The Institution of Engineering and Technology

CATAPULT Energy Systems

Future Power System Architecture Project 2

Work Package 1A Final Report - Insights into requirements of existing and new parties

A report commissioned by Innovate UK and delivered through a collaboration between the Institution of Engineering and Technology and the Energy Systems Catapult.

FUTURE POWER SYSTEM ARCHITECTURE

MEETING BRITAIN'S FUTURE POWER SYSTEM CHALLENGES

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Future Power System Architecture Project 2

Final Report

Work Package 1A:

Insights into requirements of existing and new parties

Future Power System Architecture – A report commissioned by Innovate UK

The Future Power System Architecture (FPSA) project 2 was commissioned by Innovate UK and delivered through a collaboration between the Institution of Engineering and Technology (IET) and the Energy Systems Catapult.

The collaboration built upon the shared commitment to responding effectively to the challenges presented by the energy trilemma: decarbonisation, security of supply and affordability. The Energy Systems Catapult and the IET drew upon their respective strengths and engaged with a broad community of stakeholders and other experts to deliver the project.

The collaboration brought extensive expertise and experience to the project, combining technical, commercial and customer perspectives, and included the significant contribution of senior thought leaders from the IET membership. The unique combination of complementary skills enabled innovation in approach, deep analysis and strong evidence building. The collaboration worked closely on project governance, delivery and commercial management and applied best practice in all aspects of its work. The position of the IET and the Energy Systems Catapult in the energy sector assured independence of the outcomes.

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The Institution of Engineering and Technology is one of the world's largest engineering institutions with over 167,000 members in 127 countries. It is also the most multidisciplinary – to reflect the increasingly diverse nature of engineering in the 21st century.

The IET is working to engineer a better world by inspiring, informing and influencing its members, engineers and technicians, and all those who are touched by, or touch, the work of engineers. The Institution of Engineering and Technology is registered as a Charity in England and Wales (No. 211014) and Scotland (No. SCO38698).

About the Energy Systems Catapult

The Energy Systems Catapult is the UK's technology and innovation centre set up to support companies and Government for the development of new products and services to address the new commercial opportunities created by the transformation of UK and global energy systems (covering electricity, heat and combustible gases).

The Catapult's mission is to bring the worlds of industry, academia and Government together to encourage and support the development of new technology-based products and services in the energy sector. It is a non-profit, non-partisan company limited by guarantee.

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Executive Summary

Engagement Methods

WP1A engaged with a range of stakeholders to provide evidence on the requirements of existing and new parties. Three methods of primary research were used:

1. An online consumer survey with a pre-existing panel of 1,000 domestic consumers, resulting in a 48% return rate.
2. 32 telephone interviews with commercial and public sector stakeholders.
3. A stakeholder workshop towards the end of the project with 11 of the commercial and public sector stakeholders to review consolidated findings with interviewees.

The stakeholder interview programme included the following elements:

- 14 groups of commercial and public sector stakeholders were defined, and representatives of each group were successfully engaged. This included established power sector players, market players operating non-traditional business models, local authorities, community energy schemes, smart city developers and a range of others.
- Interview and survey questions were developed with input from all Work Packages, and the interview questions refined, to reduce complexity, as a result of learning from initial interviews early in the project.
- A distinction was created, during the project, between Discovery Interviews to gather a wide range of views and insights, and Focused Interviews conducted with representatives from other FPSA2 Work Packages to allow more targeted questioning around specific issues of importance.
- The issues identified by the interviews were analysed to determine their root causes, and the extent to which these root causes are expected to be addressed by the FPSA functions, drawing on interview findings, consultant expertise, additional desk-based research and discussion with other Work Packages.

Consumer Survey

The analysis of the 480 consumer survey responses shows:

- High interest in the visions for future home energy systems that included solar PV and even higher interest for solar PV with energy storage. In general, there was an appetite for the transition to smarter energy systems in homes.
- Awareness and use of many examples of new energy systems was high, including smart meters, solar PV and smart heating systems. In contrast, a no cost measure, switching to a green electricity tariff, had the lowest levels of awareness.
- Levels of interest in getting new energy systems were in general lower than awareness levels. However, consistent with the level of awareness, the level of interest in getting a smart meter is highest. The next highest interest is for a green electricity tariff, higher than the level of awareness. Two new energy systems had lower levels of interest: electric vehicles (EVs) and smart heating systems.
- Interest in options for electricity energy supply showed high interest in the lower cost option and in supply from a local authority not-for-profit supplier.

We conclude from the survey that consumers already have a high awareness in many of the solutions that are likely to be part of a smart and flexible GB energy system.

Stakeholder Interviews

A total of 154 requirements or obstacles were identified from the 32 interviews that were held with commercial and public sector stakeholders. For each of these 154 issues a root cause was identified, for each root cause the relevant FPSA functions were recorded.

For each issue a classification was assigned, see the table above. This classification process showed that 118 or 77% of the requirements or obstacles were addressed by the FPSA functions. One further issue would be addressed with some clarification.

Yes, or qualified Yes, as might be clearer in description	**Details might be more explicit in full function description and implementation**	**118 (77%)**
In scope - but none of the functions has a relevant explicit or implicit reference to the need or barrier	**New or changed function? Or covered by a different mechanism?**	**6 (4%)**
Pre-requisite for many functions	**Not in scope for FPSA but implementation of FPSA functions and achievement of FPSA vision would be supported if this is in place – e.g. environmental performance or safety.**	**10 (6%)**
Not in scope for FPSA	**Not in scope for FPSA, for example, innovation.**	**20 (13%)**

Six requirements or obstacles were in scope but were not covered by the FPSA functions. All six of these concern governance. These could be addressed through the enabling functions, the processes for developing and implementing FPSA functions that has been developed by Work Package 4 (WP4).

Ten requirements or obstacles were classified as pre-requisites, e.g. skills or environmental compliance. A further 20 requirements or obstacles were classified as being outwith the scope of FPSA, e.g. innovation, or were very specific issues that applied to a specific stakeholder.

In undertaking this analysis it was noted that the descriptions of each function are brief – this has a number of important advantages when presenting the details of *thirty-five* functions to stakeholders. However the brevity of the functions does not allow a wider understanding of the context, purpose and scope of FPSA and each of the functions to be conveyed.

So, when reviewing the requirements and obstacles there were many examples where it was obvious that the function description matched the requirements and obstacles – from the summary description alone. In some cases the full details of the function in the FPSA1 report needed to be examined, in others a full search of the entire FPSA1 report was needed.

Several important details only became apparent during discussions with other members of the FPSA2 team, or as part of the final review of the findings in the draft report. For example, the term “power sector” is used in several functions. When the descriptions were produced it was agreed that the term “power sector” includes all customers. However, this term would commonly be applied to traditional industry players. Using the FPSA definition of this term means there is much greater clarity how the functions address the requirements and obstacles.

Hence to increase understanding of the FPSA functions there is an important requirement to provide a concise explanation of what is in the scope of FPSA and what is not in the scope of the FPSA programme.

Final Points

The stakeholder interviews show that three quarters of the requirements and obstacles raised were directly addressed by the FPSA functions, and that the remaining examples could be addressed by other means, e.g. through *Enabling Frameworks*, through clarification of the scope of the FPSA functions or by defining the pre-requisites that are outwith FPSA but are necessary for the success of the FPSA functions.

There were some examples of requirements and obstacles that occurred more often, being mentioned by several interviewees. Whilst the sample is not sufficient to claim statistical significance, these issues included:

- The most common issue attracting comment was the need for a level playing field in markets. This was expressed in two ways: firstly in terms of access for all scales of system and all types of participant.
- Connection issues were the second most common issue raised. Only one FPSA function directly addresses connection – but this is a key issue for stakeholders.
- Access to information was raised almost as often as connection. Both DNOs and market players saw a need for sharing greater information on the assets connected to distribution networks and sharing the data on system operation.
- Decision-making on the codes and regulations that govern the power sector was a key obstacle for several stakeholders. This included the institutional inertia in current systems, given that the incumbent players have most of the apparent power in the relevant groups that determine what changes are made.
- Finally, the consumer survey shows an interest in the innovative and smart systems that are the vision behind the FPSA functions as well as being at the heart of the *Gone Green* scenario. The business ideas and innovations being developed by several of the stakeholders will help implement this vision. However there were several notes of caution, in particular over the real level of take-up by consumers. Points made included the high level of financial incentive needed to create interest in DSR amongst domestic consumers.

  The need to make these market propositions easy for consumers to understand and use was also made. In conclusion, there was optimism from many stakeholders, but also balancing caution from others. As the cautious view was based on past experience of DSR trials, this is the more important evidence, underlining the need to strive to engage consumers and to minimise the obstacles to their participation.

1. Introduction

An essential input to FPSA2 is the views, experiences, requirements and aspirations of key power sector stakeholders. The FPSA Steering Group has been brought together to provide insight into the requirements[1] and aspirations of established stakeholders such as System and Network Operators and traditional suppliers. The Steering Group has access to relevant representatives from this narrow group of stakeholders to confirm and/or reinforce these insights, as necessary.

The focus for WP1A is to gather the views of existing stakeholders, with a focus on stakeholders whose activities are beyond the meter. The aim is to broaden the stakeholder set from FPSA1, and engage with the widest range of current and future stakeholders and/or parties directly or indirectly representing them.

A second strand (WP1B) is seeking research insights into the likely requirements of future stakeholders.

1.1 Methodology

There are three main elements to WP1A:

1. The consumer survey – an online survey of 1,000 domestic consumers.
2. The stakeholder interviews – phone interviews with selected stakeholders spanning a wide range of groups, from local authorities and smart city developers, to developers of demand side reduction and renewable energy solutions.
3. The stakeholder workshop – to validate the findings from the stakeholder interviews.

Ricardo Energy & Environment led WP1A, with Delta-ee organising the consumer survey. The two main sections in this report describe:

1. The consumer survey.
2. The stakeholder interviews and stakeholder workshop.

[1]In discussions with stakeholders, the language used was “needs” and “barriers”. However WPs 2, 3 and 4 have used these terms to mean specific attributes of the *thirty-five* FPSA functions. Therefore to avoid confusion the terms “requirements” and “obstacles” have been used in this report to characterise those aspects of stakeholder interactions.

2. Consumer Survey

2.1 Introduction to the consumer survey

The specification for WP1A includes electricity consumers as one of the key stakeholder groups to be covered. The proposal for WP1A highlights that a different approach is needed for this group, using an online survey rather than one-to-one phone interviews.

Delta-ee have established their own panel of homeowners for their research into the energy opportunities in the owner-occupier market. This panel allows surveys to fully explore customer attitudes towards energy in general, and to gain a deeper understanding of the decision-making process for changes in domestic energy systems.

A panel of 1,000 members were surveyed, testing interests and stakeholder identified obstacles related to the adoption of new energy solutions.

2.2 Consumer survey process

For the WP1A consumer survey, a questionnaire process was developed with the following elements:

- Development of a 10 to 15 minute long questionnaire; budgeting for 29 questions at around 30 seconds per question. The survey was developed using suggestions from WP2, WP3 and WP4. The questions are listed in Annex 1.
- Running a questionnaire inviting all 1,000 members on the panel to respond.
- Using past data profiles for the respondents to segment the responses (e.g. on gas vs. off gas; urban vs. rural, differences etc.).
- Production of data in Excel format for production of tables and charts for the report, using the entire sample of responses and segmented responses.

The questionnaire is included as Annex 1.

2.3 Consumer survey – characteristics of respondents

A total of 495 responses were received. Responses were reviewed to remove any returns that were deemed as spoilt papers – e.g. where all of the options in the same columns were selected. This reduced the survey to 480 responses. This level

of response is a statistically significant and robust sample size from the 1,000 consumers on the database.

The characteristics of the sample of 480 respondents include:

All survey panel members are owner-occupiers, which means that they have control over decisions on energy, rather than householders in rented accommodation where the landlord would make decisions on investments in energy systems.

In terms of location the respondents are fairly evenly split between rural, semi-rural and urban locations (Table 1).

In terms of the heating system used in their homes, boilers using fossil fuel dominate, in line with the wider population (Table 2).

In socio-economic terms the sample of respondents has a higher proportion in the AB and C1 groups. As all members of the survey panel are owner-occupiers, the economic grouping is consistent with home ownership (Table 3).

The age profile of the respondents is also consistent with home ownership, with no respondents in the youngest band. Three age groups account for 87% of the respondents: 35-49, 50-64 and 65-75, with 50-64 being the largest group (Table 4).

2.4 Consumer survey results

The survey covered a number of topics including:

- Changing electricity supplier.
- Vision for energy systems in the home.
- Awareness of smart energy measures.
- Options for electricity supply.

The sections below detail the questions asked in each area, and the results from the participants.

