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Innovate UK / Tempus Project – The Global Electricity Revolution for Consumers Interim Paper

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This paper has been compiled by Sustainability First. It represents an overview of the first year of a two-year Innovate UK/Tempus Energy innovation project. It is not to be construed or relied on as any form of advice on the part of, or in relation to, any of the project parties involved in this project.

About Sustainability First

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

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

Recent work on energy includes our major three-year (2011-14) multi-partner project 'GB Electricity demand – realising the resource'. This involved a systematic look at the policies, regulatory approaches and commercial and consumer issues for development of an active demand-side in the GB electricity markets.

In July 2015, Sustainability First embarked on a major three-year multi-partner project, 'New-Pin' – New Energy and Water Public Interest Network. Our aim is to establish a 'public interest voice' for the water and energy sectors.

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

Sustainability First is a registered charity. Our trustees are: Ted Cantle CBE (Chair); Phil Barton (Secretary); Trevor Pugh (Treasurer); Derek Osborn CB; David Sigsworth; Sara Bell; Derek Lickorish MBE; Richard Adams OBE and Sarah Deasley.

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

Innovate UK / Tempus Project – The Global Electricity Revolution for Consumers

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1. Introduction

'The Global Electricity Revolution for Consumers' is a two-year Innovate UK part-funded project trialling the end-to-end systems required to deliver customer demand-side response (DSR) and flexibility in GB electricity markets. Using a new, innovative technology and business model, the project aims to demonstrate how DSR and flexibility can provide cost savings for electricity customers and new commercial opportunities for energy market actors.

Tempus Energy, an electricity supplier with a business model based on optimising customer DSR and flexibility, leads the project[1]. Delivery partners include Wireless Energy Management Systems International (WEMS) and One Sightsolutions, both specialists in building and energy management systems, and Viriya, an electricity storage service company. Sustainability First is an environmental think-tank, looking at the wider policy and regulatory implications of the trial.

The project is at the halfway stage, starting on 1 May 2015 and finishing on 30 April 2017. The focus for Year 1 was on setting up the trials with electricity supply customers and developing communications software between Tempus Energy and the delivery partners. DSR signals and response has been tested. In Year 2 the trials will be run and evaluated.

The purpose of this interim paper is to: provide an overview of project progress in Year 1 – the successes, challenges and lessons learned so far; and discuss emerging regulatory and policy issues. The paper focuses on the project set-up phase including: the customer proposition and recruitment; site survey and technology installation; communications/software for flexible response; and project partner communications and management.

Tempus will produce a final report, at project close, on the project delivery and findings. Sustainability First will also produce a report on lessons learned from the project and wider policy/regulatory implications.

2. The role of DSR and flexibility

2.1. GB electricity market context

The GB electricity market was set up on the basis of 'static' demand profiles with thermal power stations to meet peak demand and 'one-way' flow electricity from large generators to passive consumers. Even with the move to renewable generation there has been a focus on using back-up conventional generation to meet peak demand.

But things are changing, with new technologies and greater penetration of renewable energy, we are moving to 'two-way' flows of electricity. Generation is becoming more distributed and variable. Demand-profiles are changing[2]. Customers are becoming more responsive. New business models are emerging. In this context, DSR and flexibility could play an increasingly important role.

[1] Tempus Energy Technology Limited is the legal entity under which the Innovate UK project sits. Tempus Energy Supply is a subsidiary of Tempus Energy technology Limited and is responsible for supply of electricity to customers. For the purpose of this paper we refer to 'Tempus Energy' for both.
[2] Including with uptake of distributed generation e.g. solar PV and projected increased use of electric vehicles and heat pumps.

2.2. Definition of DSR

For the purpose of this report we define 'demand-side response' as: *actions to change (i.e. increase, reduce or shift) levels of electricity demand at a particular moment in time, in response to a signal or pre-determined conditions*. This includes customer equipment response and use of onsite/back-up generation. Ofgem uses the broader term 'flexibility' – which covers DSR, storage and interconnection[3]. The main source of flexibility historically has been generation.

