Smarter Tariffs – Smarter Comparisons

Project Final Report

January 2023

Authors

This independent report was produced for BEIS by:

Jane Wilson & Joshua Cooper (Hildebrand Technology)

Dr Richard Carmichael (Imperial College London/Imperial Consultants)

Andrew Lever, Manu Ravishankar & Oliver Richards (Carbon Trust)

Tom Anderson & Gabriela Shutter (davies + mckerr)

Lyndsey Baker (Vital Energi)

We would like to thank BEIS for feedback during the project and comments on the report.

Any enquiries regarding this publication should be sent to us at: smartmetering@beis.gov.uk

Contents

Glossary

Table 1: Glossary of terms for this report

Term	Definition
AI	Artificial Intelligence
CPP	Critical Peak Pricing – references flat rate tariffs with some periods where prices change for certain days of very high demand
DCC	Data Communications Company
DoI	Diffusion of Innovation
DCT	Digital Comparison Tools
EAC	Estimated Annual Consumption. Used by Price Comparison Websites to make quotations if actual consumption data not provided. Data comes from ECOES.
ECOES	ECOES (the Electricity Central Online Enquiry Service) is a service funded by electricity suppliers and distributors and governed under the Master Registration Agreement (MRA). ECOES was designed to assist Suppliers in the customer transfer process by allowing the triangulation of data; it is also used to provide benefit to MRA parties and other industry stakeholders.
E7	Economy 7 (type of tariff)
E10	Economy 10 (type of tariff)
EV	Electric Vehicle
HH	Half Hourly
Half hourly settlement	Currently elective, market-wide half hourly settlement will be implemented in 2025. A full description of electricity settlement reform is available on Ofgem's web site.
LCT	Low Carbon Technology. Includes electric vehicles, heat pumps, solar PV.
Legacy time of use tariffs	Economy 7 and Economy 10 are examples of legacy Time of Use tariffs
MaaS	Mobility as a Service
MHHS	Market-wide half-hourly Settlement

NEA	National Energy Action is a fuel poverty charity that works to eradicate fuel poverty and campaigns for greater investment in energy efficiency to help those who are poor or vulnerable gain affordable heat. nea.org.uk
OTEC	Operational Change Required and Technical Complexity
PCW	Price Comparison Website
RD&D	Research, development and demonstration
REGO	Renewable Energy Guarantees of Origin
SECAS	Smart Energy Code Administrator and Secretariat
STSC	Smarter Tariffs – Smarter Comparisons
TCR	Targeted Charging Review
TDCV	Typical Domestic Consumption Value
TIL	Tariff Information Label
TOU	Time of use (tariff)
VPP	Virtual Power Plant

Chapter 1 – Introduction

The project has delivered an open-source solution to provide industry with a smart tariff comparison tool and facilitate market development and further innovation.

Background

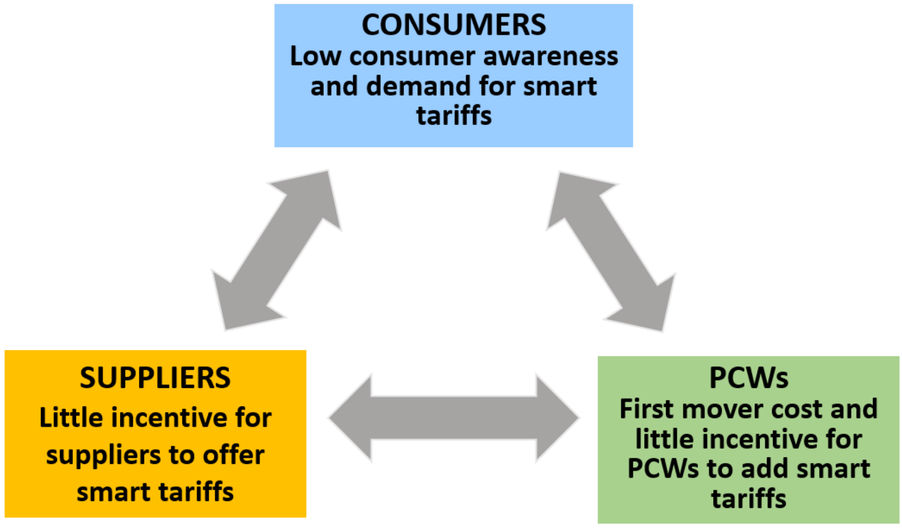
In February 2020 BEIS launched an innovation project to develop and demonstrate an innovative solution for including smart electricity tariffs in the market comparisons offered by online price comparison websites (PCWs). This recognised and responded to the current absence of smart tariffs from these comparison tools, which present important barriers to consumer engagement with a number of products and services vital for reaching net zero[1] [2], including:

1. smart time of use (TOU) electricity tariffs
2. EVs and other low carbon technologies that can enable sizable load-shifting in a convenient way

Although some smart tariffs had emerged on the GB market, there were no indications that PCWs were planning to incorporate smart tariffs into their market comparisons or use consumers' smart meter data (with their permission) to improve the comparison experience. It is likely that this situation would have continued due to a cycle that reinforces inaction (see figure, below): the absence of smart tariffs from PCWs keeps consumer awareness of, and demand for, smart tariffs low; this provides no incentive for suppliers to offer smart tariffs. In this context there is little incentive for a PCW to incur the first mover costs to develop smarter comparison tools and incorporate smart tariffs.

[1] Carmichael, R., Gross, R., and Rhodes, A. (2018) *Unlocking the potential of residential electricity consumer engagement with demand response*, Energy Futures Lab Briefing Paper, Imperial College London.
[2] Carmichael, R., Hanna, R., Rhodes, A. Gross, R., and Green, T. (2021) The Demand Response Technology Cluster: Accelerating residential consumer engagement with smart tariffs, electric vehicles and smart meters via digital comparison tools. Renewable and Sustainable Energy Reviews, 139C; 110701.

Figure 5: Circle reinforcing inaction on smarter comparisons and smart tariffs



The Smarter Tariffs – Smarter Comparisons (STSC) project[3], funded through the BEIS £505m Energy Innovation Programme (2015-2021), was the response to this need.

In February 2020 BEIS launched an Invitation to Tender for the Smarter Tariffs – Smarter Comparisons (STSC) project[4] to procure services which identify, develop and test innovative solutions to compare domestic smart tariffs.