2.4.1 Change electricity supplier

We asked: "When did you last change electricity supplier?". This was intended as a simple measure of how active the respondents were in managing their electricity costs. All respondents will have an electricity supplier, so providing a 100% response

Table 1: Profile of respondents – by location

Location	% Respondents
Rural	30%
Semi-rural	37%
Urban	33%

Table 2: Profile of respondents – by heating type

Heating Type	% Respondents
Electric	7%
Boiler (gas, oil or LPG)	88%
Fireplace	2%
District Heating	0%
Other	2%
None	1%

Table 3: Profile of respondents – by socio-economic group

Socio-economic Group	Chief income earner's occupation	% Respondents
AB	Higher and intermediate managerial, administrative or professional	48%
C1	Supervisory or clerical and junior managerial, administrative or professional	38%
C2	Skilled manual workers	14%

Table 4: Profile of respondents – by age

Age	% Respondents
16-24	0%
25-34	5%
35-49	20%
50-64	42%
65-75	25%
Over 75	7%

rate. Changing electricity supplier is an option open to all households, unlike measures to install energy systems.

In this survey, 50% of respondents had changed supplier within the last two years (see Figure 1). The 2016 CMA investigation found that 70% of domestic customers of the six largest energy firms are still on an expensive 'default' standard variable tariff. So the WP1A respondents are more active in switching supplier, using the simplest of measures to manage their electricity costs.

The data set for the respondents includes data fields on their profile (socio-economic, type of location, etc.). This allows for segmentation of the survey results by respondent profile. Figure 2 shows the survey results on changes in electricity supplier by socio-economic group – a measure of any sensitivity to energy price issues. In these cases the percentages are the percent in each group, as there are different numbers of respondents in each socio-economic group.

Figure 2 shows that the response is broadly similar across the three socio-economic groups (AB, C1 and C2); the differences are never more than 5% higher or lower. So the results from the survey are probably not strongly influenced by socio-economic group.

2.4.2 Vision for energy systems in the home

This group of survey questions asked about the respondents' vision for the energy system that they might have in their homes in the future.

Figure 1: Responses to "When did you last change electricity supplier?"

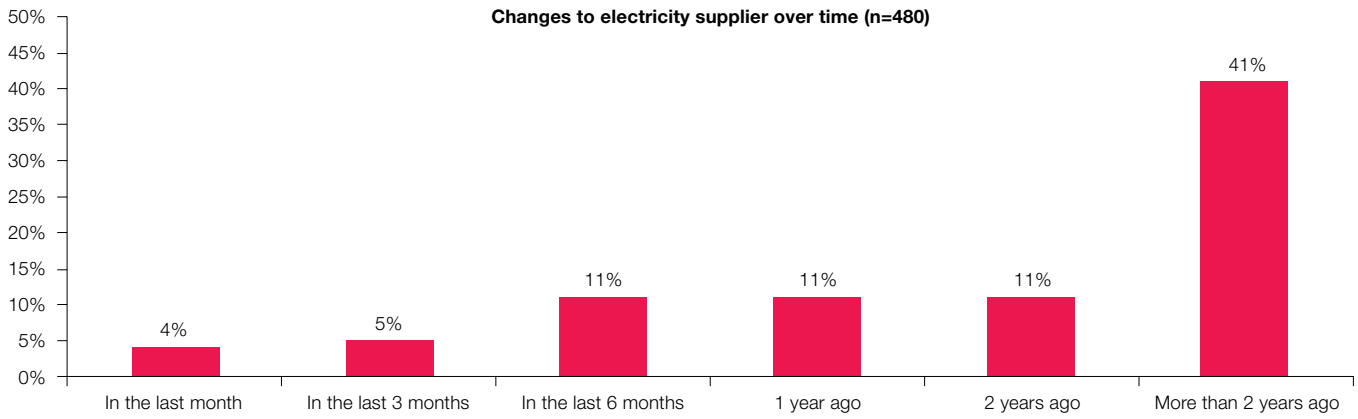
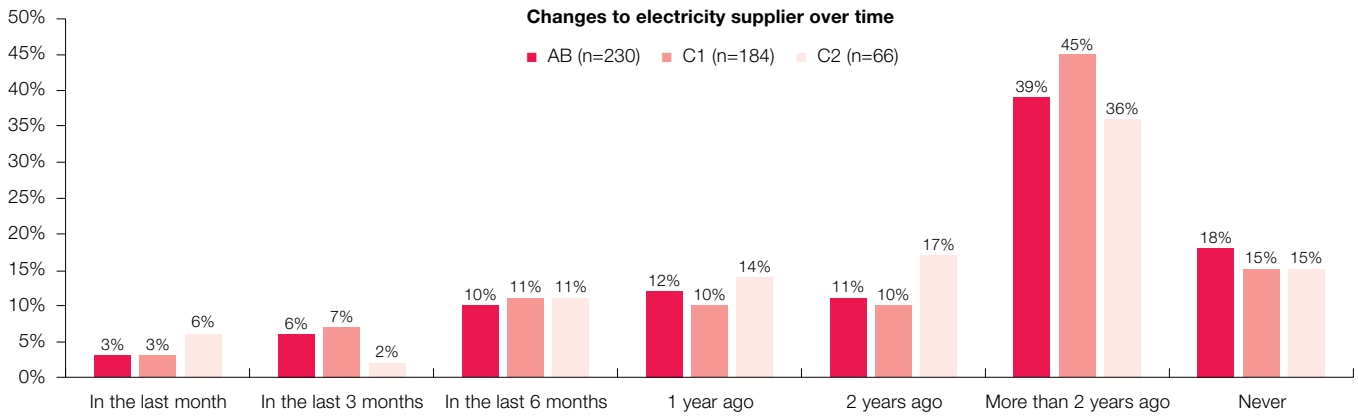


Figure 2: Responses to "When did you last change electricity supplier?" – by socio-economic group



The questions described four different visions and the respondents were asked if they would like to see this in their home. The questions and the responses are shown in Figure 3.

The first and simplest vision is on energy self-sufficiency, which gained a high share of agreement - 67% agreed or strongly agreed.

The next vision included energy storage along with solar PV, which gained an even higher agreement - 80% agreed or strongly agreed.

The third vision included switching off appliances to match the output of the solar system, where levels of agreement were lower – 43% agreed or strongly agreed.

The final vision included charging a future electric car from the solar PV system, which gained a similar level of agreement to the first view – 64% agreed or strongly agreed.

In general there is a high level agreement for all four visions – suggesting an appetite for the transition to smarter energy systems in homes.

2.4.3 Awareness of smart energy measures

A series of questions asked for the respondents' awareness of different types of energy measure in their home. In total seven different options were covered. Each option was described and a photo was provided to help clarify the type of measure that was being described. The results in Figure 4 show a wide range of levels of awareness.

Figure 3: Responses to visions of electricity at home in the future

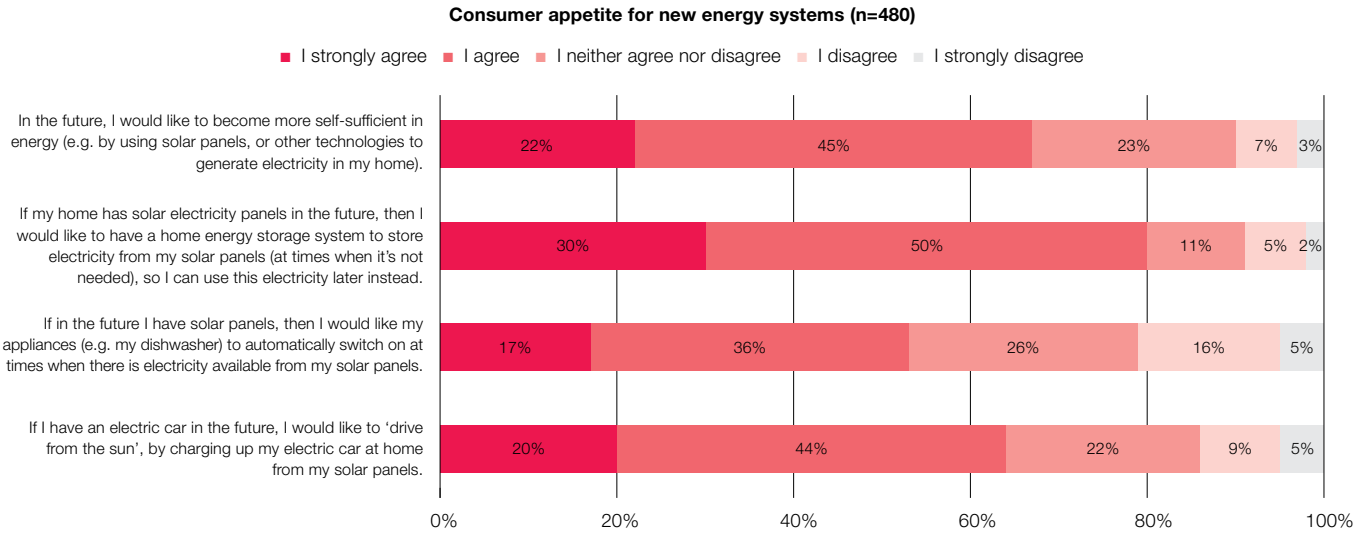
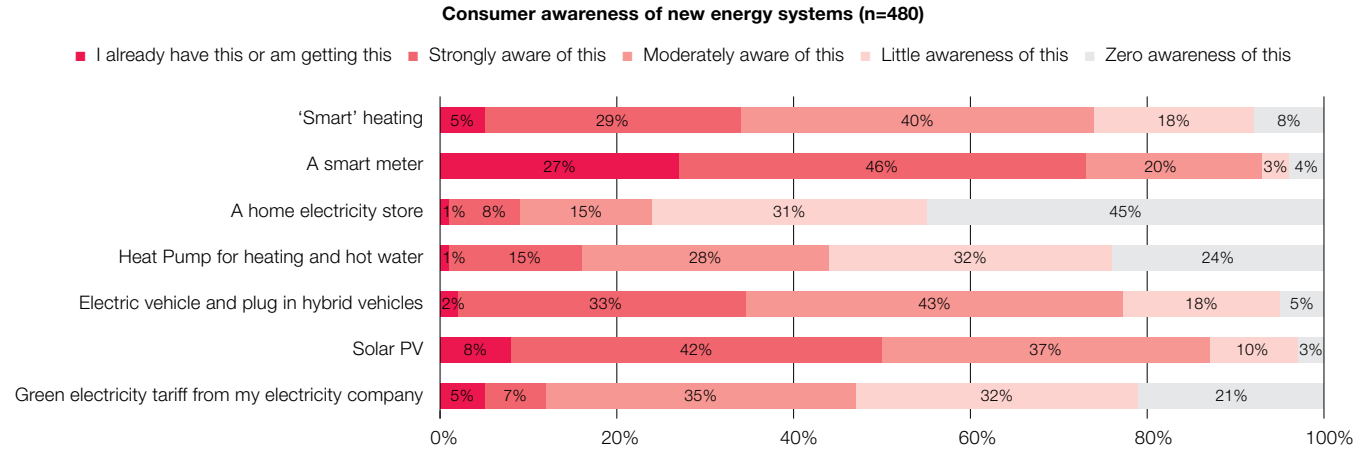


Figure 4: Awareness of new energy systems



Smart meters have the highest level of existing installations at 27%. A high percentage are strongly or moderately aware of smart meters – a total of 66%. So awareness of smart meter roll out seems to be very high. The recent TV advertising, using two separate campaigns, by Smart Energy GB will be a factor in increasing awareness.

Solar PV has the next highest level of existing installations at 8%. This is higher than the national average so the costs of solar PV may not be a high deterrent. Note, however, that this is a sample of homeowners and with 48% in the AB socio-economic group. A high percentage are strongly or moderately aware of solar PV – a total of 79%.

Smart heating has a 5% level of existing installation. This is notable due to the relatively recent introduction of these products, and that these products have not had the benefit of subsidy or incentive mechanisms. A high percentage are strongly or moderately aware of smart heating – a total of 69%. One of the main providers, Hive, has run advertising campaigns.

For electric or hybrid vehicles, at present ownership levels are low at less than 2%, but 76% of respondents are strongly or moderately aware. These results show high levels of awareness of the four different products that will play a large role in the flexible and smart energy systems of the future.

The remaining three measures show lower awareness levels - below 50%:

- Notably the awareness of home electricity stores is very low – only one respondent owned a store and levels of positive awareness were only 23%, while 45% had zero awareness. This is marked contrast to the response to vision 2 as described in section 3.2.4.2: solar PV plus electricity storage. Though vision 2 asked for a future looking view not a view for the present time.
- Heat pumps received a higher level of respondent awareness, at 33%. Given that heat pumps are complex and are not as visible as solar PV – in publicity terms and in terms of being visible on roofs - this seems a high level of awareness. This may be explained by 27% of respondents being in homes that are off the gas network and 67% being in rural or semi-rural areas, where heat pumps are more relevant and the space to install a heat pump is more likely to be available.
- While switching to a green electricity tariff had been taken up by 5% of respondents, with 42% showing awareness. Given that this is a simple option, the awareness level seems relatively low.