2.3. Value of DSR to different market actors

DSR and flexibility are valuable to different actors in the GB electricity market including[4]:

- **Suppliers** – to manage imbalance (cash-out) risks and help their customers to reduce/shift electricity consumption off-peak on a daily basis to avoid high energy and network costs, particularly in winter.
- **Distribution and transmission networks** – to defer or avoid network reinforcement, support cheaper and timelier connections, and manage network issues. The value occurs at times of annual peak demand and in constrained parts of the network.
- **System Operator (SO)** – to balance the system on a second-by-second basis by procuring reserve and frequency services on a daily basis, year-round and to ensure sufficient capacity under the Electricity Market Reform capacity market. The SO is currently the largest contractor of DSR services.
- **Generators** – to balance their position before gate closure.
- **Aggregators and third parties** – to manage the delivery of DSR services on behalf of customers, often as part of an aggregated portfolio based on multiple customers.

2.4. Benefits of DSR and flexibility

The in-principle benefits of DSR and flexibility include:

- **Reducing costs and generating revenue for flexible customers**;
- **Reducing costs to consumers** overall – by:
  - Shifting energy usage to off-peak (avoided capital costs of peaking plants);
  - Optimising balancing of wholesale markets & maximizing generation output of zero cost generation e.g. wind; and,
  - Avoided capital cost for transmission and distribution network reinforcement/ upgrading, including through peak avoidance;
- **Security of supply** – more cost effective use of existing resources & renewable energy sources; and,
- **Carbon emissions** – maximizing use of intermittent renewable generation in the energy mix.

3. The Tempus Energy Business Model

The Tempus Energy business model is based on use of bespoke IT and load control systems. The Tempus Energy Smart Aggregation™ Manager (SAM™) system, aims to control automatically in response to market signals. In order to prove the SAM software, Tempus Energy set up as a fully licensed supplier on 26 March 2015.

[3] Ofgem (Sep 2015) *Making the electricity system more flexible and delivering the benefits for consumers*, www.ofgem.gov.uk/sites/default/files/docs/2015/09/flexibility_position_paper_final_0.pdf..
[4] Ofgem (Sep 2015) *Making the electricity system more flexible and delivering the benefits for consumers*, page 18, www.ofgem.gov.uk/sites/default/files/docs/2015/09/flexibility_position_paper_final_0.pdf..

Tempus Energy offers fixed, flat rate tariffs to both its domestic and business customers (including I&C and SME). Customers get a beneficial rate if they are willing and able to flex their demand. The flexibility hardware and software is provided as part of the contract, presently at no additional cost to customers.

Tempus Energy recently launched a new 'Sunshine Tariff' for domestic customers as part of a separate pilot project with the community of Wadebridge in SW England to increase consumption during hours of solar generation, working with Western Power Distribution (WPD). Customers do not need to have solar PV to participate.

Tempus Energy is electively half-hourly settling its flexible customers. It is using the SAM system to optimise the use of demand flex against wholesale market/imbalance prices and network charges.

4. Tempus Innovate UK Project

4.1. Project specifics

The Tempus / Innovate UK project is led by Tempus Energy and involves six trials with commercial customers and a further trial of battery storage.

The project aims to show that automated demand flexibility is achievable in customer premises today, that customers can enjoy lower bills from their flexibility by allowing others to control some of their load – and in turn – can help to create a more efficient energy system overall. The project will test systems end-to-end and seeks to demonstrate the value of demand flexibility in the 'real-life' GB electricity market context.

The project will demonstrate Tempus Energy's SAM™ system. This is an algorithm-driven technology platform that aims to shift real-time consumption patterns to optimise trading on the electricity market within each half hour, through prediction and customer consumption management, enabling more cost-effective power procurement.