The project objectives were to perform exploratory research, user testing, data modelling and software development to:

- Identify and test new approaches to domestic smart tariff comparison;
- Identify and test new approaches to consumer engagement with smart tariffs and tariff comparisons;
- Design, build and test a smart tariff comparison prototype tool.

The UK is faced with a steep challenge: deployment of low carbon technology and scaling up energy efficiency measures to transition the energy system to a net zero target. This will involve mass take-up of electric vehicles and heat pumps by consumers, supported by consumer engagement with a more flexible energy system to avoid expensive reinforcements to the grid and reliance on high-carbon generation capacity.'

On the transport side the Climate Change Committee (CCC) calculates that, to meet net zero goals, policy needs to aim for electric vehicles to reach 100% of new car and van sales by 2030 or 2035 at the latest[5]. This will require exponential growth in sales[6]. The CCC's analysis finds that circa 70% of the measures the UK needs to reach its net zero targets require some level of societal and behavioural change, either on their own or combined with low-carbon

[3] Tender Reference Number 2237/02/2020
[4] Tender Reference Number 2237/02/2020
[5] Committee on Climate Change (CCC) (2019) Reducing UK emissions: 2019 Progress Report to Parliament.
[6] Regen (2018) Harnessing the electric vehicle revolution.

technologies[7]. To align with decarbonisation targets for heat, the CCC estimates the UK will need 5.5 million homes to be fitted with heat pumps by 2030, reaching deployment rates of over 1 million a year by this date compared to 26,000 a year currently.[8]

The new loads anticipated from both transport and heating could result in a doubling of overall electricity demand in the UK.[9] A second challenge is balancing the variable supply from renewables with variable demand and doing so within the constraints of the distribution grid. Investing in flexibility has the potential to deliver material net savings of up to £16.7bn per annum to the cost of a net zero whole energy system in 2050.[10] Even before new loads from vehicles and heating, residential electricity consumption makes up around 35% of total UK electricity consumption[11] and the aggregated flexibility from households is now envisaged as having the potential to provide significant system flexibility.[12]

Provision of smart tariffs, enabled by smart meters, with characteristics easily understood by customers, is one of the key market conditions for enabling the behaviour change needed to unlock this flexibility. Residential consumer engagement with demand response (DR) depends upon three mutually-supportive strands (see also Fig.6, Ch.2)[13]:

i. Uptake of smart meters
ii. Uptake of DR-promoting smart tariffs and services
iii. Uptake of automation and storage technologies to enable demand response (e.g., EVs).

There are also some additional conditions in the domestic sector that must be met to facilitate the take-up of smart tariffs. Specifically, there needs to be:

- A range of smart tariffs on the market
- Comparison tools that can handle the complexity of analysing and comparing different smart tariffs in a standard way whilst providing a compelling customer journey and experience.

To tackle these challenges, the STSC project identified and tested new approaches to domestic smart tariff comparison and consumer engagement with those tariffs. The ambition is to remove bottlenecks, build confidence, and stimulate the market for smart tariffs and smart tariff comparisons.

---

[7] CCC (2019) Net Zero: The UK's contribution to stopping global warming.
[8] CCC (2020) The Sixth Carbon Budget – Buildings.
[9] Vivid Economics & Imperial College London (2019) Accelerated Electrification and the GB Electricity System.
[10] Carbon Trust and Imperial College London, 2021 – Flexibility in Great Britain
[11] BEIS. Electricity statistics 2018 Q2: section 5 - electricity. 2018.
[12] BEIS & OFGEM (2017). Upgrading our energy system: smart systems and flexibility plan.
[13] Carmichael, R., Hanna, R., Rhodes, A. Gross, R., and Green, T. (2021) The Demand Response Technology Cluster: Accelerating residential consumer engagement with smart tariffs, electric vehicles and smart meters via digital comparison tools. *Renewable and Sustainable Energy Reviews*, 139C; 110701.

The consortium

The consortium that won the tender to deliver[14] STSC are recognised experts in their fields and includes organisations with excellent reputations for delivering customer centric solutions across a range of sectors:

Table 1: Consortium members and expertise

Organisation	Project role	Expertise
Vital Energi	Consortium lead Expertise in supporting consumers who face additional barriers to engaging with energy and/or in fuel poverty	Design, installation and management of low carbon community energy systems Management and delivery of large-scale projects
Hildebrand	Prototype delivery Smart metering expertise DCC Other User (retrieve smart meter data via DCC)	Energy technology solutions: data management, analytics, behaviour science and hardware
davies+mckerr	Consumer research	Cross sector research, consumer and business to business. Consumer motivation and branding
Love Experience	User experience design and delivery	Customer experience experts – from strategy to concept delivery. Design products at the intersection of business need, customer goal and brand differentiation.
Carbon Trust	Exploratory research with suppliers and industry specific to smart tariffs	Sustainability consultants – strategic guidance on carbon reduction, resource efficiency and commercialising low carbon businesses, systems and technologies
ICON (Imperial Consultants)	Insight into consumer engagement (smart metering, tariff switching, smart tariffs, demand response, LCT adoption) and broader context.	Dr Richard Carmichael, of Imperial College London, has extensive expertise in behaviour change and residential consumer engagement with products and services for demand response (smart tariffs, EVs, heat etc)

[14] https://www.gov.uk/government/publications/smart-meter-enabled-tariffs-comparison-project-smarter-tariffs-smarter-comparisons/smarter-tariffs-smarter-comparisons-project-winning-bid

Project objectives

Research, design and develop an open-source prototype tool driven by consumer and industry needs that:

- Accurately compares complex smart and non-smart tariffs based on consumers' actual consumption;
- Leverages smart meter data (with customer consent) to drive consumer engagement and industry innovation;
- Encourages informed consumer adoption of LCTs;
- Considers and supports consumers who face additional barriers to engaging with the energy market, smart tariffs and digital tools, not just the highly engaged and easy to reach segments;
- Identifies opportunities to standardise and simplify;
- Is ready for adoption by a range of industry stakeholders (PCWs; energy suppliers; LCT providers and buyer guides; consumer advocacy groups, etc);
- Engage industry stakeholders so they become solution adopters and project champions.

