early Adopters already participating in DSR
- Majority interested in DSR but unwilling to take the risk
- Unaware did not know about DSR and little interest in finding out more

Study of aggregators' acquisition process - three stages

- Primary reason for not taking up DSR during the first two stages was lack of interest
- \* During the third and last stage more specific reasons were given *Sources: Woolf, Ustinova, Ortega et al, 2014; Curtis, 2017*

#### Loss Aversion



# Status-quo-bias and DSR

*"you are unlikely to get blamed for doing things in the traditional way, but doing something new may carry a high personal risk of being blamed if it goes wrong"* (Grubb et al, 2014)

Radical departure from how consumers perceive energy use:

- Access to energy on a continuous basis taken as a given
- Deviation from a wellfunctioning system

Uncertainty enhances attraction of status quo:

- Inherent in Capacity Market design
- Changes in legislation
- Number of DSR events
- Complexity of regulation



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#### **Social Practice Perspectives**

- \* Energy demand is an outcome of what energy is for
- Similar buildings may have different constraints in their use of electricity
- The extent to which a DSR intervention can take place depends not only on individuals' decisions, but also time structure of business activities

## Flexibility in a hotel setting





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- Social practice insights
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#### Conclusion

- Need for research on barriers to the uptake of DSR in the commercial sector
- Decisions about DSR participation are not always and necessarily taken by careful consideration of pros and cons
- \* Non-energy experts also have a say
- Technical and real flexibility influenced by what energy is used for - which is determined by non-energy factors
- Need for DSR opportunities that are low risk and easy to understand by non-specialists

#### Business Participation in Demand Response: a review of potential barriers

#### Thanks

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ADE, 2016. Flexibility on demand Giving customers control to secure our electricity system.

BEIS, 2016. Building Energy Efficiency Survey, 2014–15: Overarching Report.

Charles River Associates, 2017. An assessment of the economic value of demand-side participation in the Balancing Mechanism and an evaluation of options to improve access - prepared for Ofgem.

Committee on Climate Change, 2017. Energy Prices and Bills - impact of meeting carbon budgets.

Curtis, M., 2017. Demand side response aggregators: How they decide customer suitability. Int. Conf. Eur. Energy Mark. EEM.

Curtis, M., Torriti, J., Smith, S.T., 2017. Demand side flexibility and responsiveness: Moving demand in time through technology, in: Demanding Energy: Space, Time and Change. pp. 283–312.

Element Energy, 2012. Demand side response in the non-domestic sector, Final report for Ofgem, in association with De Montford University. Leicester, UK.

Energyst, 2016. Demand Side Response: Turning inertia into inertia, 2016 Report.

Grubb, M., Hourcade, J.C., Neuhoff, K., 2014. Planetary Economics: The Three Domains of Sustainable Energy Development: Energy, Climate Change and the Three Domains of Sustainable Development. Routledge.

National Grid, 2017a. Power Responsive, Demand Side Flexibility Annual Report 2017.

National Grid, 2017b. Non-BM Balancing Services Volumes and Expenditure.

Sorrell, S., O'Malley, E., Schleich, J., Scott, S., 2004. The economics of energy efficiency. Edward Elgar.

Woolf, M., Ustinova, T., Ortega, E., O'Brien, E., Djapic, P., Strbac, G., 2014. Distributed generation & demand side response services for smart distribution network, Report A7 for the "Low Carbon London" LCNF project: Imperial College London, 2014.