Tempus Energy will use the SAM system to manage wholesale market/imbalance price risk and engage in peak avoidance to reduce network costs. In order to demonstrate the SAM™ system, Tempus Energy decided to set up as an electricity supplier, and has developed partnerships to connect SAM to customers. The delivery partners have expertise in: demand response, building management systems and storage.

The trial will focus on commercial customers (load profiles: 5-8 and electively half-hourly settled) – sites chosen for the trial are mainly in the food and hospitality industry, with one office building. The value of optimising the use of storage will also be trialled in the project either with a real customer or via a test-bed. Flexible response in the project is primarily provided through control of electricity consuming appliances such as heating ventilation and air conditioning (HVAC), refrigeration and cooking equipment.

Enabling equipment for metering, monitoring, and control systems have been installed in customer premises. Tempus Energy has been working with its delivery partners to develop software for communications and data transfer between: Tempus and the delivery partners; the delivery partners and customers; and Tempus and customers.

4.2. Partners

The partners for the project are:

Tempus Energy	Lead partner. Innovative electricity supplier that manages demand on a real time basis.
Wireless Energy Management Systems International (WEMS)	Provider of building management systems and associated energy and estate management services. Retrofitting energy management solutions into existing buildings using wireless monitoring and control technology.
One Sightsolutions	Building automation, energy management and cloud solutions. Provides products, programming and Building Management System (BMS) integration services related to Heating Ventilation and Air Conditioning (HVAC).
Viriya	Electrical energy storage systems and services company.
Sustainability First	An environmental think-thank and charity that undertakes research, publishes papers and organises workshops with a strong focus on regulation and policy for the energy demand-side. Led significant 3-year programme of work on the GB Electricity Demand Side[5].

4.3. Deliverables

Year 1 – build end-to-end communications systems, set up customer trials, test demand-side response, including:

- **Detailed technical plan** – design of 'ecosystem' architecture.
- **Technical design and integration** – software to enable load optimisation, with consideration of time (e.g. scheduling) and environmental (e.g. temperature) set points. Database design, development and coding.
- **Flexibility development in partner software** – ensure software developed above operates with delivery partner systems. Testing and code development.
- **Mathematical Optimization to model Automatic Demand Response (ADR) types for optimal flexibility –** mathematical modelling, coding and testing to understand optimal application of demand response signals for realising flexibility.
- **Testing flexibility and optimisation –** ADR integration and testing. Technical and commercial optimisation model for flexibility. Install monitoring and control equipment on early sites.

Year 2 – customer trials and evaluation, including:

- **Trials with customers** – customer engagement, installation of monitoring and control equipment at customer premises, testing and evaluation, before/after monitoring.
- **Final report** – evaluating success, commercials and data analysis
- **Final report on wider policy/regulatory recommendations –** including project partner and customer interviews.

[5] The 13 papers and summary of Sustainability First's GB Electricity Demand project can be found at: www.sustainabilityfirst.org.uk/index.php/gb-elec-demand-publications.

5. Lessons learned during project set-up

This section considers the successes, challenges and lessons learned during project set up, covering:

- Customer proposition and trial recruitment;
- Site survey and technology installation;
- Communications software for flexible response; and
- Working in partnership/project delivery.

5.1. Customer proposition and trial recruitment

The customer proposition is a cheaper retail tariff rate for allowing flexible load control. Tempus Energy offers commercial customers a beneficial rate if they can provide flexible response. All tariffs are on a flat p/kWh basis.

Tempus Energy led customer recruitment for the project and successfully identified the six target commercial sites for the trial, either directly – using existing contacts and relationships – or via brokers. Customers were attracted to working with Tempus Energy, and as part of the trial, primarily due to the competitive price and some were also interested in the innovative model.

Challenges to recruitment included a lack of customer understanding of how their electricity demand could become flexible and therefore result in a lower bill. Customers were cautious about the flexibility element affecting their business-as-usual operations. Tempus Energy had to work closely with customers to build their confidence in remote management of their equipment for flexibility.