The approach

Discovery and Alpha phases

The project was delivered in two phases:

- Discovery phase – initial state-of-the-art review of smart tariffs and price comparison websites complemented by interviews with suppliers and consumer research (qualitative and quantitative);
- Alpha phase – development of the STSC prototype, following an Agile methodology with ongoing capture of industry and consumer feedback for each iteration.

The consortium's approach was under-pinned by a clear strategy:

- Understand the market and engage key stakeholders; focus on stakeholders who might be likely to adopt the STSC tool;
- Put consumer and industry needs at the heart of the solution;
- Build a front end that is simple to use and brand neutral for research purposes;
- Leverage the DCC for smart meter data.

Addressing barriers to informed choices

It will be through effective consumer engagement, and ultimately full automation of data-driven results, that wide usage of smart comparison tools will be achieved. Clarity in options and relative benefits need to be made easily available to people – and these should include what is the **lowest cost**, but also the **closest fit** to their needs and preferences. Trust in the technology and clear presentation will increase follow through into switching. The STSC tool results will need to adapt based on how much the consumer wants to engage with informing the engine about their preferences and potential future investments into LCTs.

Consumers will be provided with benchmarks and counterfactuals from existing data sets (non-smart tariffs) to create awareness of the cost, benefits and risks (in economic and environmental terms) of switching and of doing nothing.

People considering the significant capital investment of purchasing an LCT need to understand the total cost of ownership of their technology in order to determine payback periods. The comparison model integrates a representation of running costs as they relate to that capital investment.

Project Outputs

The project delivered the following:

- Online smarter comparisons tool prototype:
    - The final version of the prototype is live at smarttariffsmartcomparison.org and can be used by any household with a SMETS2 meter, or a SMETS1 meter that has been enrolled in the DCC's national network.
- Open source code with full technical implementation support material;
- Reports:
    - Project final report
    - Technical report (Annex A)
    - Project research reports covering qualitative, quantitative and user research reports (Annex B)

Reading this report

Appreciating that readers may only be interested in specific elements of the report, most chapters are self-contained.

Report overview

Chapter 1, "Introduction", outlines the context, activities and outputs of the project.

Chapter 2, "Market context and potential for impact", summarises the barriers to consumer engagement with smart tariffs and LTCs addressed by the tool and its anticipated impact on behaviour and the wider energy system.

Chapter 3, “Smart tariffs”, provides extensive details on the nature of smart tariffs.

Chapter 4, “Industry: learnings & requirements”, describes the stakeholder groups engaged, learnings from desk research and interviews and requirements of the tool.

Chapter 5, “Consumer: learnings & requirements”, does the same at a consumer level and includes cross references to the davies+mckerr research reports annexed to this report.

Chapters 6, “Consumer solution”, 7, “Industry requirements” and 8, “Industry solution” explain the development of the tool itself and feedback received from users and industry.

Chapter 9, “Maximising impact and ongoing development”, covers the practical distribution of the tool, opportunities for maximising impact and further research opportunities.

The report ends with Chapter 10, “Conclusions and recommendations”, which summarises key findings and recommendations.

Chapter 2 – Market context and potential for impact

Organisations using the open source Smarter Tariffs-Smarter Comparisons (STSC) tool have the potential to realise benefits in the GB energy market for consumers and across a range of stakeholders.

Market context

Switching behaviours

The UK Government has encouraged switching energy supplier or tariff as a key route to residential energy consumer engagement and a more competitive market[15].

Switching currently requires engaged consumers. Many households who do switch are repeat switchers, but around half of consumers report they have never switched or have only switched once.[16] There have been significant efforts to increase switching[17] and overall supplier switching rates reached over 20% in April 2019 [18], but concerns remain over levels of engagement, non-switchers missing out on opportunities to save, [19] [20] and the reliability and speed of switching.[21] Switching to smart tariffs that encourage demand response is also part of the business case for smart meters: in its cost-benefit analysis of the Smart Metering Implementation Programme (SMIP) the UK Government estimates that by 2034 25% of consumers will switch to static time of use electricity tariffs (which apply different rates at fixed time periods such as a lower rate during off-peak times and higher rate during the evening peak-time).[22]

Reasons given for not switching tariffs include the belief that they 'would not save much' by switching[23] and uncertainty about the new supplier being cheaper than their previous supplier

[15] Ofgem (2017) Decision: Selection criteria for mandatory supplier testing of measures to promote domestic consumer engagement
[16] Ofgem. (2019) State of the Energy Market
[17] Ofgem. Insights from Ofgem's consumer engagement trials: What works in increasing engagement? 2019
[18] Ofgem. (2019) State of the Energy Market
[19] CMA (2016) Energy market investigation: Final Report.
[20] Helm D. (2017) Cost of Energy Review.
[21] Ofgem. (2019) State of the Energy Market
[22] BEIS (2010) Smart meter roll-out cost-benefit analysis. BEIS.
[23] CEPA. (2017) Distributional impact of time of use tariffs - Final report for Ofgem.

in a few months' time.[24] [25] [26] [27] Such a lack of belief in tariff differences discourages participation in energy markets[28].

It should be noted BEIS recently published a consultation on introducing opt-in switching (where disengaged consumers on expensive default tariffs will get personalised switching advice with a simple method of switching to a cheaper tariff) and testing opt-out switching from 2024, where the most disengaged consumers are switched unless they choose not to be, reducing the need for engagement.[31]

This could suggest that most consumers may not participate in new smart tariff offerings either. However, there are signs that there is potential for higher levels of switching and take-up of smart TOU tariffs:

- 82% of non-switchers report that they "would [switch] to save money".[29] This suggests that many more consumers could be motivated to switch if offerings have credible potential for savings. Reviews of pilots and surveys indicate that financial savings are the primary motivation for enrolling and remaining in smart TOU services[30] [31] and a recent UK survey for Smart Energy GB found that reducing bills was the most appealing benefit of TOU tariffs.[32]
- Smart tariffs may be seen by customers as offering more credible potential for genuine savings: consumer scepticism about getting 'something for nothing' could be reduced with greater understanding that the flexibility they provide has a financial value to the system and to suppliers.
- As a wider range of suppliers offer smart tariffs (incentivised by the introduction of half-hourly settlements), customers will be able to switch to a smart tariff without changing supplier and so loyalty to their existing supplier will become less of a barrier to the uptake of TOU tariffs.

