Consultation response

Setting Standards for Smart Appliances

Do you agree that the government should take powers to allow for regulation on standards for smart appliances?

Government should encourage industry-led standards development wherever possible.

A government power to regulate standards is a valid way to proceed, however it is not the only way. The Global System for Mobile (GSM) technical standard governing digital mobile telephony was developed by many organisations but with effort guided and supported through political means. Similarly, the Universal Serial Bus (USB) technical standard was developed by a consortium of private companies.

In these examples, innovation has been rapid. It would have been very hard for any government to mandate in practice. The world is already headed towards fifth generation digital mobile telephony.

In some respects, smart appliances are similar to digital mobile phones. Smart appliances have the potential to help or to hinder the networks they are attached to. Any appliance needs to work with any Supplier, any smart home controller, any Distribution Network Operator and so on; therefore, co-development is essential. There are likely to be multiple generational leaps as new opportunities and sources of value are discovered; it will be very hard to keep up with mandating standards.

Energy Systems Catapult recommends considering the goodwill and "buy-in" of organisations to a standard that comes from more active participation of industry. Alongside acquiring the powers to step in where required, we would suggest the government considers creating a market and innovation environment favourable to co-development and practical demonstration of the required standards (e.g. through the industrial strategy challenge fund or sponsoring an industry body to lead in this space). Government could set overall objectives, such as ease for consumers to switch provider and, in return, the industry players able to meet the objectives could be granted new regulatory freedoms.

Government should ensure an appropriate overall commercial framework is in place.

The proposal to build in frequency responsiveness to heating, ventilation and cooling appliances could create value for the Transmission network by potentially reducing the cost of procuring frequency response. However, it has the potential to introduce liabilities for other parties.

- For the Supplier, they will be exposed to the imbalance liability for energy they have bought but not used due to appliances not running due to a low-frequency event (or vice versa).
- For the Distribution network, coordinated response of appliances in response to a national frequency issue may create a local voltage issue.

The overall commercial frameworks and metering arrangements to ensure traceability to acts or omissions of each party are as important as the technical standards for individual smart appliances.

Energy Systems Catapult has undertaken extensive work on how to apply the methods used in other industry sectors, such as global mobile telephony and modern computing, to develop suitable commercial frameworks that can stimulate and support a rapid pace of innovation across organisational silos. An overview is available in our 'Enabling Multi-vector Market Design' report.

Government should plan for whole-system stability and security risks that might emerge.

Standards for smart appliances should not be made independently of other system considerations. Continuing with the frequency response example, multiple smart appliances increasing or decreasing load in response to frequency have the potential to introduce highly problematic system behaviours if their control algorithms are conflicting rather than complementary.

Further, information systems associated with smart appliances will introduce new cyber-security risks.

Holistic system simulation is a low-cost way to evaluate such interactions. However, the government needs to be mindful that such stability and security risks are emergent properties of the whole system as opposed to the behaviours of one individual organisation. Consequently, individual organisations are unlikely to consider it their responsibility.

Energy Systems Catatpult has developed a capability to help with this here.

Do you agree that a label is a good way to engage consumers with smart appliances? Please include your views and experiences with key aspects of labels which are most effective at engaging consumers, including analysis on uptake of the relevant device.

Government should ensure labels explain consumer benefits clearly and consistently.

Energy Systems Catapult has undertaken extensive consumer research on heating and mobility. This response is based on this evidence.

Insights on domestic heat are available in our 'How can people get the heat they want at home without the carbon' report.

Insights on transport are availaable in the Energy Technologies Institute's report 'An affordable transition to sustainable and secure energy for light vehicles in the UK'.

The energy industry does not have a history of consumer engagement. This is in part because the benefits are often not of direct value to end consumers. An education campaign is unlikely to make significant headway unless it is oriented towards promoting immediate consumer benefits. As an analogy, the "HD Ready" label was one many consumers found helpful when buying a new television as it articulated future utility of the appliance of direct relevance to the experience.

Energy Systems Catapult has run extensive trials of advanced domestic energy services enabled by smart appliances. The insights are available in our 'Domestic Energy Services' report.

The mainstream consumers involved clearly value being able to compare offers easily. Clear labels with consistent definitions are critical to enabling this. However, innovation inevitably involves constant change. Government should consider including responsibility to curate such a language into its sponsorship of the industry body mentioned in the answer to question one.

There is a risk that a label would just encourage businesses to do what is on the label, rather than learn how to deliver a consumer benefit and to innovate as expectations evolve.

Government should use powers to regulate standards sparingly for systemic issues.