For those that owned these systems already we asked if there had been any issues with installation or operation of the new energy system. The numbers of installations in most cases are very small. For solar PV and smart heating systems, the numbers of installations are higher and hence there were examples of problems with installations. The details of the numbers of issues for solar PV and for smart heating systems are shown in Table 5 and Table 6.

Table 5: Issues experienced with solar PV system

Issues experienced with solar PV system	# of Respondents
No problems experienced.	31
Connecting the solar PV to the electricity network.	1
Meters operating incorrectly.	4
Electricity supply cutting out.	2
Other issues.	1

Table 6: Issues experienced with smart heating system

Issues experienced with smart heating system	# of Respondents
No problems experienced.	20
With the installation of the smart heating system.	2
Reading the information on energy use.	0
Using the controls and information to save energy.	1
With my smart phone or tablet connecting with the heating system.	1
With the boiler and heating responding to the controls on my smart phone or tablet.	1
Other issues – please describe.	1

In both examples, the majority of installations have been problem free. The largest number of problems have been with solar PV and metering – likely to be old disc meters running in reverse. This causes a

problem when a subsequent meter reading shows an apparent drop in consumption, followed by a dispute and resolution discussion with the electricity supplier over bills and installation of a new meter.

2.4.4 Interest in getting new energy systems

For those respondents who did not own, or were not getting a new energy system, they were asked about their levels of interest in getting these systems in future. Results are provided in Figure 5 below. Note that the sample size is different in each case, for example 27% of the full sample had, or were getting, a smart meter so the remaining sample is 350 respondents.

Consistent with the level of awareness, the level of interest in getting a smart meter is highest, with 33% of respondents strongly and 35% moderately interested in getting a smart meter. Again, the recent TV campaigns are likely to be a factor in this. The next highest interest is for a Green electricity tariff, with 12% strongly and 50% moderately interested in getting this measure. This is higher than the level of awareness which was 7% strongly aware and 35% moderately aware.

Two new energy systems had more than 50% with low or zero interest.

For electric vehicles 31% had low and 29% had no interest in electric vehicles, with only 10% strongly interested. Electric vehicles have a high initial cost and could be considered to have an important impact on travel options. Figure 6 below shows that strong interest is higher in the AB and C2 group and zero interest is highest in the C2 group, showing some correlation with socio-economic position.

Figure 5: Interest in getting new energy systems

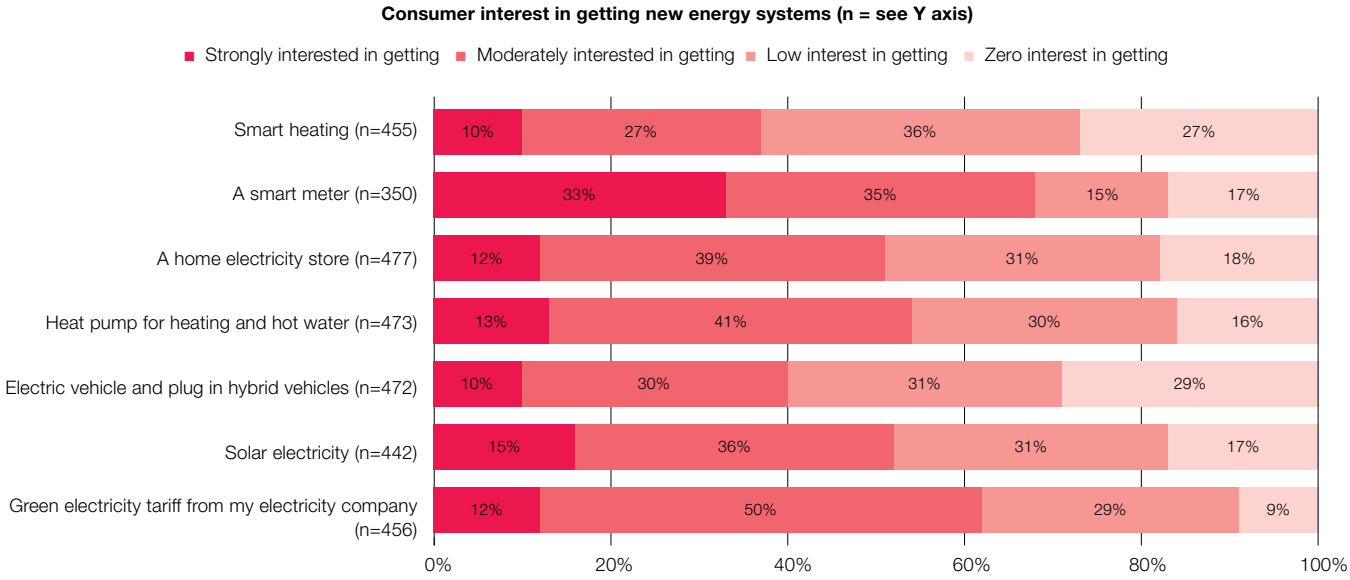
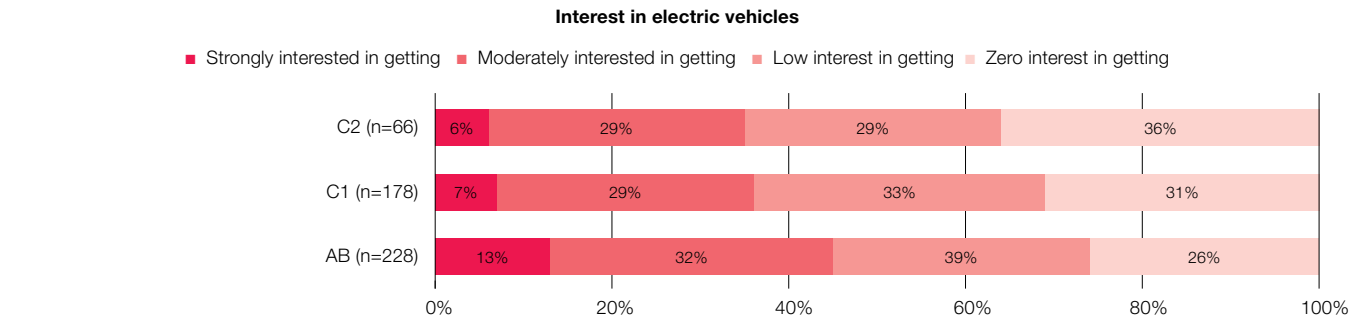


Figure 6: Interest in getting new electric vehicles – by socio-economic group



The other new energy system with low interest was smart heating systems, with 36% with low interest and 27% with zero interest, only 10% had a strong interest. There is no clear trend in the segmented data that offers any insight on the lower level of interest in smart heating.

Figure 7 below shows the difference between awareness of, and interest in getting, solar PV.

Interest in getting solar PV is lower than awareness, 42% are strongly aware vs 15% strongly interested in getting. 3% have zero awareness and 17% have no interest in getting solar PV. This is to be expected as interest is a stronger commitment.

The breakdown of interest by socio-economic group shows some differences (see Figure 8 below), but not to the same degree as shown in the interest in electric vehicles. For example, 41% of the AB group have moderate level of interest, but only 13% are strongly interested.

2.4.5 Options for electricity supply

The final group of questions asked where on interest levels in three different options for electricity supply (Figure 9 below).

Figure 7: Awareness vs Interest in solar PV

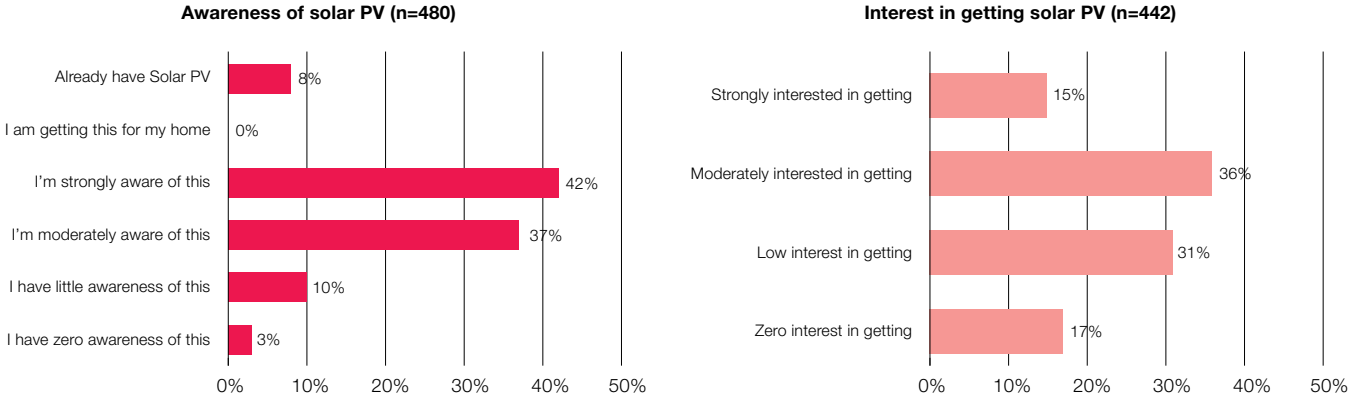


Figure 8: Interest in getting solar PV – by socio-economic group

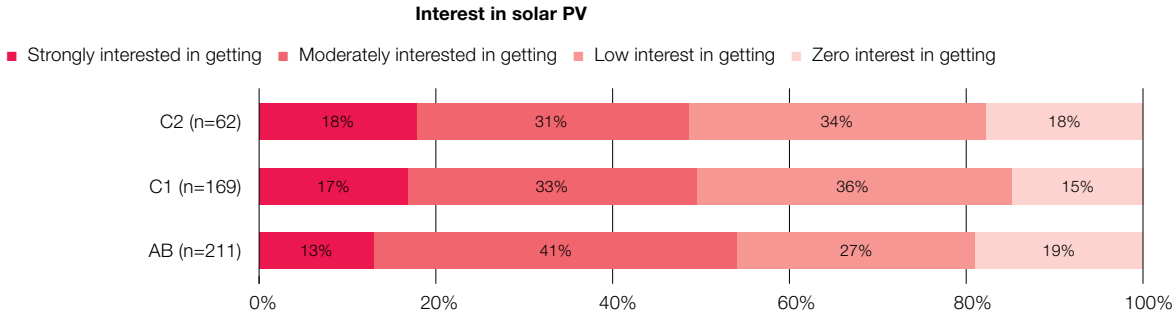
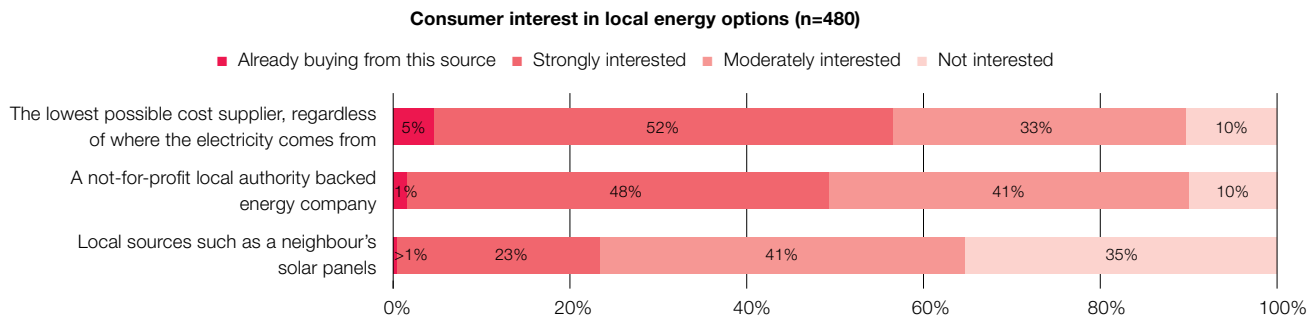


Figure 9: Interest in local energy supply options



Lowest cost was the option of greatest interest with 5% stating that they already had this and 85% of respondents stating that they are interested in this option.

However, 89% were interested in a not-for-profit local authority backed offer. Only 1% stated that they used this option, possibly reflecting the relatively recent launch of companies like Robin Hood Energy.

Local sources such as neighbour's solar panels also showed a high level of interest, at 64%, but this was notably lower than the first two options.

The concerns that were mentioned showed a number of patterns (Table 7 below).

2.5 Consumer Survey – Conclusions

The analysis of the consumer survey responses shows:

- High interest in the visions for future home energy systems that include solar PV and even higher interest for solar PV with energy storage. In general, there is a high level of interest in all four visions – suggesting an appetite for the transition to smarter energy systems in homes.
- Awareness and use of smart meters was high, perhaps aided by recent TV campaigns. Ownership and awareness of solar PV and smart heating systems had the next highest levels of awareness. In contrast, a no-cost measure, switching to a green electricity tariff, had the lowest levels of awareness.
- Levels of interest in getting new energy systems were in general lower than awareness levels. However, consistent with the level of awareness, the level of interest in getting a smart meter is highest, with 33% of respondents strongly and 35% moderately interested in getting a smart meter. The next highest interest is for a green electricity tariff, with 12% strongly and 50% moderately interesting in getting this measure. This is higher than the level of awareness which was 7% strongly aware and 35% moderately aware. Two new energy systems had more than 50% with low or zero interest: electric vehicles and smart heating systems.
- Interest in three options for electricity energy supply showed three distinct patterns: high interest in the lower cost option, high interest in supply from a local authority, not-for-profit supplier and low interest in buying from a nearby householder.