Consumer engagement with PCWs

Reliance on digital comparison tools (DCTs) is an important feature of UK switching behaviour and is underlined by consumers' strong interest in financial savings when switching tariffs. The potential value of independent market comparison is further suggested by the finding that UK

[24] GfK UK Social Research. (2017) Consumer Engagement in the Energy Market 2017: Report on a survey of energy consumers.
[25] Which? (2017) CMA Consultation Response to the CMA's Statement of Scope for its market study on Digital Comparison Tools (DCTs).
[26] Jackson G. (2017) Octopus Response to CMA DCTs market report.
[27] Which? (2017) Response to the CMA's Statement of Scope for its market study on Digital Comparison Tools (DCTs).
[28] He X, Reiner D. (2018) Consumer Engagement in Energy Markets: The Role of Information and Knowledge (Working Paper).
[29] GfK UK Social Research. (2017) Consumer Engagement in the Energy Market 2017: Report on a survey of energy consumers.
[30] Chase A, Gross R, Heptonstall P, Jansen M, Kenefick M, Parrish B, et al. (2017) Realising the Potential of Demand-Side Response to 2025 - Summary Report.
[31] Brattle Group/UCL (2017) The Value of TOU Tariffs in Great Britain: Insights for Decision-makers, a report for Citizens Advice. vol. 1.
[32] Smart Energy GB. (2019) The smart future: lifestyle tariffs.

consumers' trust in energy firms is the lowest of all market sectors[33] and Ofgem acknowledge an important role for the advice and guidance available through third party intermediaries like PCWs.

- 67% of bill-payers looking for energy deals used PCWs in the past year[34] and 44% of consumers who actually switched reported using a third-party service[35] – up markedly from 39% in 2014[36].
- Those who did use PCWs generally found them easy to use and were very or fairly satisfied with the experience[37].

However, consumers do have concerns about aspects of the price comparison and switching processes themselves. 71% of respondents to a 2019 survey for the Ofgem mentioned concerns over some form of risk associated with switching[38] and less than half (47%) thought comparing energy tariffs was easy[39]. Perceived overall difficulty in changing suppliers deters switching[40] but at present, to get accurate quotes for flat-rate tariffs on a PCW, customers need to find a non-estimated annual statement and manually input their consumption data into the tool, a process which is often time-consuming, confusing, and imprecise, and which deters comparison and switching.[41]

The rollout of smart meters to households across Great Britain presents an opportunity to help mitigate some of these perceived risks and concerns if smart meter consumption data is leveraged, with permission, by smarter comparison tools. This adds value to smart meter data and so could add further value for households with or considering getting a smart meter. Research for Citizens Advice found that only around 7% of consumers identified the potential for accessing new products or services as a benefit of smart meters.[42]

Potential impact of STSC tool

The consumer benefits of services using the STSC tool are shown in Table 2 below.

[33] Citizens Advice. (2016) Trust in the Energy Sector and Billing.
[34] CMA. (2017) Digital comparison tools market study Update Paper.
[35] Ofgem. (2019) Consumer survey 2019
[36] Ofgem. (2016) Helping consumers make informed choices – proposed changes to rules around tariff comparability and marketing
[37] CMA.(2017) Digital comparison tools market study Final report.
[38] Ofgem. (2019) Consumer survey 2019
[39] GfK UK Social Research. .(2017) Consumer Engagement in the Energy Market 2017: Report on a survey of energy consumers.
[40] He X, Reiner D.(2017) Why consumers switch energy suppliers: The role of individual attitudes. Energy J ;38:25–53.
[41] Fletcher A. (2016) The Role of Demand-Side Remedies in Driving Effective Competition: A Review for Which?
[42] Citizens Advice.(2018) *Early consumer experiences of smart meters*.

Table 2: Primary user benefits and impacts of using the STSC tool

User benefits	Impacts
Easier, more accurate and tailored tariff comparisons using consumer's smart meter data (no need to input consumption)	Drive engagement with comparison tools and switching behaviour
Adding smart tariffs in market comparisons	Support customers to identify the most appropriate tariff for their needs.
Adding EVs and other LCTs to comparison tools	Drive awareness and informed adoption of smart tariffs and LCTs
	Drive adoption of smart meters
	Drive adoption of LCTs

Low-carbon technologies: EVs and heat

While most attention on residential consumer engagement with smart TOU tariffs and Demand Response (DR) has focussed on manual load-shifting by changing daily behaviours (such as use of wet appliances)[43] [44] [45], the greatest opportunities for flexibility, and financial rewards, will largely involve the large loads for EV-charging and heating. **EVs and other storage and automation technologies can deliver greater DR with more convenience, predictability and reliability than manual DR**.[46]

As EV adoption grows, smart managed charging will be required to avoid the need to upgrade the distribution network and to enable greater decarbonisation of power. Left unmanaged, charging an electric vehicle (EV) would lead to roughly doubling a typical household's evening peak demand (based on a 3.5 kW Nissan Leaf).[47] Fortunately, smart EV charging to optimise

[43] Carmichael, R., Schofield, J., Woolf, M., Bilton, M., Ozaki, R. and Strbac, G. (2014) *Residential consumer attitudes to time-varying pricing*, Report A2 for the 'Low Carbon London' LCNF project: Imperial College London.
[44] Hledik R, Faruqui A, Weiss J, Brown T, Irwin N. (2016) The Tariff Transition - Considerations for Domestic Distribution Tariff Redesign in Great Britain, Volume I:. Final Report; Brattle Group/Citizens Advice;.
[45] Parrish B, Gross R, Heptonstall P. (2019) On demand: can demand response live up to expectations in managing electricity systems? Energy Res Soc Sci 2019;51: 107–18
[46] Carmichael, R., Hanna, R., Rhodes, A. Gross, R., and Green, T. (2021) *Renewable and Sustainable Energy Reviews*, 139C; 110701. The Demand Response Technology Cluster: Accelerating residential consumer engagement with smart tariffs, electric vehicles and smart meters via digital comparison tools.
[47] ICF Consulting. (2016) Overview of the Electric Vehicle market and the potential of charge points for demand response. DECC.

consumer savings and system benefits appears to be both technically feasible and acceptable to consumers.[48] [49] [50] [51]

There are also indications that substantial savings in EV-charging costs are possible on TOU tariffs.[52] [53] [54] [55] Moreover, these savings are benchmarked against the cost of EV-charging on flat-rate tariffs so even greater savings are possible when switching between EV-charging costs and spending on petrol/diesel for the same driving behaviour.