Certain smart appliance features, such as frequency responsive heating, ventilation and cooling appliances, might deliver substantive overall system benefits but limited direct consumer benefits.

Embedding frequency responsive controls into appliances could reduce costs for day-to-day grid balancing or it might be limited to a failsafe mechanism in case of a major cyber-security breach. Depending on financing arrangements, such benefits may not provide specifically clear benefits to adopting consumers (rather it may be part of some social good) and so including such information on an appliance label is unlikely to change buying choices. The benefits may not even accrue to a given appliance vendor or services provider, so would need to be mandated before being adopted.

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The consultation stage Impact Assessment published alongside this consultation document explores the costs and benefits of the options considered for this policy. It indicates that mandating standards for smart appliances provides the greatest net benefits, compared to voluntary standards. Do you agree with our analysis? In particular, please consider the following, and provide analysis to back up your views:

a. Likely consumer uptake of smart appliances, including which type of consumers and anticipated time frame;

Government should promote the ability to trial business models for LCT deployment, technologies and tariff offerings in a joined-up environment.

Energy Systems Catapult is currently in the process of completing a trial on the purchasing of electric vehicles (EVs) and the consumer's considerations in making such purchases.

Energy Systems Catapult has undertaken significant work in understanding consumers and their behaviour around domestic heating services and has learned that analysis of consumers using appliances yields much greater understanding than surveys and models. The 'Living Lab' capability is available for use to explore options and outcomes, both financial and experiential, of different types of appliances and associated services.

b. Consumer use of the smart function provided by smart appliances in relation to different types of tariffs, including fixed and variable;

Government should ensure an appropriate overall commercial framework is in place.

Energy Systems Catapult has undertaken extensive work on how to deliver heat plans, a smart tariff that delivers heat as a service for a monthly cost rather than charging for kWh, to consumers.

This work aims to understand, shape and bound customer service expectations alongside discovering how to price Heat Plans affordably and competitively. The ESC is also currently completing a trial with consumers on the preferences of buying EVs and of smart charging tariffs. Both of which will have considerable applicability to this work; Q3a and Q3b specifically.

The EV work is being carried out as part of the ETI's Consumers, Vehicles and Energy Integration project and deliverable "D2.1 consumer attitudes and behaviours report" available here provides insight into a lot of relevant consumer research.

c. Potential financial benefits to consumers through smart appliance usage in combination with smart tariffs and offers;

Smart appliances, alone (i.e. without supporting arrangements or tariffs) are unlikely to provide immediate financial benefits to the consumer and even if there is some financial redress, it is possible that it'll to be too small to be interesting to a mass-market of consumers. It is not clear where any financial benefit, to an individual consumer, is likely to come from in a market where kWhs are traded. The uptake of 'smart' appliances, reducing the cost of reinforcing networks and providing more generation would have societal benefits by reducing costs to all, but the incentives to develop and adopt 'smart' approaches will depend on wider arrangements for price formation and value transfer throughout the value chain. This must be carefully considered, including potential impacts on different kinds of customers (e.g. those able to afford smart appliances versus those who are not).

Someone who is affluent enough to buy an EV, charge it off the street (because they can afford a home with off street parking) and PV for their roof (which they will have to own) and a battery (which they'll need to have space for) will stand to gain a great deal more than someone who is not. Do they really need financial reward for avoiding using electricity at peak time? Contrast with someone who has old white goods and 'dumb' electric heating. They will be penalised without

having access to 'smart' appliances.

Energy Systems Catapult has developed a capability, to assess and simulate the movement of value across the supply chain, in a holistic manner, exploring the impact of competing motivations (between different organisations and predicting the financial impact of delivering outcomes.

Government should ensure appropriate overall commercial frameworks are in place.

Realising the full benefits of smart appliances requires clear commercial frameworks for the transfer of value and/or liability to reconcile competing business drivers of different actors in the value chain. For example:

- A Distribution Network Operator (DNO) may have the motive to reduce or delay investment in network upgrades by managing the way appliances are used; but since they have no direct customer relationship this will need to be reflected through commercial incentives on suppliers.
- The Supplier may have the motivation to keep their customer happy, minimise wholesale electricity costs and avoid imbalance penalties; but may not have a commercial agreement to access to the data/control tied into proprietary smart appliances.
- The heat pump vendor has the motivation to increase appliance sales, avoid product warranty issues and safeguard intellectual property embodied in smart thermostats; which may affect the business case for opening access to third parties such as Suppliers or DNOs.

The government could try to mandate standards to deal with these competing objectives, but it is often difficult to keep standards developing at the pace of innovation.