For customers recruited via brokers (the primary method for these sorts of commercial customers), the brokers often failed to explain and/or the customer may not fully understand the requirements of Tempus Energy for flexibility, and it was not generally possible for Tempus Energy to discuss contract terms directly with customers prior to contract signing.

Due to limited commercial development of electricity storage to date, it has been challenging to identify and recruit large-scale storage units for the trial. The decision was made to focus on small-scale storage. One site has now been potentially identified.

Lessons/recommendations:

- A clear, full and upfront explanation of the supplier (i.e. Tempus Energy) offer is needed – including flexibility requirement from the customer.
- Current disproportionate costs of elective half-hourly settlement for households & SMEs need to be addressed.
- Commercial barriers for storage need to be addressed. For the trial, part subsidy of storage assets may be required.

5.2. Site surveys and technology installation

Site surveys were carried out jointly by Tempus Energy and one of the delivery partners (WEMS/One sightsolutions/Viriya). The following equipment was required for the trials and installed on sites as appropriate:

- **Main controller** used to communicate with Tempus Energy and assets on site;
- **Advanced/smart meters or secondary devices** for monitoring electricity consumption at 60 second intervals;
- **Monitoring equipment** for temperature (e.g. space, A/C, hot/cold water, fridges and cold room) and humidity; and
- **Interfaces / switches for control –** Integrated control (e.g. A/C or HVAC) or control via switches (e.g. relay / contactor or smart plugs).

For customers with existing **Building Management Systems**, it was necessary to develop new/additional software for remote monitoring, signalling and control of assets. **Figure 1** shows the interaction of new and existing enabling systems and equipment for flexible response.

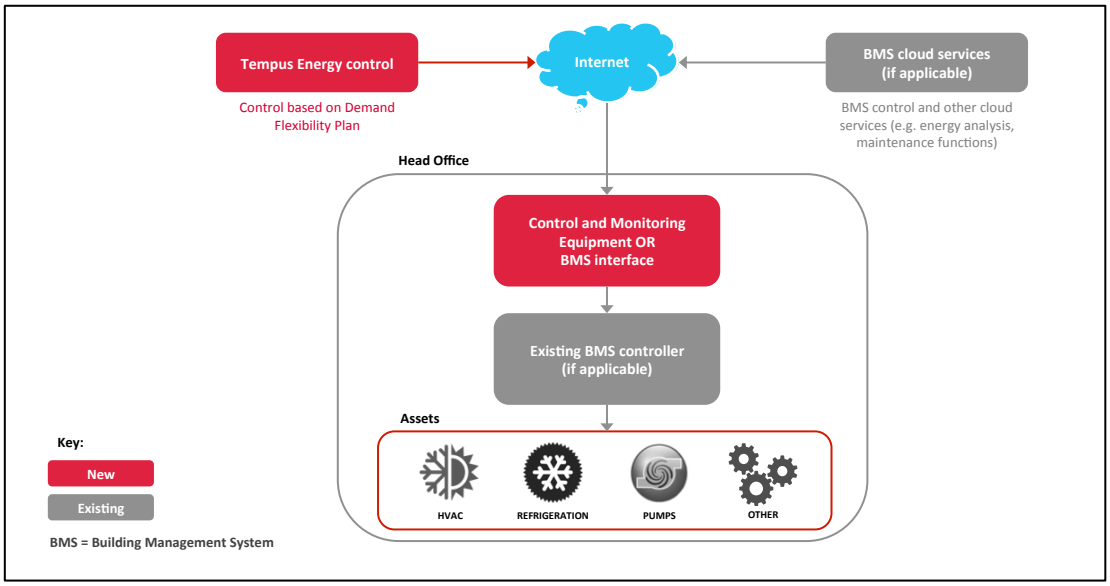


Figure 1: Tempus' system interacts with new and/or existing technology at the customer site.