These responses from consumers reflect the changing landscape in the energy sector, with consumers having a high awareness of, and interest in getting, smart meters, their own generation and energy storage systems. This is consistent with the vision that underpins the FPSA programme, with greater levels of consumer participation (e.g. using smart meters), more local distribution connected generation and new energy supply concepts.

Table 7: Concerns regarding local energy supply options

Lowest cost supplier	Not-for-profit LA energy company	Local sources e.g. neighbour's solar PV:
81% strongly or moderately interested in both options, 33% strongly interested in both		
Concerns: Reliability, cheapest may not be best, ethics, sustainability…	Concerns: Something new, reliability, government interference, supplier goes bust, lack of experience, rubbish LA…	Concerns: Neighbour disputes (most common concern), billing, reliability, top-up supply…

3. Stakeholder Interviews

The stakeholder interviews were one-hour structured interviews to understand the requirements that different groups of stakeholders had for the power sector and the obstacles they faced in their interactions with the power sector. From this information we assessed how well the details of the *thirty-five* FPSA functions matched the stakeholder requirements and obstacles.

3.1 Stakeholder groups

The specification for WP1A emphasised the need to speak to a wide range of stakeholders and in particular those working behind the meter, i.e. non-traditional power sector participants, those connected to distribution networks and generating, storing and managing energy. An initial list of stakeholder groups was expanded to cover a wide range of organisations (Table 8 opposite).

Table 8: Interviews completed by stakeholder group[2]

Stakeholder Group	Held
Local authorities	3
Planning authorities	0
Smart city developers	1
Distributed energy developers and/or operators	3
Providers of energy and heat services: waste heat recovery and/or generation, CHP & DH operators	2
Suppliers and other market players operating non-traditional business models	5
Providers of home and business energy management systems and services	3
Customers and customer representatives and groups	1
Community energy scheme developers and/or operators	3*
Storage system makers and developers (domestic to grid scale)	2
Power sector: traditional suppliers, TOs, DNOs , IDNOs, GB SO	5
Transport - EVs, chargers and agencies	1
Equipment suppliers	2
Other	1
	32

[2]NB some interviewees fit in more than one group, e.g. Bristol City Council is a local authority who have set up a licenced supply business. The classification by group uses the core activity undertaken by the organisation as the method for classification. So Bristol City Council is classed as a local authority.

**In addition to these interviewees, for a separate project, Ricardo Energy & Environment has interviewed three innovative community energy projects in Scotland. These include projects with local electricity supply and projects controlling demand to better match renewable energy output. These interviews will be used to produce a short online publication on the progress of these ideas and how they could be relevant to other community groups. The evidence from these interviews is also a useful source for WP1A.*

3.2 Interview types

The interview programme has a mix of Discovery interviews and Focused interviews. Discovery interviews target a wide range of stakeholders with a wide range of questions on requirements and obstacles faced and constraints to identify stakeholder identified obstacles. Focused interviews have been requested by WP2 and WP3 and include specific questions to inform these Work Packages. 32 interviews were held by the end of Phase 3 (see Table 9).

3.3 Interview questions and analysis

The interviews were semi-structured with questions on:

- Recent projects and initiatives – which provided an important context for the rest of the interview.
- Requirements from the GB electricity system – now and in the future.
- Obstacles to the projects and initiatives.
- Views on functions needed.

The list of structured questions used is included as Annex 2. The questions covered a wide range of topics. Some of these were less relevant to some stakeholders, and in some cases the interview focused on requirements and obstacles – in these cases it was not possible to cover all of the topics listed in Annex 2.

The details provided by interviewees varied widely, as we interviewed a wide range of stakeholders, some of whom have focused interests, while others have much broader interests. For example, several of the requirements or obstacles relate to UK targets for carbon, energy efficiency, while others clearly had affordability of energy as the motivation, hence the interviewees highlighted issues that were clearly linked to policy objectives on carbon and fuel poverty.

Each interview was reviewed to draw out:

- Examples of needs from the current and future electricity system in GB.
- Examples of obstacles experienced in the current or expected in the future electricity system in GB.

Table 9: Completed interviews (32)

Organisation	Type	Interviewee
PassivSystems	Discovery	Colin Calder
Energy for London	Discovery	Syed Ahmed
Highview Energy Storage	Discovery	Gareth Brett
GeoTogether	Discovery	Patrick Caiger-Smith
Sustainability First	Discovery	Judith Ward
Kiwi Power	Discovery	Yoav Zingher
Powervault	Discovery	Joe Warren
Star Refrigeration	Discovery	Dave Pearson
Open Utility	Discovery	James Johnson
SmartKlub	Discovery	Charles Bradshaw-Smith
Centrica Local Energy markets	Discovery	Matt Hastings
Solar Trade Association	WP3 Focused	Leonie Greene
GTC	WP2 Focused	David Overman
Bristol City Council	Discovery	Bill Eldrich
Centrica Connected Home	Discovery	Sudeep Maitra
WPD	WP2 Focused	Nigel Turvey
Liverpool LEP	Discovery	James Johnson
TfL	Discovery	James Ingram
ENWL	WP2 Focused	Steve Cox
National Grid	WP2 Focused	Roisin Quinn
Smarter Grid Solutions	WP3 Focused	Graham Ault
Siemens	Discovery	Prof Paul Beasley
IBM	Discovery	Dave Gorman
Citizens Advice Bureau	Discovery	Stew Horne
Dixons Carphone	Discovery	Florian Ritzmann
PWR	Discovery	Mike Parr
Challoch	Discovery	Simon Minett
Northern Powergrid	WP2 Focused	Mark Drye
Push Energy	Discovery	Nicola Waters
Fintry Development Trust	Discovery	Gordon Cowtan
Mull Access project	Discovery	Gillian Hurding
Tower Power	Discovery	Georgy Davies

Each requirement and obstacle was reviewed to identify the root cause of the requirement or obstacle. In some cases this expanded the scope of the issue raised by the interviewees – as the example given was one small example of a more general case.

Each obstacle and root cause was checked against the *thirty-five* new and changed functions proposed by FPSA. The aim of this step was to:

- Check if important requirements or obstacles were not covered by the FPSA functions.
- For those not covered, to determine the reason, this could be:
  - The issue is out of the scope of the FPSA programme.
  - The issue is a pre-requisite, an aspect that supports FPSA and will be necessary for the FPSA vision and functions to succeed, but is not part of a function.
  - If the FPSA function or its more detailed description could be clarified or expanded to ensure that the requirement or obstacle was covered.

As an example, the requirement for greater skills in the power sector – as more complex technical markets will be used in future, with a wider range of options. Hence skill levels will probably need to increase. Skills and training is out of the scope of FPSA, but this is an important pre-requisite for success.

Each requirement and obstacle identified through the stakeholder interviews, were included in an analysis spreadsheet (see example of analysis in Table 10 below).

The analysis process examined each of the requirements and barriers from the interviews producing an assessment of the links to the functions and a classification. A selection of these were reviewed with other members of the FPSA team, helping to sharpen the process used and calibrate the assessments of each requirement and obstacle.

Table 10: Example of analysis of an obstacle

Requirement or obstacle	Evidence	Root cause	Answer	Do the functions address the root cause?	
Obstacle	Obstacle: Access to markets is often via a minimum participant size. Aggregation can help, but this has limits, for commercial reasons. With domestic scale storage + EVs + DSR, require a route for very small scale assets to contribute to markets.	Auction rules for EFR, STOR, CM etc.	Market design and market implementation based on larger systems e.g. to manage transaction costs.	**Yes**	**Yes - covered under several functions and 16.2 includes the key words "full range"**

No	Function Summary	No	Function Summary	No	Function Summary	No	Function Summary	No	Function Summary
H6	Enable customers to choose from a full range of market options which determine how they interact within the power system including individual, community and smart city services.	H4	Provide market mechanisms e.g. peer-to-peer trading, to allow all customers to access the value realised by their actions.	H1	Provide aligned financial incentives across the power sector (e.g. innovative or flexible tariffs) encompassing power, energy and ancillary services which provide appropriate signals to users and do not distort competition while giving consideration to their impact on customers.	H5	Provide a market structure that allows customers to engage actively with the power system.	H3	Implement and co-ordinate a framework where the roles and value propositions of all significant stakeholders across the power sector can be managed.

Table 11: Classification of requirements and obstacles

Do the FPSA functions address the root cause?		Comment	Number in category	% in category
Yes or - Yes but clarify	Yes, or qualified Yes, as might be clearer in description	Details might be more explicit in full function description and implementation	118	77%
No	In scope - but none of the functions has a relevant explicit or implicit reference to the requirement or obstacle	New or changed function? Or covered by a different mechanism?	6	4%
Pre-requisite	Pre-requisite for many functions	Not in scope for FPSA but implementation of FPSA functions and achievement of FPSA vision would be supported if this is in place – e.g. environmental performance or safety.	10	6%
Not an FPSA function	Not in scope for FPSA	Not in scope for FPSA.	20	13%

The next step used a stakeholder workshop held on 23rd March 2017 with 11 stakeholders to:

- Capture any additional requirements and obstacles from the 11 stakeholders.
- Test how well key requirements and obstacles chosen by the stakeholders are covered by the FPSA functions.

Details of the workshop, the attendees, key requirements and obstacles chosen by the stakeholders at the workshop etc. are included in Annex 3.

Each of the 154 requirements and obstacles from these two sources have been classified into one of five categories (Table 11 above).

Table 11 shows that 118, or 77% of the requirements and obstacles are addressed by the proposed FPSA functions, or with a minor clarification, will be addressed by the FPSA functions.

In the example in Table 10, the obstacle is the difficulties that smaller players experience in accessing relevant markets. Access may be a direct obstacle, as a threshold is used (e.g. MW) or a technical requirement indirectly requires this (e.g. having a double circuit connection for the Enhanced Frequency Response (EFR) auction).

Function H2 is: “Implement and co-ordinate a framework where the roles and value propositions of all significant stakeholders across the power sector can be managed.”

Domestic customers are in aggregate significant stakeholders, in fact are the most significant stakeholder. The FPSA term “power sector” was used to include all parts of the system, including behind the meter and hence domestic consumers and their installations and equipment. Hence with this definition applied, function H6 clearly covers this obstacle and is classified as “Yes”.

Ten of the requirements and obstacles were assessed as pre-requisites for the successful implementation of FPSA functions. Examples include the increasing level of skills that will be needed in the power sector to implement and operate the more complex and flexible systems anticipated.

21 of the requirements and obstacles were assessed as not in scope for the FPSA programme. One example is the increasing innovation that will be needed in the Power Sector to develop and test the complex and flexible systems anticipated.

The following sections provide examples of some of the requirements and obstacles. The sample chosen are examples where there are several similar examples cited by several stakeholders – so these examples are more significant in the analysis.

3.3.1 Requirements and obstacles classified not covered by a function

One example of the six that were assessed as not being covered by the FPSA functions are shown below in Table 12. This example is very similar to points made in two other interviews. These points could be picked up in the design of *Enabling Frameworks*. The other four examples in this classification are more specific issues on the direction and processes for governance.

Table 12: Requirement or obstacle classified as not covered by FPSA functions

Requirement or obstacle	Evidence	Root cause	Do the functions address the root cause?	
Obstacle: Governance - the process of changing codes is dominated by the large market players. See very strong behaviour by incumbents to defend even small risks to current business models, doing so with speed and resources. Hence change to the established systems is slow.	Same point made in two other interviews.	Governance reinforces the status quo and slows change.	No	Part of *Enabling Frameworks*
Requirement: On governance, balance between participant and effectiveness. Need to have a group that will enable you to make a decision and move forward. This may not include all voices.	Interview.	Practical point re. efficient decision-making.	No	Potentially an aspect for *Enabling Frameworks*
Requirement: There is a requirement for the energy industry to move at a much greater pace. Specifically, change of pace in terms of governance and regulation; and changes to market, charging and code. The current systems were built for large transmission connected generation; this is not where we are or where we are going.	Interview.	Swifter decision-making needed.	No	Potentially an aspect for *Enabling Frameworks*
Requirement: Governance, parts of current governance are fit for purpose and parts that are being amended. There is a requirement to consider how well co-ordinated these amendments/changes are.	Interview.	Practical point re. co-ordination of decision-making.	No	Potentially an aspect for *Enabling Frameworks*
Requirement: Need to look at the speed of changes: require to find the balance between giving people enough time to understand the changes that have been proposed (e.g. how it will impact on their business) while being able to make changes quickly to correct issues without delay.	Interview.	Swifter decision-making needed.	No	Potentially an aspect for *Enabling Frameworks*
Obstacle: Governance - the process of changing codes is dominated by the large market players.	Same point made in two other interviews.	Resources (people, data and analysis) of large market players.	No	Potentially an aspect for *Enabling Frameworks*

3.3.2 Requirements and obstacles classified as pre-requisites

The ten requirements and obstacles classified as pre-requisites are shown below in Table 13.