Energy Systems Catapult has undertaken extensive work on how the methods applied in the global mobile telephony, modern computing and other sectors experiencing rapid innovation can be applied into the energy sector to establish suitable commercial frameworks in our 'Enabling Multi-vector Market Design' report.

The total consumption is likely to be the same over time since deferring chilling of a fridge-freezer or delaying the washing cycle is simply a time-shift and so the cost will be picked up later. When a standard price per kWh is used then there is no saving to the consumer. With time-of-use tariffs a 'smart' appliance triggered to protect network performance in one time-period could push consumption into a higher price time period (particularly for cooling appliances that have to operate periodically to avoid spoilage and health risks). This will make deciding on the "triggers" for 'smart' operation require whole-system consideration.

Using appliances more, when energy is plentiful, for example when there is excess wind might not reduce consumer costs if their appliance operates when it's not required. For example, a freezer that is cold doesn't need to chill again (even if the price is low).

d. Monetised and non-monetised costs for industry to comply with standards, including consumer businesses, smart appliance manufacturing businesses, smart appliance service providers, supply chains and the electricity industry (such as Distribution Network Operators);

No specific additional comments.

e. Potential impact on the price of smart appliances which comply with standards compared with non-smart appliances.

No specific additional comments.

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In this document, we have proposed minimum functionalities for each principle. Do you agree with these functionalities? What functionalities should be considered in addition to those listed above? Please divide your responses according to:

a. Interoperability;

Government should ensure appropriate overall commercial frameworks are in place

Energy Systems Catapult recommends that commercial interoperability also needs to be considered. Since 'smart' appliances may unlock services for multiple different organisations with commercial arrangements set up to support. For example, a smart fridge freezer might provide some service to a DNO but the freezer manufacturer may want to see a revenue stream in order to mitigate increased warranty claims, from increased numbers of operational cycles, for example. Business models will need to ensure that consumers are not tied in. For example, smart appliances should be able to be moved to different houses and not be restricted to a given supplier or DNO.

Energy Systems Catapult is conducting work to look at commercial gateways that would look at the standardisation of 'service classes' with a view that all suppliers and DNOs would have a common language to describe the functionalities of an appliance. For example, regardless of the specific device an appliance may offer increase consumption, reduce consumption, store energy, discharge stored energy. With some common service parameters all parties can trade on capabilities and performance without complications of understanding the nuances of every device which also allows for more rapid deployment of new equipment.

b. Grid-stability and cyber-security;

Energy Systems Catapult recommends separating considerations of grid-stability and cyber-security given that the specific problems and solutions are quite different.

Grid-stability issues, around smart appliances, centre around:

1. Government should seek to architect standards in a holistic manner, integrated with other key system resources

    - responsiveness (how quickly can the appliance respond to data, in some cases this will also be as a result of how quickly data can inform the system and be processed) and;
    - co-ordination with other systems

Energy Systems Catapult is developing a capability to simulate and model, at the sub-second time-frame, the impact of different interoperability choices, with the required stabilisers and contingencies need to co-ordinate the different controlling elements (across multiple energy-vectors) within the energy system; from sources (generators) to loads (consumers), via networks. Once set, these decisions will be difficult and costly to change later so Energy Systems Catapult has built a capability to capture ideas, assess options and then propose solutions.

Cyber-security considerations revolving around the threat posed by IoT (internet connected equipment) devices both in terms of are often expressed in terms of:

a) their direct affectedness

1. Government should seek to architect the ICT infrastructure

    - Appliance robustness to cyber-attack is as much a function of the interconnectedness of networks as it is of the appliances themselves. At this point it is probably too hard to legislate (through technical standards) the communications networks and connected technologies. In many cases devices might connect to mobile handsets or home computing equipment which would provide a path to infiltrate IoT equipment. One way

to ensure secure communication would be to mandate the use of the DCC for all smart appliance traffic but this would likely stifle innovation. Compliant devices, however, could be mandated to meet certain minimum standards around port locking etc. and the government may wish to focus here.

b) and then through the impact they can have on other parts of the system

While all reasonable precautions should be taken to make systems resistant to hack, it is sensible to make the assumption that they will one day be hacked. For this reason, concentrating on mitigating the impacts of such intrusion are at least as important as prevention.

As part of a "robustness through architecture" approach, Energy Systems Catapult thinks that an Independent hardware protection protocol (IHPP) is required in future consumer electronic products which detects abnormal voltage and frequency conditions, locally on the grid, and responds to provide an emergency response to critical grid failure, coupled with a randomised "time-delay before on" function following a return to normal to account for black/ cold start conditions, thereby ensuring that there isn't a surge immediately following restoration of supply. These should be isolated from any software / communicative system to prevent 'hacking' and to ensure the fastest possible response times. This level of protection should be in addition to standard reversionary modes such as defaulting to predictable operation in the event of loss of communications etc.

c. Data Privacy;

No specific additional comments.

d. Consumer Protection.