Despite this, while the literature on EV adoption discusses smart charging of EVs in terms of system benefits, the potential for savings from smart-charging to help drive EV adoption has typically[56] [57] not been considered. Equally,

> *"as EV adoption costs fall, EVs could increasingly become the key driver for cost-conscious consumers to engage with smart tariffs and other DR offerings. The cost of lithium-ion battery packs has tumbled by 79% since 2010[58] and is expected to fall a further 66% between 2017 and 2030[59]. For some households, the cost-effectiveness of combining an EV or a home battery with a smart tariff, and/or other DR services, may be further increased by installing solar PV to allow self-generated electricity to be stored, peak rates further avoided, and revenue accrued through Smart Export Guarantee (SEG) tariffs now offered by suppliers in the UK following the end of the Feed-in-tariff (FIT)[60]. An analysis of near-term opportunities for growth in EV, battery and solar PV found that strong mutual benefits and reduced payback periods make these technologies even more disruptive together than in isolation[61]." (Carmichael et al[62])*

---

48 EA Technology. (2017) Smart charging: a brief guide to managed electric vehicle home charging. Western Power Distribution;
49 EA Technology. (2017) Consultation on managed electric vehicle charging: summary of responses.
50 Fell MJ, Shipworth D, Huebner GM, Elwell CA. (2015) Public acceptability of domestic demand-side response in Great Britain: the role of automation and direct load control. Energy Res Soc Sci 2015;9:72–84.
51 Smart Energy GB. (2018) The smart route to electric vehicles: smart meters will put Britain's electric vehicle revolution in the fast lane
52 Hall S. (2018) The smart route to electric vehicles. Smart Energy GB.
53 Rhys J. (2018) Cost Reflective Pricing in Energy Networks: the nature of future tariffs, and implications for households and their technology choices. Energy Systems Catapult.
54 Smart Energy GB. (2019) The smart future: lifestyle tariffs. Smart Energy GB.
55 Octopus Energy. (2018) Agile Octopus: a consumer-led shift to a low carbon future.
56 Green Alliance. How the UK can lead the electric vehicle revolution. London: Green Alliance; 2018.
57 Mazur C, Offer GJ, Contestabile M, Brandon NB. Comparing the effects of vehicle automation, policy-making and changed user preferences on the uptake of electric cars and emissions from transport. Sustainability 2018;10:4–6.
58 Chediak M. The latest bull case for electric cars: the cheapest batteries ever. BloombergCom 2017;vol. 8. 2017, https://www.bloomberg.com/news/article s/2017-12-05/latest-bull-case-for-electric-cars-the-cheapest-batteries-ever.
59 BloombergNEF. New energy outlook. BloombergNEF; 2018.
60 Solar Trade Association. Smart export guarantee. 2019. https://www.solar-trade. org.uk/seg/.
61 Institute for Energy Economics and Financial Analysis (IEEFA). Electric vehicles and batteries can drive growth of residential solar: EV and battery cost reductions important for encouraging new demand. 2019.
62 Carmichael, R., Hanna, R., Rhodes, A. Gross, R., and Green, T. (2021) *Renewable and Sustainable Energy Reviews*, 139C; 110701. The Demand Response Technology Cluster: Accelerating residential consumer engagement with smart tariffs, electric vehicles and smart meters via digital comparison tools.

As with EVs, the move towards the electrification of at least a portion of domestic heat also entails a need for flexibility and an opportunity for household savings on energy bills and engagement. Within UK homes, space heating and domestic hot water account for 80% of energy requirements.[63] This is largely provided by gas, with only 7% of households using electric heating.[64] Though uptake of heat pumps has been low in the UK to date,[65] [66] electrification of heating could, in future, add greatly to morning and evening peak loads. However, smart flexible electric heating[67] may offer opportunities for system savings even greater than from EVs.[68]

While smart meters, smart tariffs, EVs and heat pumps, it's been suggested, have for the most part, been treated as separate consumer engagement targets and challenges, promoting awareness of them as inter-related elements in a package, or 'technology cluster'[69], should be more rewarding and compelling for consumers.[70] **Smarter comparison tools can play a key role in raising awareness of the greater benefits that come from combining smart tariffs with DR-enabling technologies such as EVs and other smart automation and storage devices.**

The need to clearly communicate running costs and payback periods is even more acute due to the tendency for people to be less influenced by distant or long-term costs and benefits (so-called 'temporal discounting') compared to immediate cost and benefits (e.g. up-front purchase costs).

[63] Palmer J, Cooper I. United Kingdom housing energy fact file. DECC; 2013.
[64] Palmer J, Terry N, Kane T. Further analysis of the household electricity survey early findings: demand side management. DECC/Defra; 2013.
[65] Committee on Climate Change (CCC). UK housing: fit for the future?. 2019.
[66] Ofgem. The decarbonisation of heat (Ofgem's Future Insights Series). 2016
[67] Carmichael R, Rhodes A, Hanna R, Gross R. (2020) Smart and flexible electric heat: an Energy Futures Lab briefing paper. Imperial College London;
[68] OVO Energy & Imperial College London. (2018) Blueprint for a post-carbon society: how residential flexibility is key to decarbonising power, heat and transport. OVO Energy & Imperial College London;.
[69] Rogers, E.M. (2003) Diffusion of Innovations. 5th ed. New York: Free Press.
[70] Carmichael, R., Hanna, R., Rhodes, A. Gross, R., and Green, T. (2021) *Renewable and Sustainable Energy Reviews*, 139C; 110701. The Demand Response Technology Cluster: Accelerating residential consumer engagement with smart tariffs, electric vehicles and smart meters via digital comparison tools.