These cover a wide range of factors that will be important in the success of the future GB Power System, covering innovation, skills, business models etc.

Table 13: Requirement or obstacle classified as a pre-requisite for the FPSA functions

Requirement or obstacle	Evidence	Root cause	Answer	Do the functions address the root cause?
Requirement: Need to avoid a top-down design for FPSA, there will not be a perfect solution, innovation and local activity will result in a diverse range of solutions.	Pace of change, breadth of change, and range of participants in future system.	Need for flexibility.	Pre-requisite.	A principle for FPSA.
Requirement: Require ways to allow experimentation with technical and business models.	Issue recognised in Ofgem sandbox proposals.	Limited opportunity for new entrants to experiment.	Pre-requisite.	Links to the innovation pre-requisite. May be part of EFs?
Obstacle: Environmental performance not a factor in Ancillary Services markets.	Build of diesel farms for STOR and CM.	Environmental performance not a core function.	Pre-requisite.	Pre-requisite for all functions - that the outcomes should be consistent with environmental legislation. Could be extended to cover best practice.
Requirement: Need viable business models to be part of the solution - for behind the meter systems and for the DNOs/DSOs.	Many technical concepts reduce demand - but still require the distribution network - so business models need to support new and existing assets.	Viable business models required to be part of the architecture.	Pre-requisite.	Pre-requisite for all functions - a test of the likely impact on current and future business models. May be part of EF stakeholder process.
Requirement: Experience on connection of complex site shows a lack of experience in the DNO to respond to bespoke solution. This is an increasing risk - standard solutions will not always be suitable requiring greater engineering skills to agree a solution.	Connection application.	Insufficient engineering skill to deal with new solutions.	Pre-requisite.	Risk of skills shortage to support a major change in the GB energy sector.
Obstacle: Supply chain for appliances will not develop and sell solutions that include DSR until the markets are visible and hence they can see a return.	Makes business sense.	Dialogue in advance with supply chain.	Pre-requisite.	Effective communication with stakeholders of all types.
Requirement: The application process and testing of systems to gain a supply licence was focused on technical issues - not the probity of the directors. As more new suppliers enter the market this is a risk.	Experience of supply licence application process.	Gap in processes for supply licences.	Pre-requisite.	Include a fitness test for Directors of organisations?
Requirement: Pool of people experienced in setting up a licenced supplier with industry knowledge is very small. To deliver a more local and distributed model will require a larger number of skilled people outside of the traditional players.	Experience of supply licence application process.	Small pool of experienced people.	Pre-requisite.	Risk of skill shortage to support a major change in the GB energy sector.
Requirement: With less energy passing through networks, there is a requirement for new business models and charging that supports operating and investment.	Falling demand is in BEIS energy statistics, networks costs are mainly fixed.	Lower volumes on networks, but costs fixed.	Pre-requisite.	Not a function, but key for future of networks.
Obstacle: Technical solutions to network issues may not be acceptable to investors and hence will not provide the solutions required. ANM or adding storage to generation sites may not work if the funders cannot agree.	Investors require certainty that returns will be made, so key agreements such as connection cannot be re-negotiated if this opens up a risk of loss of revenue without an ability of redress.	Technical solutions require to be tested against the typical funder requirements.	Pre-requisite.	Pre-requisite for all functions - a test of the likely impact on current and future business models. May be part of EF stakeholder process.

3.3.3 Requirements and Obstacles classified that are out of scope

The 21 requirements and obstacles that have been classed as being out of scope are shown below in Table 14.

Table 14: Requirement or obstacle classified as out of scope

Requirement or obstacle	Evidence	Root cause	Answer	Do the functions address the root cause?
Obstacle: RIIO ED1 limits the innovation in DNOs including the transition to DSO activity.		RIIO was not designed to deliver this transition.	Not an FPSA function.	Transition to DSO is not a function within FPSA, nor is the design of price controls.
Requirement: On carbon the focus should be on energy efficiency as the primary approach.	EE is the lowest cost approach, building assets to serve waste is not cost effective.	Serving demand is core to power system thinking - irrespective of the requirement for the demand.	Not an FPSA function.	Environmental and energy efficiency issues addressed outwith FPSA.
Obstacle: Innovation incentive too low in RIIO, focus is expenditure on reinforcement.	Mentioned by several stakeholders.	Degree of innovation in price regulation.	Not an FPSA function.	Price regulation sets the economic and hence investment framework for the sector - but not part of FPSA.
Obstacle: Existing domestic loads too small for effective DSR.	Domestic DSR not active yet.	EV and heat pumps sales modest.	Not an FPSA function.	Not for FPSA to deliver, but functions should not inhibit these markets.
Obstacle: Design of homes and home energy systems is not optimal for low carbon heating. As well as not aiming for high efficiency fabric, the lack of hot water storage, high temp distribution makes low carbon heating more expensive.	Comparison of UK and European homes. Lack of policy in UK (e.g. low carbon homes cancelled).	Energy policy not joined up - costs of low carbon could be lower.	Not an FPSA function.	Wider energy policy issue.
Obstacle: Electricity costs are not large enough to motivate customers, especially domestic.	Percentage of customers on highest tariffs.	Saving too low vs. the hassle of action.	Not an FPSA function.	Not a function, but a key issue for success.
Obstacle: Price regulation for DNOs insufficient for innovation.	Slow adoption of innovation and high turnover of innovation staff in DNOs.	Innovation a small part of DNO income, so has a small influence.	Not an FPSA function.	Key point - but not in scope, issue is the fundamental economic regulation for DNOs.
Obstacle: DNOs do not have all the powers required to become DSOs.	RIIO ED1 is a step in this direction, but there is no explicit policy or mechanism to deliver the transition to DSOs.	No explicit policy or mechanism to deliver the transition to DSOs. A key part of the BEIS call for evidence.	Not an FPSA function.	Legal issue as power will come from primary or secondary legislation.
Requirement: The innovation expected under RIIO has not materialised.	Early in price control - so hard to prove this.		Not an FPSA function.	Price control out of scope, also not enough evidence yet.
Obstacle: Housing developer clients opt for the lowest cost solution, which is an obstacle to introducing innovation.			Not an FPSA function.	Not in scope as about stimulating demand via planning.
Requirement: No obligation for the other statutory utilities to discuss strategic investment and upgrades. For example, the city would want to install superfast broadband along with upgraded utilities.	First-hand experience.	Multi-vector and multi-utility thinking not part of planning and investment.	Not an FPSA function.	Partly - does not include investment to supply multi-utility improvements. Most relevant to smart cities. Would expect this to be a DSO role.
Requirement: Developers of innovative ideas cannot access funding and get DNO co-operation for innovations that they propose. Limits innovation and participation of customers and customer led solutions in innovation.	LCNF processes and projects.	LCNF applications are DNO led - but future innovations will originate from other participants.	Not an FPSA function.	None of the functions has an explicit mention of innovation, but complements FPSA. So a parallel industry activity.
Obstacle: Big 6 players are resistant to disruptive technologies, for example they wish to 'pre-influence' the technologies.	Interviewee view. Plus other stakeholders commented on the low level of innovation.	Large organisations maintaining the status quo.	Not an FPSA function.	Not a function - but an important issue.

3.4 Findings

With 154 examples of requirements and obstacles, there are many which have similarities. A series of findings have been developed, to present the information in a form that is condensed. These findings are just that; they present a condensed articulation of the requirements of stakeholders and the obstacles they perceive. The value of the findings is to help FSPA determine if there are requirements and obstacles not already included in the *thirty-five* functions.

The findings are in Table 15 below, along with the number of requirements and obstacles that have been linked to each finding.

Table 15: List of findings

Ref	Title	No
F001	F001 - Decision Making Processes.	7
F002	F002 - Aggregation at DNO level.	1
F003	F003 - Local network management to match local generation.	5
F004	F004 - Storage as a solution for networks issues.	4
F005	F005 - No local markets for energy storage.	1
F006	F006 – Strategic distribution investment.	12
F007	F007 – Accurate settlement.	4
F008	F008 – Technology neutrality and open access to markets.	25
F009	F009 – Accessing value in the traded market.	1
F010	F010 – New metrics for the low carbon energy system.	2
F011	F011 – Engaging public sector and local stakeholders.	5
F012	F012 - Current licences create barriers to more flexible systems and entry of new players.	3
F013	F013 - Cost savings for customers need to be at the core of new markets.	8
F014	F014 - RIIO will not deliver the transition to DSOs.	5
F015	F015 - The increasingly complex energy system needs to allow customers to understand their interaction with the system.	1
F016	F016 - Require greater degree of innovation and faster application of innovation.	8
F017	F017 - Existing codes and regulation are obstacles.	2
F018	F018 - Access to information.	10
F019	F019 - Need viable business models.	7
F020	F020 - Need greater skills to deliver a smart flexible system.	3
F021	F021 - Need greater co-ordination between electricity, transport and heat sectors.	8
F022	F022 - ANM is a partial solution - need greater range of solutions.	3
F023	F023 - Greater co-ordination between SO and DNOs to provide co-ordinated approach to flexible and ancillary services.	3
F024	F024 - Smart meter specification and roll out not supporting opportunities.	6
F025	F025 - Reliance on open systems and risk of cyber attack.	2
Unique	Unique issue - No finding included.	18

3.5 Details of findings

This section provides details of the findings, each flows from one or more of the requirements or obstacles highlighted during the interviews. In most cases, the findings draw on many of the requirements or obstacles from the interviews.

The finding and a short discussion and conclusion are provided for each of the 25 findings. Where there is a clear link to other Work Packages this is highlighted.

Where there are relevant FPSA functions the reference numbers are listed. In some cases a large number of functions are relevant – however only a sample are listed.

Reference: F001- Decision-making Processes			
Finding	**Decision-making has a disposition towards the status quo.**		
Discussion	Observations were made that industry working groups were dominated by the large players, with simple majority voting on proposals for change. This was seen as a barrier to change and hence the current players and business models are not challenged, or change slowly.		
Conclusion	This is not an FPSA function, but may inform thinking on how decisions are made in the enabling functions.	**Relevant functions**	N/A

Reference: F002 - Aggregation at DNO level			
Finding	**There is a disconnection between the activities of aggregators, or individual sites, in participating in National Grid markets and the issues at DNO level.**		
Discussion	National Grid operate an increasing number of markets to manage the security and standards for the transmission system. These include: • Supplemental Balancing Reserve (SBR). • Demand Side Balancing Reserve (DSBR). • Capacity Market (CM). • Short Term Operating Reserve (STOR). • Frequency Response (FR). • Firm Frequency Response (FFR). • Enhanced Frequency Response (EFR). • Transmission Use of System (TUoS or Triads). All of these are designed to address transmission level operating issues. While some market participants will be mainly transmission connected (e.g. for SBR), there are many distribution connected participants (e.g. for CM, STOR, EFR and Triads). In a system where the DNO network is passive and all parties have firm connections, there is no impediment to these distribution connected participants, and this offers higher liquidity and hence lower cost for TS operation. In future, DNO systems will be more dynamic, managing peaks and GSP activity and with more flexible connection arrangements that will not offer 100% firm connection (e.g. through Active Network Management). So distribution connected participants may not be able to be sure that they will be available to participate. See F023 for a related issue – co-ordination of SO and DNO actions.		
Conclusion	In future, there may need to be better alignment between the TSO and DNOs to enable high levels of market participation and hence reduce costs of TSO and DNO system operation. In summary, DSR/Active Management needs whole system co-ordination to fully exploit its capability.	**Relevant functions**	H5, H6

Reference: F003 - Local network management to match local generation			
Finding	**Local network management and local supply is needed to match local generation.**		
Discussion	Several interviewees pointed out the expectation that levels of distribution connected generation will increase very significantly; using solar PV, wind, hydro, CHP and other generation types. At the same time increasing EVs, battery storage and electricity for heating will significantly change load profiles. This transition weakens and changes the traditional role for transmission connected generators and the flow down of electricity from remote power stations via the transmission system to GSPs and hence local networks and consumers. If the future is local, then there is a need for local network management. Local demand management and local supply is needed to support this transition. The transformation from DNO to DSO is a key part of this. But local systems may not be on a DNO based geography, they may be city or town level, or district within a city. So DSO approaches may need to be applied at a more local level. Local supply is part of this transformation, allowing local generators, and their customers, to contribute to local network and supply management. Current arrangements force players to be licenced electricity suppliers. This is an expensive route and the costs of set up make it hard to offer a different cost or different product as the rules are the same for all players. Some evidence that new entrants have taken too much risk against low margins and are at risk of failure.		
Conclusion	This will require care in how market propositions are explained, and how the billing information is provided – to show the impact of DSR actions.	**Relevant functions**	D1, H1, H2, H4