Installations themselves ran smoothly without inconvenience to the customer. The systems required for flexible response are now in place and any issues with the equipment will be flagged remotely. It has helped that WEMS and One Sight were able to use equipment that they are already familiar with. Viriya has worked directly with storage manufacturers, project developers and Tempus end customers to find potential storage units to include in the trial.

The main challenges were that: it took multiple site visits to convince the client and/or their system integrator of no disruption to operations; installations often had to be undertaken outside of business hours to avoid disruption; their were some site specific issues (e.g. power switched off to change meter, intrusive wiring requirements, locational access issues in central London); and there have been delays to IT communications setup due to customer permissions / security, including for existing BMS systems.

Lessons:

- Helpful to pre-trial technologies on small scale before wider roll out.
- Critical to understand business operations of each customer and minimize potential for disruption during the survey, installation and operation of equipment.
- Early discussion needed with customers about the IT communications requirements and security / permissions.

5.3. Communications software to enable flexible response

A major part of the project has been the design of the Application Programming Interface (API) for data transfer between Tempus and WEMS / One Sightsolutions / Viriya. The API has been designed to enable different types of demand-side response providers to participate. The focus to date has been on testing, modelling, demand forecasting, optimisation and the interface between the API and cloud services.

The API software has been successfully developed, and has undergone repeated testing and monitoring to ensure there are no errors. Site monitoring and data analysis has enabled delivery partners to understand usage patterns and identify potential for flexible response.

There were a few early issues with the technical specification for the API but these have been resolved. The main challenge has been ascertaining what loads customers are prepared to flex and ensuring switching does not interfere with BAU operations.

Custom logic was written to deploy on site, including to enable monitoring and control through existing BMS systems. There have been challenges linking to existing BMS systems due to third party management. Some troubleshooting has been required to set up IT communications on sites – in particular, security permissions have made it difficult to set up the signal for DSR events on some sites.

For storage assets, a key focus will be on the potential impacts on storage cells of responding to flexibility signals.

Lessons:

- Need to make technical requirements between parties clear from the outset.
- Importance of thorough pre-testing of system end-to-end before trialling with business customers.
- Communications / IT security permissions important.
- Enabling DSR communication via existing modern BMS systems is achievable, it is more costly and time consuming on older BMS systems, but still possible.
- Coding to allow DSR may be bespoke for different control systems – potential issue of scalability.
- Work with manufacturers to optimise performance of assets for flexibility (e.g. storage cells).

5.4. Working in partnership / project delivery

Considerable time was spent upfront on the collaboration agreement between the partners to ensure that issues of intellectual property and liabilities were addressed, and all parties were comfortable with their roles and responsibilities.

The project has been effectively managed by Tempus. All milestones have been achieved on time. Overall the project is on track and is currently running slightly below budget. Staffing costs have been lower than expected, however installation costs have been higher.

The software development has progressed well. The partners are also confident that most site installations will be achieved and ready for the flexibility trials to begin in Q5 (1 May 2016 - 31July 2016).

Innovate UK has been supportive throughout the project, with a dedicated officer to participate in meetings and monitor progress. The IUK process is rigorous with clearly defined guidelines for assessing project progress. Changes to the project deliverables, timetable and budget, need full justification. These factors are to some extent inevitable when trying to track progress and funding in any grant aided innovation project.

6. Policy and regulatory considerations for a smart business model

Tempus Energy is in the vanguard of developing a smart supplier business model and there are many current policies in development – of which some will be critical to the IUK / Tempus project and other similar projects being able to develop at scale.

This section covers recent regulatory and policy developments of relevance to the project, similar business models and questions around implementation at scale, including supportive policies and regulations and issues to be addressed.