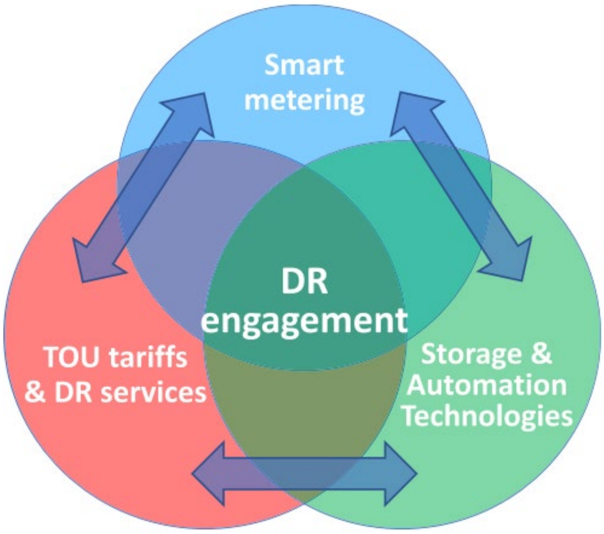
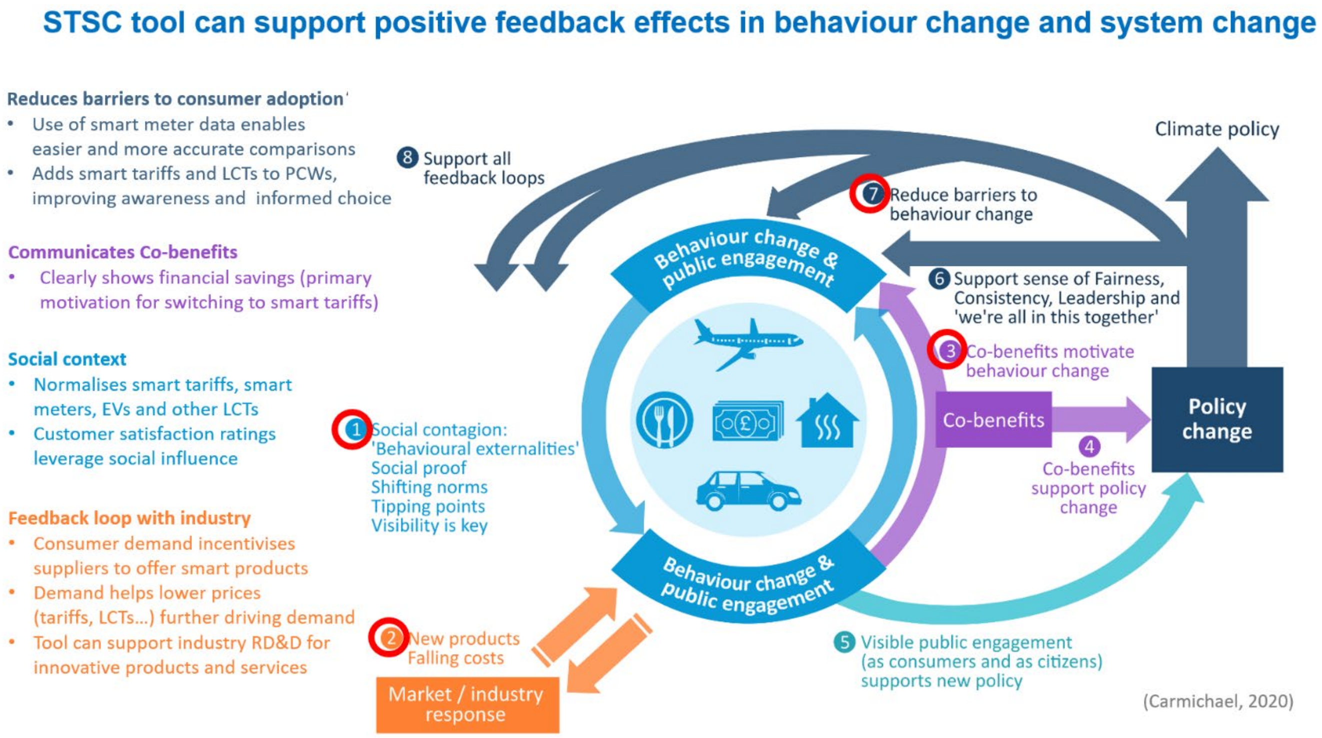


Figure 6: The Demand Response Technology Cluster: Smarter comparison tools could help raise awareness that smart meters, smart tariffs, and storage and automation technologies enable greater benefits when combined and could increase consumer engagement across all these technologies and services. Each component can act as an enabler and or driver for adoption of other components, e.g., smart meters enable smart tariff adoption and EVs and EV-tariffs could drive smart meter adoption. (Source Carmichael, R., Hanna, R., Rhodes, A. Gross, R., and Green, T. (2021)

Behaviour change & social contagion effects

In contrast to the ‘vicious cycle’ stalling the development and uptake of smart tariffs (as shown in Figure 1, Chapter 1), smarter comparison tools could play a key role in kick-starting several ‘virtuous cycles’ driving the development and take-up of smart products and services. These are depicted in Figure 7 below.

Figure 7: Smarter comparison tools could support positive feedback loops for behaviour change and system change[71]



Smarter comparison tools should unlock behaviour change by removing several barriers to switching mentioned above and by encouraging the informed adoption of smart meters, smart tariffs, EVs and other LCTs. This behaviour change could produce further impacts by triggering self-reinforcing positive feedback effects that accelerate change in consumer engagement and also the wider system. Increasing attention is now being paid to how to support system change and to ‘social tipping points’ that can activate “contagious processes of rapidly spreading technologies, behaviours, social norms, and structural re-organisation”.[72]

The STSC tool could generate initial behaviour change and help support social influence effects leading to accelerating behaviour change (‘1’ in the Fig. 7). The visibility of smart tariffs within comparison tools will help to normalise smart meters, smart tariffs, EVs and other LCTs associated with them. Positive customer reviews (or customer satisfaction ratings for tariffs) could play a further important role in reducing uncertainty and scepticism about these as yet unfamiliar products and services, further helping to bring a variety of social influence and social contagion effects into play.

Diffusion of innovation scholars note that the ‘observability’ of an innovation (being able to see it being taken-up by others) is associated with faster adoption.[73] There is evidence of ‘social contagion’ in a range of energy-related behaviours, including SUV sales, solar-PV adoption

[71] Adapted from Carmichael (2020) Beesley Lecture: Behaviour Change, Public Engagement and Net Zero: building momentum in societal and system change. Beesley Lectures 2020 (online), Lecture 2, 12th Nov 2020.