Reference: F004 - Storage as a solution for networks issues			
Finding	**DNOs do not see storage as a solution for networks issues.**		
Discussion	Storage offers many types of electricity system service. Several of which are focused on supporting DNO and TO system operation. Several DNOs have developed their own trials of battery storage systems (e.g. UKPN's Leighton Buzzard site). However, for commercial applications to date, there is no market mechanism to ensure that design assumptions agreed between storage developer and the DNO will hold true through market operation in real-time.		
Conclusion	Energy storage offers benefits for DNOs, however the connection offers made reflect the current rules and do not provide necessary flexibility and value stacking. Function H1 is intended to address this.	**Relevant functions**	H1, C1

Reference: F005 - No local markets for energy storage			
Finding	**No local markets for energy storage.**		
Discussion	Storage offers many types of electricity system service. At the moment, all of the effective markets open to operators of storage systems are to solve transmission level system issues and hence markets are operated by National Grid. Most energy storage systems will be distribution connected, hence storage could offer support for operation of distribution systems. In a future system with much greater distribution connected generation, this use of storage could offer important advantages for local management of networks. The detail of this will depend on the use case. For example, a use case that defers network reinforcement will need to be in the right network location and have a high level of reliability.		
Conclusion	DNOs or DSOs, should be able to contract distribution connected generation for local balancing, peak reduction, deferment of reinforcement etc.	**Relevant functions**	H1

Reference: F006 – Strategic distribution investment			
Finding	**More strategic action needed for DNO investment.**		
Discussion	DNOs only respond to the connection requests that are received, there is limited ability to consider strategic investment that would support local generation or demand development. This applies to demand sites and generation sites. For example, large regeneration projects often have multiple phases over several years – to allow for phased development and sale of property. However, the connection approach is to consider the development phase by phase and hence not invest strategically ahead of the demonstrated need for the full scale development. The current reactive approach could be a barrier to smart city development, where wider scale investment will be needed to enable a wide range of consumers to engage with, and benefit from, smart city systems. RIIO introduced routes to increase allowed expenditure – but the volume of comments made on this issue suggest this is not yet seen to be effective.		
Conclusion	While undoubtedly true that DNOs do not take this risk, the risk is held by the site developer and the DNO does not have a business model that can support this type of risk capital investment. The more important case is where large numbers of small consumers, or prosumers within a smart city initiative are dealt with in a reactive and serial way, rather than as part of a strategic change. This might be implemented by defining strategic area for investment, working with local authorities and smart city developers.	**Relevant functions**	D1, C1, F1

Reference: F007 – Accurate settlement			
Finding	**Accurate settlement is needed for domestic customers.**		
Discussion	Domestic demand makes a major contribution to peak demand at distribution and transmission level. In turn, this sets the capacity needed and the assets and cost base for the electricity industry. For this reason, there is a need to move from profiles to accurate measurement and settlement of domestic electricity use: 1. This enables demand management of existing domestic loads and offers benefits to customers and network operators in terms of reduced cost, reduction of peaks, shifting of demand etc. 2. This manages the risk from the roll out of EVs, which will potentially be a very significant additional load at peak times (3kW to 7kW or more per home). Without smart meters and accurate settlement, there will be no incentive for consumers to manage the timing of EV charging. 3. Accurate settlement is needed to deliver time of use tariffs, which in turn are needed to realise the full benefit from the investment and cost of smart meter roll out.		
Conclusion	Proposals are underway to undertake this transition however there are concerns about the timing and success of these major changes.	**Relevant functions**	H2, C6

Reference: F008 – Technology Neutrality			
Finding	**Some aspects of electricity system operation have a disposition towards a sub-set of the potential solutions.**		
Discussion	This was mentioned by many stakeholders, specific examples include: • Auction rules for CM offer generation 15 year contracts, while DSR is offered a one-year contract. The result is likely to be significant diesel generation, with carbon and air quality impacts, with less zero carbon DSR. • Small scale distributed store could offer reliable contributions to Enhanced Frequency Response, as there is a low probability of all systems and circuits failing. These may be unintended consequences, but this blocks innovative ideas, when innovative ideas will be needed for 2030.		
Conclusion	Greater scrutiny of decisions, processes, market rules etc. to avoid ruling out viable and innovative solutions.	**Relevant functions**	H3, H1, H4

Reference: F009 – Accessing value in the traded market			
Finding	**There is a disconnection between the traded electricity market and the markets to maintain system operation.**		
Discussion	With increasing levels of intermittent generation there are likely to be: • Greater potential for parties to be in imbalance and hence spikes of high pricing in the wholesale market. • Increasing system security and stability issues. As highlighted under F002, National Grid has an increasing number of markets to manage impact 2. This means that a range of new solutions and market players have been able to develop, and invest in, innovative ways to earn value in the new markets listed under F002. Many of these are solutions that will be needed for the 2030 system, using payments from these markets to support initial investment. These markets are needed to deal with the consequences of consumer demand and generator output – to avoid serious system problems. If these solutions and market participants could access the traded markets, could this system imbalance be avoided in the first place? In short, would it be cheaper for consumers and generators to avoid these issues rather than manage the potentially severe impacts?		
Conclusion	Consider how new solutions could avoid system issues and if this offers a lower cost route to manage future system challenges.	**Relevant functions**	H1

Reference: F010 – New Metrics for the flexible energy system			
Finding	**In moving to a flexible and low carbon energy system, new metrics will be needed to measure system performance.**		
Discussion	Compared to DNOs, DSOs will need a very different set of metrics (beyond CI and CML) to measure performance. Metrics will need to evolve to reflect new services and new priorities. For example, flexible connections that might allow disconnection of homes with storage or EVs in operation. In the transition to low then zero carbon forms of energy, carbon savings will be a less useful metric. Hence more fundamental metrics such as energy efficiency, or system energy losses, or cost, may be more appropriate in future.		
Conclusion	Consider new metrics for energy system performance associated with FPSA functions, metrics that recognise that DSO functions and low carbon will be the norm, so new metrics will be needed.	**Relevant functions**	A1, E1

Reference: F011 – Engaging public sector and local stakeholders			
Finding	**In moving to a low carbon energy system, local stakeholders will be more important (local authorities, smart city developers etc.).**		
Discussion	Local energy system concepts will need local authorities, urban regeneration companies, smart city initiatives to work with the electricity sector and solution providers and consumers. However, the electricity system is becoming increasing complex, a trend that will continue. At the same time public sector expertise in energy is reducing, through reductions in head count and focusing on core statutory duties.		
Conclusion	Electricity industry players will need to work harder to engage with and develop local solutions with public bodies and local project initiatives.	**Relevant functions**	H5, H1, C2, C4

Reference: F012 - Current licences create barriers to more flexible systems and entry of new players			
Finding	**The current licences embed current commercial models on the main industry participants.**		
Discussion	The current licences define the commercial operation of the main power sector players. The increasing interest in peer-to-peer trading has put a focus on the supply licence. The requirements of the supply licence require a significant customer base, to recoup the investment in starting up and to manage the risks of trading and imbalance. It is unlikely that the commercial models that are built into the supply licence will serve all of the needs for the future. One specific example was to provide a back office function as a separate activity – serving small scale suppliers.		
Conclusion	New commercial models will be needed and with this different forms of licence. This may be a longer term change.	**Relevant functions**	H3, H4, F1

Reference: F013 - Cost savings for customers need to be at the core of new markets			
Finding	**Cost savings for customers may be overlooked in the drive to innovate and use smart and flexible systems.**		
Discussion	The affordability of energy needs to be a key issue in the development of the FPSA functions. This should also include assessment of any distributional aspects – will some groups of customers be unable to access the benefits or be disadvantaged? One stakeholder observed that ancillary services will be an increasing percentage of bills – so all customers would have an opportunity to reduce this by participating in the relevant markets.		
Conclusion	Cost to consumers and the social impacts of changes need to be included in development and implementation of FPSA functions.	**Relevant functions**	H1, H5, H6, F1

Reference: F014 - RIIO will not deliver the transition to DSOs			
Finding	**The current price control will not enable DNOs to make the transition to DSOs.**		
Discussion	Several stakeholders were looking forward to the flexibility and opportunities that the transition to a DSO would offer. However, several of these pointed out that the current price control would not deliver this. This degree of change was not included in the current price control – but these comments show stakeholders are already anticipating the advent of DSO activities.		
Conclusion	Not an FPSA function, but will need clarity of the timescale and regulatory pathways for the transition to DSO management of networks.	**Relevant functions**	N/A

Reference: F015 - The increasingly complex energy system needs to allow customers to understand their interactions			
Finding	**Complex energy systems and markets will need to be presented to customers in ways that they can understand and validate.**		
Discussion	Several stakeholders were concerned about the likely complexity in future markets, e.g. DSR for domestic customers. This concern covered the likely uptake, given that switching supplier is low, and the ability of customers to understand and validate a bill that includes savings from DSR activities.		
Conclusion	This will require care in how market propositions are explained, and how the billing information is provided – to show the impact of DSR actions.	**Relevant functions**	H3, H4, H5, H6

Reference: F016 - Require a greater degree of innovation and faster application of innovation			
Finding	**Innovative solutions will be needed to deliver the smart flexible system, so greater levels of innovation will be needed.**		
Discussion	Stakeholders commented on the greater need for innovation and a greater pace for innovation. There were also calls for different options for which organisations could apply for and use innovation funding; DNO only funding and funding for other organisations.		
Conclusion	This is highly likely to be the case, and is explicitly allowed for in function F1.	**Relevant functions**	N/A

Reference: F017 - Existing codes and regulation are obstacles			
Finding	**The electricity system has many codes and regulations, many of these do not anticipate the innovative ideas and propositions now proposed.**		
Discussion	This point was made in a generic and in specific ways. Specific examples included: • The limits in G83 and G59 and how these are perceived as barriers to adding energy storage. • The Data Communications Company (DCC) is not well designed for DSR, due to third party access to data and day+1 data transfer. More generically the codes and contracts act as an obstacle to local systems and solutions, including DSR. Many aspects of smart and flexible operations were not anticipated in the codes – so this is not surprising. A core part of FPSA thinking is around the speeding up of changes to codes to support new ideas.		
Conclusion	Codes and regulations need to change to enable new solutions and commercial propositions – the modification of regulations, codes and standards needs to be more agile.	**Relevant functions**	C5, E6, E7

Reference: F018 - Access to information			
Finding	**Information on assets and system operation needed for operations of systems and markets.**		
Discussion	Many stakeholders commented that greater sharing of information would be needed in order to allow existing and new assets to be used to manage the power system. This point was made by DNOs and market players. The advantages included greater visibility of assets as well as greater liquidity in markets and hence more completive and cost effective new markets.		
Conclusion	Access to asset and operational data will be needed to support the efficient and cost effective operation of new markets and services.	**Relevant functions**	C1, C2, C6

Reference: F019 - Need viable business models			
Finding	**Changes to the GB system and the new FPSA functions need to result in solutions that can be funded and hence deliver the benefits expected.**		
Discussion	Several stakeholders commented on the need for business models to be investable. This applies to DNOs as well as owners of generation, storage, aggregators etc. A smaller number commented on the need for any changes to be acceptable to funders of existing generation assets.		
Conclusion	The need to have viable business models and attract funding should be considered in the design of FPSA functions. This might need funders to be part of the stakeholder groups in the enabling functions.	**Relevant functions**	F1

Reference: F020 - Need greater skills to deliver a smart flexible system			
Finding	**The skills in the network companies will need to develop to deliver a smart flexible system.**		
Discussion	Several stakeholders noted the increasing complexity of the technical solutions and the associated regulatory and commercial frameworks. The need for increasing levels of skill were noted – as more solutions will be available and they will be more flexible, requiring greater analysis to ensure successful implementation.		
Conclusion	The smart flexible GB electricity systems will require greater level of skills – though this is not an aspect for FPSA to deliver. Not a function, but the need to have viable business models and attract funding should be considered in the design of FPSA functions. This might need funders to be part of the stakeholder groups in the enabling functions.	**Relevant functions**	N/A

Reference: F021 - Need greater co-ordination between electricity, transport and heat sectors			
Finding	**To manage the impact and cost of low carbon heat and transport requires greater co-ordination and accommodation of these energy vectors in planning and implementation of networks.**		
Discussion	Several stakeholders made points on the current level of recognition of energy vectors in planning and connecting heat and transport systems. This covers: • Connection consumption and peak demand from charging electric vehicles. • Connection consumption and peak demand from heat pumps. • Enabling the use of CHP to supply heat and electricity. • Enabling the flexible use of heat and transport systems, to create, store and trade energy. • Installations of heat and broadband systems alongside electricity related street works.		
Conclusion	Will require greater consultations with, understanding of, and working with, operators of other energy systems and utilities.	**Relevant functions**	B1, B2