6.1. Overview of recent regulatory and policy developments

- **DECC** – Amber Rudd's reset speech[6] highlighted the importance of smart energy. The Smart Energy System paper[7] set out DECCs programme of work including a focus on household DSR. The Energy Bill[8] includes powers to enable a timely move to half-hourly settlement. Upcoming call for evidence on a Smart System.
- **Ofgem** – Flexibility paper[9] and workstreams including: Distribution System Operator (DSO) role; aggregator role; legal and commercial status of storage; support I&C participation in flexibility; EU discussions on future distribution charges. Cash-out reform. Letter setting out ambition to enable elective half-hourly settlement for households and SMEs (load profiles 1-4) by early 2017, with decision on introduction of mandatory half-hourly settlement in first half of 2018, collaborative work with DECC[10]. Ofgem's latest position is now set out in their 2016-17 forward work programme[11]
- **Smart grid forum –** Workstream six report[12].
- **National Grid** – Power Responsive campaign[13] to raise I&C customer awareness and participation in DSR schemes. Development of new products: demand turn-up, Enhanced Frequency Reserve.
- **Competition and Markets Authority (CMA)** – call for half-hourly settlement pathway to be clarified and to investigate the case/costs for mandatory half-hourly settlement[14]. Recommendation to withdraw the simpler choices component of Retail Market Reform (RMR).
- **National Infrastructure Commission Report[15]** smart power and storage**.**
- **Energy and Climate Change Select Committee (ECC) reports** – investor confidence in the UK energy sector and[16] pre-legislative scrutiny of Government's draft legislation on energy[17].

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[6] DECC (Nov 2015) *Amber Rudd's speech on a new direction for UK energy policy*, www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy.
[7] DECC (Dec 2015) *Towards a Smart Energy System*, www.gov.uk/government/uploads/system/uploads/attachment_data/file/486362/Towards_a_smart_energy_system.pdf
[8] DECC (March 2016) *Energy Bill 2016*, http://services.parliament.uk/bills/2015-16/energy.html.
Ofgem (Dec 2015) *Half-hourly settlement: the way forward*, open letter, www.ofgem.gov.uk/publications-and-updates/half-hourly-settlement-way-forward.
[9] Ofgem (Sep 2015) *Making the electricity system more flexible and delivering the benefits for consumers*, www.ofgem.gov.uk/sites/default/files/docs/2015/09/flexibility_position_paper_final_0.pdf.
[10] Ofgem (Dec 2015) *Half-hourly settlement: the way forward*, open letter, www.ofgem.gov.uk/publications-and-updates/half-hourly-settlement-way-forward.
[11] Ofgem (Mar 2016) *Forward Work Programme 2016-17*, www.ofgem.gov.uk/publications-and-updates/forward-work-programme-2016-17
[12] Smart Grid Forum - Workstream Six (2015) *The customer-focused smart grid: Next steps for regulatory policy and commercial issues in GB*, www.ofgem.gov.uk/sites/default/files/docs/ws6_final_report.pdf.
[13] www.powerresponsive.com
[14] Competition and Markets Authority (CMA) (March 2016) *Energy Market Investigation – Provisional decision on remedies*, www.gov.uk/cma-cases/energy-market-investigation.
[15] National Infrastructure Commission (March 2016) *Smart Power*, www.gov.uk/government/uploads/system/uploads/attachment_data/file/505218/IC_Energy_Report_web.pdf.
[16] House of Commons Energy and Climate Change Committee (Feb 2016) *Investor confidence in the UK energy sector*, Third Report of Session 2015–16 www.publications.parliament.uk/pa/cm201516/cmselect/cmenergy/542/542.pdf.
[17] House of Commons Energy and Climate Change Committee (May 2016) *Pre-legislative scrutiny of Government's draft legislation on energy* www.publications.parliament.uk/pa/cm201516/cmselect/cmenergy/776/776.pdf