Predicting consumer protection requirements is difficult, and risks both constraining innovation and encouraging providers to meet only the 'minimum bar' of expectations.

Energy Systems Catapulthas conducted extensive research, observing the behaviours of consumers in delivering heating experiences. This research has highlighted the importance of deep understanding of consumers needs and expectations and of tailoring products and services accordingly. The detail around Consumer Protection varies depending on the approach to standards. Where government mandate standards then protections might simply ensure these are being met. In a market place driven by consumer feedback (think of Uber, eBay and AirBnB as examples where consumers rate the service delivered) then rapid feedback informs innovation and evolution of offerings.

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Do you consider that we have correctly outlined above the risks associated with smart appliances? Are there any that are missing and need to be addressed? Please provide evidence.

Energy Systems Catapult believes that the following items should be added to the list of risks:

1. There is a risk that without co-ordination smart device capabilities could make network effects worse by responding in a way that compounds the effect that caused it. For example, if smart devices respond to a network signal to reduce consumption while grid-connected batteries begin to deliver power to the network then system oscillations may occur.
2. Mandating standards can have the effect that innovation stops at the "minimum" expectation and further development might not be seen as cost-effective or necessary.
3. There is a risk that without auto-responsive smart functions built into appliances then cyber-attacks exceed the ability of the National Grid to balance.

Consumer protection is important to the government, and we will continue to monitor and engage with this to ensure consumers are protected in a smart energy system. This work will include assessment of distributional impacts of smart appliances and consideration of product safety provisions. Do you consider there to be major principles of protection which have not been covered above which will be developed into standards for smart appliances?

Government should seek to architect technical standards in parallel with consumer protections.

The ability to interact with a 'smart' energy system is not equal or equitable. For example;

- Tariffs that are available on the basis of significant capital outlay may disadvantage some consumers who are less able to afford smart appliances
- Tenants may be unable to get permission to install them in rented accommodation.
- Some consumers, with cognitive impairments, or who have less engagement with the energy system, or with insufficient time might not understand how to maximise the benefits.
- Some consumers may not be able to shift demand patterns in a way to take advantage of smart appliances.

Energy Systems Catapult has done extensive work and is continuing to develop the ability to explore consumer propositions, including business models for delivery and use, in parallel with protections, consumer experiences etc.

Government should commission a study into whole life affordability, conducted with consumer requirements, placed ahead of network cost minimisation.

Unlike other markets, the energy sector(s) seem to operate with a "system-first" mentality and then add consumer protections. Much is talked about in terms of deferred reinforcement but it is not clear is if this is to delay cost or avoid it altogether. Substantial costs in introducing 'smart' followed by reinforcing anyway, when penetration of low-carbon technologies reaches a certain threshold, may increase whole-life costs, rather than reducing.

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Do you agree that the standards should be applied as uniformly as possible across smart appliances, for example, horizontally, and should be catered to individual appliances only where necessary?

Some of the suggested principles do not align well to general applicability. For example, the idea that an appliance might, directly, display its cost to use would, perhaps, be costly to implement on devices which don't, naturally, tend to have a display.

The idea that devices might operate when there is an excess of supply to demand is sometimes sensible for some devices (batteries, EV chargers etc.) but will rarely be applicable for cold and wet appliances (don't want to make a freezer too cold or run a washing machine when it's not required, for example). There are some appliances where short term fluctuations in output might not even be noticed e.g. hot-tubs, electric hobs, freezers etc. There are appliances which might look like they are ready to provide some 'smart' functionality but would largely inconvenience the customer. Take for example a microwave which finishes heating a dish just before a request to alter consumption is received but the consumer has another item to heat in the microwave, should the first be allowed to spoil?

In addition, the number, and type of, appliances are changing all the time, with new technology and innovation appearing all the time so standards that are flexible are more likely to keep up with the pace of new offerings.

Government should set to standardise certain parameters rather than appliances.

Energy Systems Catapult has been developing an approach to generate service classes based on key parameters (such as time to ramp up/down, volume storage, charge/discharge time etc. This allows for cross comparison by a user and/or provider, allowing them to price for annual consumption and risk. This would mean that as new appliances and equipment becomes available their performance, against standards, can be assessed and compared objectively such that service providers can be assured of their performance without needing to keep updating standards constantly.