Reference: F022 - ANM is a partial solution - need greater range of solutions			
Finding	**Advanced Network Management has successfully enabled connection of generation, but this has not been possible in all cases.**		
Discussion	Several stakeholders noted that ANM solutions only offer a partial solution to grid constraints, as the available capacity can quickly get used, e.g. in areas where there is a high level of solar PV seeking connection. Hence, greater innovation needed to provide new solutions that free capacity. This might include real-time thermal ratings and other ways to increase capacity.		
Conclusion	ANM is a useful tool, but will reach limits, so new solutions and approaches will be needed – which is core to the purpose of the FPSA programme.	**Relevant functions**	F1

Reference: F023 - Greater co-ordination between SO and DNOs to provide a co-ordinated approach to flexible and ancillary services			
Finding	**The operations undertaken by DSOs will require good co-ordination with operations undertaken by the SO.**		
Discussion	One stakeholder cited an example where SO and DNO systems had both been used to manage network issues – but the two actions taken had counter-acted each other and no net benefit was realised. With increasing SO ancillary markets and potential local markets managed by DSOs, there is an obvious need for greater co-ordination.		
Conclusion	Greater co-ordination will be needed between SO and DNOs to provide a co-ordinated approach to flexible and ancillary services.	**Relevant functions**	A1, C5, E6, E7

Reference: F024 - Smart meter specification and roll out not supporting opportunities			
Finding	**The staged roll out of smart meters does not enable the full range of opportunities expected.**		
Discussion	Several stakeholders commented that the current roll out of smart meters does not support the solutions and business models that they have in mind. Examples include supplier switching and half-hour trading for local generation and demand. This is a result of the SMETS1 meters being currently installed and some gaps in the current functionality and communication systems. When SMETS2 meters are used it is expected that many of these issues will be resolved.		
Conclusion	Smart meter roll out using SMETS2 meters needs to be completed.	**Relevant functions**	H2, H4

Reference: F025 - Reliance on open systems and risk of cyber-attack			
Finding	**Greater use of technology with internet of wireless communications raises risks of cyber-attack.**		
Discussion	In general, traditional industry players considered that they had cyber-attack issues well covered – however the nature of this topic meant that details were not discussed. However, one stakeholder noted the risks in having greater use of open systems and the risk this posed for cyber-attack. This is a greater risk for the behind the meter systems, were these issues not considered by consumers and the equipment suppliers. Though it was noted that if there were a diverse range of equipment types and providers, this diversity would reduce the risk of an attack and have complete success.		
Conclusion	Cyber-attack risks will need to be considered by the sector, the equipment providers and users.	**Relevant functions**	F4

3.6 Future use of stakeholder insights

There are many details of specific stakeholder requirements and stakeholder obstacles in the interviews and in the analysis of the requirements and obstacles. This report does not identify which stakeholders raised each requirement or obstacle – to encourage stakeholders to share insights.

However, the full details of the requirements and obstacles could be used in future FPSA work by providing a valuable and easy test to confirm that any changes in the definition or proposed implementation of the functions continues to address the requirements and obstacles highlighted by different stakeholders.

4. Conclusions

This section takes the two sources of evidence, the consumer survey and the stakeholder interviews, and draws out key points from both sources.

A primary role for the WP1A stakeholder survey was to gather stakeholder views on requirements and obstacles, and to check how well the proposed FPSA functions address these requirements and obstacles and their root causes.

118, or 77%, of the requirements and obstacles could be linked to FPSA functions – so the majority of the issues raised were clearly addressed by the proposed functions. Several of the other issues, e.g. governance, could be addressed through the details in the *Enabling Frameworks*, the processes that will develop and implement the FPSA functions.

In addition to the requirements and obstacles that are relevant to the proposed FPSA functions, there were requirements and obstacles that are important, but are not covered in the scope of FPSA and hence the functions, or are pre-requisites for the FPSA functions. 6% of the requirements and obstacles were classified as pre-requisites and a further 13% were classified as being outwith the scope of the FPSA programme. Three examples include:

1) Innovative solutions will be needed to deliver the smart flexible system, so greater levels of innovation will be needed. Several stakeholders commented on the greater need for innovation and a greater pace for innovation. There were also calls for different options for which organisations could apply for and use innovation funding; DNO only funding and funding for other organisations. The FPSA functions do not address innovation – this is an issue outwith the scope of FPSA.
2) Skills were mentioned several times, as the smart and flexible system envisaged will require a greater degree of skill in the technical specialists that specify, implement and manage the more complex systems expected.

3) Environmental performance was mentioned several times, covering energy efficiency, carbon targets and the use of diesel generation. It is assumed that the implementation of FPSA functions will be achieved using solutions that comply with all of the relevant environmental legislation. However, the issues raised by stakeholders were considering setting better practical than the minima set down in legislation.

This highlights an important issue – that the reporting and communication of FPSA functions needs to be accompanied by an explanation of what is in scope and what is out of scope.

In addition to the detailed points above, the analysis of requirements and obstacles showed that many of these related to several functions, in some cases five or more functions. Hence, to address the root causes of the stakeholder identified requirements and obstacles will mean that several functions will need to be implemented; implying the need for a co-ordinated programme.

Example issues that were mentioned frequently include:

1) The most common issue attracting comment was the need for a level playing field in markets. This was expressed in two ways: firstly in terms of access for all scales of technology for all types of participant. One observation was that ancillary services will be an increasing proportion of future electricity bills, so all consumers will need access to ways to reduce this. The second point was that all forms of technology solution should have access to markets – the point being that rules some time explicitly or implicitly rule out some types of solution.
2) Connection issues were the second most common issue raised. Only one FPSA function directly addresses connection – but this is a key current issue for stakeholders. It is also important for the success of the FPSA vision – as this requires that a wide range of systems are connected. Connection issues were raised for generation, storage and demand sites. The common theme was a lack of strategic articulation and investment. This covered the approach to connecting strategic development sites, e.g. key city economic development zones, as well as a more joined up approach to managing connection queues caused by auctions for ancillary services markets.
3) Access to information was raised almost as often as connection. Both DNOs and market players saw a need for sharing greater information on the assets connected to distribution networks and sharing data on system operation. The key driver was increasing visibility so that participation could be wider, leading to greater market liquidity and more cost-effective local markets for network support services.
4) Governance in decision-making on the codes and regulations that govern the power sector was a key obstacle for several stakeholders. This included the institutional inertia in current systems, given that the incumbent players have most of the apparent power in the relevant groups that determine what changes are made. The resources needed to attend and provide analysis and evidence was cited as a further obstacle. Finally, there were some practical points made about the balance between increasing representation and the need to increase speed in decision-making.

Finally, the consumer survey shows an interest in the innovative and smart systems that are the vision behind the FPSA functions as well as being at the heart of the *Gone Green* scenario. The business ideas and innovations being developed by several of the stakeholders will help implement this vision. However, there were several notes of caution, in particular over the real level of take-up by consumers. Points made included the high level of financial incentive needed to create interest in DSR amongst domestic consumers. The need to make these market propositions easy for consumers to understand and use was also made. In conclusion, there was optimism from many stakeholders, but also balancing caution from others. As the cautious view was based on past experience of DSR trials, this is the more important evidence, underlining the need to strive to engage consumers and to minimise the obstacles to their participation.

5. Glossary of Terms

This section provides proposed definitions of key terms relevant to this Work Package, for consolidation into the FPSA2 project glossary.

Discovery Interview	Using the standard set of open questions to uncover stakeholder identified requirements, obstacles and views on functions required.
Focused Interview	Interview requested by other Work Packages with specific questions from these Work Packages.
Requirement	A requirement from the GB electricity system that stakeholders expect to be needed in current or future years.
Obstacle	Obstacle in the current or future market that will prevent, or restrict, adoption of new solutions. This is a differentiation from the obstacle facing the implementation of the functions, covered in WP3.

Annex 1: Consumer Survey Questions

Detailed questions on each system

Block 1: Broad views

Please indicate how strongly you agree or disagree with the following statements

	I Strongly Agree	I Agree	I Neither Agree or Disagree	I Disagree	I Strongly Disagree
Q1: In the future I would like to become more self-sufficient in energy (e.g. by using solar panels, or other technologies to generate electricity in my home).					
Q2: If in future I have solar panels, then I would like to use a home energy store, storing electricity generated from my solar panels at times when I don't use it, or by having my appliances (e.g. my dishwasher) automatically switch on at times when there is electricity available from my solar panels.					
Q3: In the future I would like to 'drive from the sun', by charging up my electric car at home from my solar panels.					

Block 2: Detailed Questions on each System

Green electricity tariff

Many electricity companies now offer to supply customers from generation that is renewable, so from wind, solar, hydro and other forms of renewable energy.

Examples include Ecotricity's Greenenergy tariff or Co-operative Energy's Green Pioneer tariff.

Q4: For 'green electricity tariff' please select one of the following answers:

- I already have this.
- I am getting this for my home.
- I don't have this, but I'm strongly aware of this.
- I don't have this, but I'm moderately aware of this.
- I don't have this, and have little awareness of this.
- I don't have this, and have zero awareness of this.

If answer to Q4 is 'I already have this' or 'I am getting this for my home' move to the 'Solar Electricity Panels' section, else move to Q5.

Q5: Please indicate how interested you are in getting a green electricity tariff

- Strongly interested in getting.
- Moderately interested in getting.
- Low interest in getting.
- Zero interest in getting.

Solar Electricity Panels

Solar electricity panels – commonly known as solar PV – capture sunlight and convert it into electricity to run household appliances and lighting. Typically, solar PV can provide half of your annual electricity needs. Solar PV can be added to a house, with the existing heating system still providing all of the heating and hot water needs.

Typical home solar electricity system.

Q6: For 'solar electricity panels' please select the answer that applies to you from the following:

- I already have this.
- I am getting this for my home.
- I don't have this, but I'm strongly aware of this.
- I don't have this, but I'm moderately aware of this.
- I don't have this, and have little awareness of this.
- I don't have this, and have zero awareness of this.

If answer to Q6 is 'I already have this' or 'I am getting this for my home' move to Q8, else move to Q7.

Q7: Please indicate how interested you are in getting solar electricity panels for your home.

- Strongly interested in getting.
- Moderately interested in getting.
- Low interest in getting.
- Zero interest in getting.

If Q7 is answered, move to 'electric vehicle and plug in hybrid vehicle' section.

Q8: Have you encountered any of the following problems? [Select all that apply or "no problems experienced"]

- Connecting the solar PV to the electricity network.
- Meters operating incorrectly.
- Electricity supply cutting out.
- Other issues – please describe.
- No problems experienced.

Electric Vehicle and Plug In Hybrid Vehicle

An electric vehicle uses a battery and electric motor, it is charged using electricity. Examples include the Nissan Leaf and the Renault Zoe.

Plug In Hybrid vehicles include a battery and an electric motor, combined with a petrol/diesel engine. Examples include the Mitsubishi Outlander P-HEV and the Vauxhall Ampera.

Both types can be charged from the electricity system.

Q9: For 'Electric Vehicle and Plug In Hybrid Vehicles' please select the answer that applies to you from the following:

- I already have this.
- I am getting this for my home.
- I don't have this, but I'm strongly aware of this.
- I don't have this, but I'm moderately aware of this.
- I don't have this, and have little awareness of this.
- I don't have this, and have zero awareness of this.

If answer to Q9 is 'I already have this' or 'I am getting this for my home' move to Q11, else move to Q10.

Q10: Please indicate how interested you are in getting an electric vehicle or plug in hybrid vehicle.

- Strongly interested in getting.
- Moderately interested in getting.
- Low interest in getting.
- Zero interest in getting.

If Q10 is answered, move to 'Heat Pump for heating and hot water' section.

Q11: Have you encountered any problems? [Select all that apply or "no problems experienced"]

- Installing an electric vehicle charging point at home.
- Electricity system at my home tripping out.
- Running out of charge when travelling.
- Finding and using public charging points.
- Other issues – please describe.
- No problems experienced.

Heat Pump for heating and hot water

A heat pump is a device that replaces your existing heating system. It works with radiators or underfloor heating. It can provide all your heating and hot water needs, just like a boiler.

Instead of burning fuel to produce heat, it uses electricity to harness heat from the outside air or the ground. Heat pumps can be up to 300% efficient – so for every one unit of electricity it consumes it gives three units of heating out (for comparison a typical central heating boiler uses one unit of fuel to produce around 0.9 units of heating out).

Q12: For 'Heat Pump for heating and hot water' please select the answer that applies to you from the following:

- I already have this.
- I am getting this for my home.
- I don't have this, but I'm strongly aware of this.
- I don't have this, but I'm moderately aware of this.
- I don't have this, and have little awareness of this.
- I don't have this, and have zero awareness of this.

If answer to Q12 is 'I already have this' or 'I am getting this for my home' move to Q14, else move to Q13.