6.2. Supportive policies and regulations

- **Smart meter implementation**[18] – Replacing existing meters with smart electricity meters (26 million) and gas meters (22 million) in homes. Smart/advanced meters in ~30 million smaller non-domestic premises. Development of the smart meter code of practice[19]. The CMA has pressed the importance of meeting the end date for smart meter rollout of 2020. Smart grid vision and roadmap.[20]
- **Half-hourly settlement** – Mandatory half-hourly settlement for large commercial customers (load profiles 5-8) through BSC code modification P272 by April 2017[21]. Ofgem intention to make elective half-hourly settlement easier/more attractive. Potential mandatory half-hourly settlement for households and SMEs.
- **Capacity crunch –** 2016-17 and 2017-18. As conventional generation closes, including as a result of EU directives, there is a greater opportunity for the demand-side to provide much needed flexibility.
- **Imbalance signals** – single and more cost reflective cash-out price to provide a sharper signal for imbalance.
- **DSR markets** – e.g. new National Grid Balancing products for demand turn up and Enhanced Frequency Reserve. Changes to existing schemes to enable participation of actors with smaller clip sizes (e.g. STOR runway).
- **Demand Side Balancing Reserve (DSBR)** – timescales to be extended.
- **Capacity market (CM)** – seen two fold increase in demand-side participation from the first (263 MW) to second round (~500MW) of the T-4 auction, but still a small proportion overall. Transitional auction 475MW of unproven DSR capacity contracted.
- **DNO flexibility** – now looking at location specific flexibility as they move from innovation trials to BAU.

As a result, we are seeing increased interest in DSR from different market actors including offers from suppliers/aggregators, networks and SO[22].

[18] DECC (Dec 2014) *Smart Metering Implementation Programme*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384190/smip_smart_metering_annual_report_2014.pdf.
[19] Energy UK (Aug 2015) *Smart Metering Installation Code of Practice (SMICoP),* www.energy-uk.org.uk/publication.html?task=file.download&id=5040.
[20] DECC and Ofgem (Feb 2014) *Smart Grid vision and roadmap*, www.gov.uk/government/uploads/system/uploads/attachment_data/file/285417/Smart_Grid_Vision_and_RoutemapFINAL.pdf.
[21] Ofgem (June 2015) *Ofgem response to the BSC Panel's second request for an extension to the Implementation Date of BSC Modification P272* https://www.ofgem.gov.uk/publications-and-updates/ofgem-response-bsc-panel-s-second-request-extension-implementation-date-bsc-modification-p27
[22] National Grid (April 2016) *Power Responsive: Demand-Side Response (DSR) market snapshot*, www.powerresponsive.com.

6.3. Issues for consideration

Below are some of the issues and challenges that have emerged of relevance the project.

Aggregator and third party access to wholesale market	Challenge of operating as an aggregator / third party without being a signatory to the Balancing and Settlement Code. Hence Tempus Energy had to set up as an electricity supplier to: prove the innovative SAM™ system; trade on the wholesale market; and benefit from half-hourly settling customers.
Demand-side competing against supply-side under schemes	Recent SBR auction to procure generation capacity, but no auction for DSBR, demand-side capacity at the same time. Current capacity market competition with new diesel farms.
Elective half-hourly settlement	Tempus Energy has found the costs of electively settling household and SME customers unduly high, because: Metering operator (MOPs) charges are designed for I&C market, so disproportionate for small customers / low volumes. MOPs also concerned about type of meter required. There is not enough competition in the MOP market to drive costs down. Elexon charges are high to settle half-hourly customers on actuals, in particular due to requirements for posting collateral. Costs also high for DCDA (Data Collector Data Aggregator) - data flow between meter and Elexon. The rules are complex with extensive checks to validate data. While accurate billing is necessary for large sites, this is less critical for smaller sites.
Mandatory half-hourly settlement	Benefits of mandatory half-hourly settlement include: potential for greater competition, tariff innovation, supplier volumes reflect their actual half hourly consumption, more accurate supplier forecasting and faster settlement process[23]. Main challenge for end customers on Time of Use Tariffs is that inflexible and peaky profiles would have higher bills.
Cost-reflective pricing	Tempus Energy is not offering Time of Use tariffs. But the move to smart meters will make it easier to relate a customer's usage to actual wholesale prices at a particular time, and half-hourly settlement will encourage suppliers to make tariffs more cost reflective[24].
BMS / Common operating standards	Demand-side response and flexibility can be enabled through existing Building Energy Management Systems (BMS), but it will be critical to consider the role of