[72] Otto IM, Donges JF, Cremades R, Bhowmik A, Hewitt RJ, Lucht W, et al. Social tipping dynamics for stabilizing Earth’s climate by 2050. Proc Natl Acad Sci U S A 2020.

[73] Rogers, E.M. (2003) Diffusion of Innovations. 5th ed. New York: Free Press.

and electricity conservation behaviours.[74] In addition, observing the positive behaviour of others can trigger people to make low-carbon choices[75]. For most households the main driver for tariff switching has been, and is likely to continue to be, financial savings. However, if the cheapest tariff is also the greenest then there is a new opportunity for consumers' environmental motivations to reinforce rather than compete with price signals.[76]

Market and industry feedback loops

Social contagion is not the only positive feedback loop that STSC could help to trigger and support. Consumer engagement could prompt change in industry offerings: rising demand should encourage and enable industry to diversify smart offerings thereby further supporting customer engagement with smart meters, tariffs and technology. Technology learning curves and falling costs are another aspect to self-reinforcing feedback effects between consumers and industry ('2' in the figure above).

Smarter comparison tools are also a good example of the value of communicating the 'co-benefits' of carbon-cutting behaviours ('3' in the figure above) – in this case chiefly the financial savings offered by smart tariffs, which are a primary driver for consumer engagement.

See Chapter 9 for a discussion of opportunities for exploitation of the STSC tool by a broad range of stakeholders and discussion of how impact of the tool could be maximised.

Meeting the needs of consumers who face additional barriers to engaging in the energy market: a core element of the project was ensuring the tool addressed consumer protection concerns, particularly those who may perceive switching to a smart tariff as especially risky (e.g. low income and fuel poor consumers), and for those who face barriers to engaging in the energy market and using digital tools (referred to as 'vulnerable consumers' in this report). In addition to desk research, these groups were included in the consumer research (see Chapter 6 for research findings). Meetings were held with Ofgem, National Energy Action, BEIS and Citizen's Advice to discuss these people's unique requirements. The organisations understand the specific challenges and needs of these consumers that should be considered and shared them with the consortium.

Fuel poverty

Fuel poor consumers were identified as a key segment for consideration early in the project as whilst they are often thought to be less likely to engage in the market, they may be amongst those able to benefit from smart tariffs that reward flexibility in energy consumption. For example, households with high day-time occupancy such as those who are unemployed, pensioners, or those with certain types of health conditions,, may be more able to shift load to off-peak hours and benefit from cheap-rate electricity, which may at times include negative

[74] Frank, R.H. (2020) Under the Influence: Putting Peer Pressure to Work. Princeton: Princeton University Press.
[75] Schultz PW, Nolan JM, Cialdini RB, Goldstein NJ, Griskevicius V. (2007) The Constructive, Destructive, and Reconstructive Power of Social Norms. Psychol Sci 2007;18:429–34.
[76] Confirmed within the Quantitative Research – see Chapter 6

pricing. It therefore felt to be important to consider if and how an STSC tool could engage this segment.

Definitions of fuel poverty differ across the GB countries but are consistent in substance, defining a fuel poor consumer as someone whose energy costs are high relative to their income. Government statistics indicate that as of 2019, 13.4% of households in England were in fuel poverty, 12% in Wales and 24.6% in Scotland.[77]

Heating and fuel poverty: Fuel poverty is closely linked to building energy efficiency[78] and homes using direct electric heating. In England 21.4% of electrically heated homes are in fuel poverty compared to 12.7% using gas. 24.6% of all Scottish households are in fuel poverty, but the figure among those with electric heating is 43% while for gas users it is 22%[79]. Across GB, 8% of households use electricity as their main source of heating, typically with thermal storage[80] and these have double the likelihood of being in fuel poverty than those using gas[81].

Though uncommon, households with on-peak electric heating and no storage (i.e. no capability for electricity storage, heat storage or pre-heating, due to poor retention of heat in the building) are likely to be the main group for whom smart TOU tariffs do not offer opportunities to reduce energy bills

Households with storage heaters may be able to save on smart tariffs by storing heat during off-peak hours. Storage heaters are the primary method of heating for around 1.7 million UK households[82]. Around 3.5 million UK households use reduced-rate electricity overnight to store heat in night storage heaters and domestic hot water (DHW) tanks. Citizens Advice[83] highlight the poor experience of many households on non E7 and E10 dual-rate tariffs (so-called 'legacy TOU tariffs') and draw attention to the need to improve support for tariff choice and informed adoption for these households and tariffs. Reported willingness to switch to a smart TOU tariff has also been found to be greater among consumers on legacy TOU tariffs than other households.[84]

Energy spend awareness and fuel poverty: Households in fuel poverty can be more engaged with their energy spend than any other segment. In line with the literature, the qualitative research in the STSC project showed that evidence of what savings switching would bring is critical to people when considering changing suppliers. They look for guidance on the impact of making the switch, ideally shown visually as potential savings.

---

[77] BEIS Fuel Poverty Statistics: 2019 (England), Scottish House Condition Survey 2019 (Scotland), Fuel poverty estimates for Wales: 2018 (Wales).
[78] BEIS Fuel Poverty Statistics: 2019 (England), Scottish House Condition Survey 2019 (Scotland)
[79] Frerk M, Roper A. (2020) An electric heat pathway: looking beyond heatpumps.
[80] OFGEM.(2015) Insights paper on households with electric and other non-gas heating..
[81] BEIS. (2020) Annual Fuel Poverty Statistics in England, 2020 (2018 data) 2020:1–70.
[82] Carmichael R, Schofield J, Woolf M, Bilton M, Ozaki R, Strbac G. (2014) Residential consumer attitudes to time-varying pricing, Report A2 for the "Low Carbon London" LCNF project, Imperial College London.
[83] Citizens Advice. (2018) False Economy.
[84] Fell J, Nicolson M, Huebner GM, Shipworth D.(2015) Is it time? Consumers and time of use tariffs: Trialling the effect of tariff design and marketing on consumer demand for demand-side response tariffs.