Q13: Please indicate how interested you are in getting a heat pump for heating and hot water for your home.

- Strongly interested in getting.
- Moderately interested in getting.
- Low interest in getting.
- Zero interest in getting.

If Q13 is answered, move to 'A home electricity store' section.

Q14: Have you encountered any problems? [Select all that apply or "no problems experienced"]

- Getting a heat pump installer.
- The capacity of the electricity supply for my home.
- Heating tripping out due to electricity supply issues.
- Operating the new heating system.
- Other issues – please describe.
- No problems experienced.

A home electricity store

This system stores electricity in your home, this can be used alongside home electricity systems such as solar electricity, storing the electricity you produce to be used later in the day or in the following days. Examples include the Tesla PowerWall and the Powervault G200.

Q15: For 'a home electricity store' please select the answer that applies to you from the following:

- I already have this.
- I am getting this for my home.
- I don't have this, but I'm strongly aware of this.
- I don't have this, but I'm moderately aware of this.
- I don't have this, and have little awareness of this.
- I don't have this, and have zero awareness of this.

If answer to Q15 is 'I already have this' or 'I am getting this for my home' move to Q17, else move to Q16.

Q16: Please indicate how interested you are in getting a home electricity store for your home

- Strongly interested in getting.
- Moderately interested in getting.
- Low interest in getting.
- Zero interest in getting.

If Q16 is answered, move to 'a smart meter' section.

Q17: Have you encountered any problems? [Select all that apply or "no problems experienced"]

- Getting a home energy store installer.
- Finding a suitable location for the energy store.
- Connecting the electricity store to the electricity system in my home.
- Confirming energy cost savings made.
- Other issues – please describe.
- No problems experienced.

A Smart Meter

A smart meter is the new version of gas and electricity meters and is currently being rolled out across the country. They measure the gas and electricity you are using, and show how much you are spending in pounds and pence. An accompanying 'in-home display' is also provided with them. This is a portable device which you can take around the house and is intended to make it a lot easier to track your energy consumption.

The key benefit is that smart meters send automatic meter readings directly and securely to your energy supplier, resulting in more accurate bills and you no longer having to provide meter readings (or wait in for the reader to come around) and you can receive near real-time estimates on your fuel use.

Q18: For 'a smart meter' please select the answer that applies to you from the following:

- I already have this.
- I am getting this for my home.
- I don't have this, but I'm strongly aware of this.
- I don't have this, but I'm moderately aware of this.
- I don't have this, and have little awareness of this.
- I don't have this, and have zero awareness of this.

If answer to Q18 is 'I already have this' or 'I am getting this for my home' move to Q20, else move to Q19.

Q19: Please indicate how interested you are in getting a smart meter for your home

- Strongly interested in getting.
- Moderately interested in getting.
- Low interest in getting.
- Zero interest in getting.

If Q19 is answered, move to 'Smart heating' section.

Q20: Have you encountered any problems? [Select all that apply or "no problems experienced"]

- With the smart meter installation.
- Reading the information on energy use.
- Using the in-home energy display.
- Using the information to save energy.
- Other issues – please describe.
- No problems experienced.

'Smart' heating

Smart heating systems are home automation systems for controlling a home's central heating. They allow the user to control the temperature of the house throughout the day using a schedule. Smart heating systems are typically internet-connected, which means that homeowners can change their heating preferences from anywhere using other internet-connected devices such as smart phones and tablets.

Some smart heating systems also have learning capabilities and can automatically learn when the house is likely to be occupied, and when it is likely to be empty. This allows them to automatically pre-heat or pre-cool the house, so the temperature is suitable when you arrive home. Examples include Nest, Hive and Samsung Smart Things.

Q21: For 'smart heating' please select the answer that applies to you from the following:

- I already have this.
- I am getting this for my home.
- I don't have this, but I'm strongly aware of this.
- I don't have this, but I'm moderately aware of this.
- I don't have this, and have little awareness of this.
- I don't have this, and have zero awareness of this.

If answer to Q21 is 'I already have this' or 'I am getting this for my home' move to Q23, else move to Q22.

Q22: Please indicate how interested you are in getting smart heating for your home

- Strongly interested in getting.
- Moderately interested in getting.
- Low interest in getting.
- Zero interest in getting.

If Q22 is answered, move to Q24.

Q23: Have you encountered any problems? [Select all that apply or "no problems experienced"]

- With the installation of the smart heating system.
- Reading the information on energy use.
- Using the controls and information to save energy.
- With my smart phone or tablet connecting with the heating system.
- With the boiler and heating responding to the controls on my smart phone or tablet.
- Other issues – please describe.
- No problems experienced.

Q24: Have you experienced any other issues with the new smart systems we have asked about and how they work with the electricity system? Open response.

Q25: What other new energy systems are you looking to use in your home? Open response.

Part 2: Local Energy Supply

Local Energy Supply

Q29: When did you last change electricity supplier?

- In the last month.
- In the last 3 months.
- In the last 6 months.
- 1 year ago.
- 2 years ago.
- More than 2 years ago.
- Never.

Buying your electricity

In the future, electricity may be produced and sold by a wide range of organisations or even your neighbouring homeowners. This will arise from increasing use of local generation e.g. small and medium scale solar power, wind energy and hydro power schemes. These may be owned and operated by the local council, a local business (e.g. a supermarket) or individual homeowners.

Q30: If the price for electricity was attractive and switching to buy electricity locally was simple and easy to do, please indicate how you feel about buying your electricity from the following source/organisations:

For each source, select one option only

Local sources such as a neighbour's solar panels	Not interested	Moderately interested	Strongly interested	Already buying from this source
A not-for-profit local authority backed energy company	Not interested	Moderately interested	Strongly interested	Already buying from this source
The lowest possible cost supplier, regardless of where the electricity comes from	Not interested	Moderately interested	Strongly interested	Already buying from this source

If answer to Q30 is 'not interested' or 'moderately interested' for any of the sources/organisations, go to Q31, else FINISH.

Q31: What issues would concern you about buying from [pick examples where the previous answer was 'Not interested' or 'Moderately interested'. Open response.

FINISH

Annex 2: Stakeholder interview topics

Past Experience	
Q1	Please describe a current or past energy-related initiative or project that you have been involved with.
Q2	To what extent was this innovative, and in what ways?
Q3	What did you learn?
Opportunities	
Q4	What are the opportunities to replicate the type of project or initiative that you are working on?
Q5	What are the opportunities to innovate to make this type of project or initiative better?
Obstacles and constraints	
Q6	What would have made your project or initiative easier?
Q7	What did you do to get round the issues that you encountered?
Q8	What were the external obstacles and constraints that you faced?
Q9	Which are the greatest obstacles and are they interrelated?
Q10	What would happen if these obstacles were not removed?
Q11	What do you see as the root causes of these obstacles and constraints?
Requirements from the power system	
Q12	What do you need the power system as a whole to do, to enable the projects and initiatives that you have in mind?
Q13	How will this change in the future i.e. what will you need in 5 and 10 years time?
Functions needed from the power system	
Q1	What functions do you (or your projects, clients etc.) need the power system to perform that are not available now?
Q2	What requirements need to be done to make changes in the power system a success?
Q3	When do you expect these new functions to be needed?
Final Information	
Q4	What projects, initiatives or ideas are you expecting to undertake next?
Q5	Which stakeholders should we involve in the FPSA programme?
Q6	What else would you like to say?
Q7	Could we use the example or quote you?
Outro	
Q8	If we have further questions - would you be happy to be contacted again, by phone or email?
Q9	How do you prefer to receive information about developments in the industry?
Q10	Can we add your details to our database e.g. to receive the FPSA2 report?

Annex 3: Stakeholder Workshop

Interviewees were invited to a workshop on 23rd March, 11 sector stakeholders attended, along with representatives from WP4, WP5 and WP6.

The attendees were:

Sector Stakeholders

First Name	Last Name	Organisation
Sam	Wevers	Centrica Connected Home
Stew	Horne	Citizens Advice (by phone)
Syed	Ahmed	Energy for London
Erwin	Frank-Schultz	IBM
Richard	Hardy	Kiwi Power
James	Johnston	Open Utility
James	Mulroney	Smarter Grid Solutions
Leonie	Greene	STA
Judith	Ward	Sustainability First
Aimee	Betts-Charalambous	TechUK
Matthew	Webb	TFL

FPSA Team

First Name	Last Name	Organisation
Sacha	Meckler	Analysys Mason
Mark	Chambers	Energy Systems Catapult
Duncan	Botting	Global Smart Transformation
Gordon	Graham	The IET
Mike	Kay	P2A
Olivia	Carpenter	Ricardo Energy & Environment
John	Harvey	Ricardo Energy & Environment
Colin	McNaught	Ricardo Energy & Environment

The agenda for the workshop

Last Name	Organisation
10:00 - 10:30	Registration and Coffee
10:30 - 10:45	Brief introduction to FPSA and the facilitators
10:45 - 11:30	Review of market requirements and obstacles identified by stakeholders
11:30 - 12:30	Working groups: Feedback
12:30 - 13:00	Ensuring FPSA is addressing these requirements and obstacles
13:00 - 14:00	Lunch
14:00 - 14:15	Working groups: Synthesis of attendees views on requirements and obstacles and the FPSA functions

The stakeholders were gathered as three groups on separate tables.

Ten examples of requirements and obstacles were presented to the stakeholders. These were chosen to reflect:

- Examples that were mentioned by several stakeholders – so likely to be of wider importance and relevant to the workshop attendees.
- Examples that were relevant to the stakeholders who had registered for the workshop.

The delegates were asked to vote for those requirements and obstacles that they considered most important – each stakeholder was only given five votes – so they needed to prioritise which of the ten examples were most important. The ten examples and the votes are shown in the following table:

The stakeholders were also asked to provide additional examples of requirements and obstacles in addition to the ten examples presented. Eight further examples were provided, listed below, all eight of these were added to the analysis of requirements and obstacles.

Table 16: Workshop attendee votes for key requirements and obstacles

Ref	Requirement or Obstacle	No of Votes
1*	**Requirement:** How to identify and use asset information - for local energy concepts and DNOs.	8
2	**Obstacle:** open systems are open to attack, e.g. if common interfaces and standards are used.	3
3	**Obstacle:** Generic issue is that markets may not always offer a level playing field for all technologies and bidders.	3
4	**Obstacle:** Technical solutions to network issues may not be acceptable to investors and hence will not provide the solutions needed. So ANM or adding storage to generation sites may not work if the funders cannot agree.	2
5*	**Obstacle:** Peer-to-peer trading is very significantly constrained by the need to buy services from a licenced supplier. Could have a new entity, a market enabler who provides market balancing and settlement services for local energy suppliers, new entrant suppliers.	8
6	**Obstacle:** LA plans for economic development require large scale investment in reinforcement. Needs a mechanism to allow strategic investment to be carried out, with cost recouped by the DNO over time and new connectees to use the new infrastructure.	4
7	**Requirement:** Customers will need simple propositions in the DSR and other markets, which can be understood before sign up and the resulting bill (or income) can be understood and verified.	6
8	**Requirement:** Local matching of generation and demand, reducing net flow in wider network, looking for nodal incentives for matching.	5
9*	**Requirement:** SO and DNO need to co-ordinate - cited an example in a different DNO area where the SO called for a 5MW STOR reduction and due to the local ANM this resulted in 5MW of DG being curtailed.	8
10	**Obstacle:** Governance - the process of changing codes is dominated by the large market players.	4

Table 17: Workshop attendee additional examples of requirements and obstacles

Type	Details
Requirement*	Consider winners and losers from system architecture changes.
Obstacle*	Rigid two-tier definition of networks (obstacles to micro-grids etc.).
Obstacle	Market structure – change to RIIO Revenue not aligned for DNOs to facilitate this system change. To unlock the market. Moving away from need to build more network capacity.
Requirement	Multi-vector/cross-sector co-ordination is lacking: transport, energy, heat, customers in London.
Obstacle	Obstacle to process: lack of skills. Ability to understand technology and how to derive maximum value from technology, within the context of the power sector. Technology can be installed but is there the capacity to implement.
Requirement	What can/should government do vis-à-vis markets.
Obstacle	Capacity of network is constrained which impacts upon ability to deliver zero carbon transport in London.

In the final workshop session, three of the pre-selected and two of the attendee selected requirements and obstacles were selected to identify the functions that addressed these issues.

These examples are indicated by an asterisk (*) in the two preceding tables. In all five cases, functions were identified that addressed these requirements and obstacles.

The Institution of Engineering and Technology

CATAPULT Energy Systems

Future Power System Architecture Project 2

Final Report

Work Package 1A:

Insights into requirements of existing and new parties

The full set of FPSA2 documentation including the Main Synthesis Report, Policy Briefing paper, individual Work Package Reports and project data files are available online via the Institution of Engineering and Technology and the Energy Systems Catapult.

www.**theiet**.org/fpsa

es.catapult.org.uk/fpsa

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