[23] Cornwall Energy (Feb 2016) *Treasure Island – the search for half hourly settlement for smaller customers*, Energy Spectrum, Issue 509.
[24] Sustainability First (Mar 2016) *Smarter, fairer? A discussion paper on cost-reflectivity and socialization of costs in domestic electricity prices*, http://www.sustainabilityfirst.org.uk/index.php/project-archive/discussion-papers.

	common operating standards and technical language in the UK and internationally.
Barriers to commercialisation of electricity storage	Licensing & classification of storage. Large-scale storage is treated as a subset of generation, which impacts on questions around ownership and operation. Large-scale storage should be defined as a distinct activity, included in the licencing framework with an exemption for small-scale storage[25]. Storage is treated as end consumption under the Climate Change Levy (CCL), Renewable Obligation (RO), Contract for Difference (CfD) Feed in Tariff (FIT), small scale FIT – and this treatment creates a cost/disincentive with regard to trading with storage. Under connection and distribution charging agreements, storage attracts capacity charges and headroom assessment for both import and export. HMRC approaches to Enterprise Allowances may also be problematic for large-scale storage.

7. Key policy and regulatory developments

The key policy and regulatory issues of importance to the development of smarter supplier business models are:

- Ofgem consideration of aggregator/third party access to wholesale markets as part of their work on the role of aggregators.
- DECC/National Grid ensure demand-side and generation treated equally in schemes for balancing and capacity.
- Ofgem/Elexon early focus on removing barriers to elective half-hourly settlement.
- DECC/Ofgem consideration of the role of BMS systems in enabling commercial customer DSR and common UK/international standards.
- DECC/Ofgem classify storage as a distinct activity, rather than generation, and ensure fair treatment under renewable incentive schemes and network connection and charging arrangements.

[25] UK Power Networks and Poyry (Oct 2015) Electricity Storage in GB: Smarter Network Storage 4.7 Recommendations for regulatory and legal framework, http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/.

8. Acronyms

ADFS	Automated Demand Flexibility System
ADR	Automatic Demand Response
API	Application Programming Interface
BMS	Building Management System
BSC	Balancing and Settlement Code
CM	Capacity Market
CMA	Competition and Markets Authority
DCC	Data Communications Company
DCDA	Data Collector Data Aggregator
DE	Distributed Energy
DECC	Department of Energy and Climate Change
DNO	Distribution Network Operator
DSBR	Demand Side Balancing Reserve
DSO	Distribution System Operator
DSR	Demand Side Response
DUOS	Distribution Use of System
ECC	Energy and Climate Change (Committee)
EMR	Electricity Market Reform
EFR	Enhanced Frequency Reserve
HVAC	Heating Ventilation and Air Conditioning
I&C	Industrial and Commercial
LCNF	Low Carbon Network Fund
MOPs	Metering operator
Ofgem	Office for Gas and Electricity Markets
PV	Photovoltaic
RMR	Retail Market Reform
SAM	Smart Aggregation Manager
SBR	Supplementary Balancing Reserve
SCR	Significant Code Review
SME	Small and Medium Sized Enterprise
SMETS	Smart Metering Equipment Technical Specifications
SNS	Smarter Network Storage
SO	System Operator
SRAG	Settlement Reform Advisory Group
STOR	Short Term Operating Reserve
ToU	Time of Use
WPD	Western Power Distribution
WEMS	Wireless Energy Management Systems International