Heat in the STSC project: Heat is a key element of fuel poverty and night storage heaters can provide some off-peak flexibility. Heating will be a crucial aspect of smart tariffs due to its large energy demand, potential to provide a large amount of DR/flexibility and reduce fuel poverty. However, the STSC work focusses more on EVs than electric heating, since:

- Smart flexible heating solutions that can alleviate fuel poverty are less market-ready than EV-related offerings. Adoption of EVs and smart charging is anticipated to grow much quicker than electrification and flexibility in domestic heating.
- The opportunity for flexible heat involves greater complexity and uncertainty than EVs, including the real-world performance of heating technologies *in situ* and a need to consider building fabric and or storage devices as well as smart low-carbon heating systems (or hybrid systems) and smart tariffs.

Exploring opportunities for households with night storage heaters and Economy 7-type legacy TOU tariffs to reduce bills via smart tariffs is one area for further research that could be pursued.

Consumers facing additional barriers to engagement - defining vulnerability

There is no standard definition of 'vulnerability' within the industry. Instead, it is usually defined based on the context, as demonstrated by the following definitions which were shared by the respective organisations interviewed in this project:

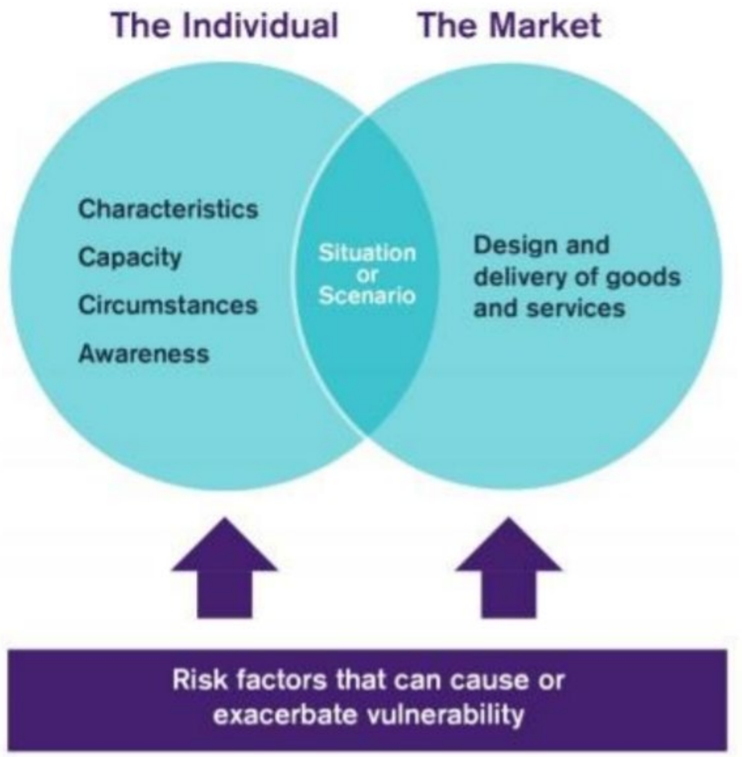
Table 3: Definitions of vulnerable within the industry

Organisation	Definition
Heat Trust	Vulnerable customers are defined as those customers who are significantly less able to protect themselves or their interests in the energy market and/or significantly more likely to suffer detriment than a typical heat customer.
Financial Conduct Authority	A vulnerable consumer is someone who, due to their personal circumstances, is especially susceptible to detriment, particularly when a firm is not acting with appropriate levels of care.[85]
Ofgem	We define vulnerability as when a consumer's personal circumstances and characteristics combine with aspects of the market to create situations where he or she is: significantly less able than a typical domestic consumer to protect or represent his or her interests; and/or significantly more likely than a typical domestic consumer to suffer detriment or that detriment is likely to be more substantial

[87] Majority of interviewees were either Head of Product or Head of Proposition

Ofgem's approach also looks at 'risk factors' in both the individual and the design and delivery of goods and services (see Fig. 8).

Figure 8: Consumer vulnerability in the energy market depends not only on individual characteristics, but also their situation/scenario and the design of goods and services (Source: Ofgem [86])



In this context, 'vulnerability' was therefore defined as consumers who may face additional barriers to engaging with the energy market, smart tariffs and digital comparison tools. Industry engagement in the project concluded that this may include households that are:

- Unable to benefit from smart tariffs due to their demand profile and or limited ability to shift load;
- Unable/unwilling to adopt smart tariffs;
- Unable/unwilling to adopt smart meters;
- Unable/unwilling to switch tariffs/suppliers;
- Unable/unwilling to use smarter comparison tools (e.g due to a disability, no access to internet, or lack of agency)
- Unable/unwilling to adopt technologies/services that facilitate flexibility (e.g., EVs and other smart or storage devices).

[87] Majority of interviewees were either Head of Product or Head of Proposition

Key points

- Tariff-switching and PCWs are key elements of UK energy consumer engagement. The rollout of smart metering affords opportunities to support greater energy consumer engagement and better consumer experiences.
- Smart meters, smart tariffs, EVs and heat pumps have, it's been suggested, been treated as separate consumer engagement challenges; communicating that benefits (for consumers, grid and environment) are greater when combining these technologies and services should be more compelling for consumer engagement.
- There is an excellent opportunity for smarter comparison tools to unlock greater and more informed consumer adoption of smart tariffs, smart meters and low carbon technologies that enable flexibility and deliver benefits for households, the environment and grid management.
- There is further scope for smarter comparison tools to support positive feedback loops to accelerate change in consumer engagement and the products and services offered by industry.
- Smart tariffs and smarter comparisons present opportunities to benefit fuel poor consumers and those who face additional barriers to engaging in the market, provided engagement tools are tailored to their needs

Chapter 3 – Smart tariffs

This chapter draws out all the factors to be included when comparing smart tariffs: pricing structure, non-pricing characteristics and consumer understanding.

This project set out to develop a tool that could adequately compare smart tariffs today and in the future in a manner that enables domestic consumers to engage with smart tariffs and support their decision-making process.

Successful implementation relied on having a deep understanding of:

1. suppliers' current smart tariff offerings;
2. how those tariffs might evolve over the next five – ten years.

The start point was the lack of a commonly agreed 'smart tariff' definition in the marketplace; at minimum a smart tariff could be described as any tariff that is not standard flat rate.

Methodology

Research was conducted to provide:

- An assessment of current smart tariffs (UK and global) to understand what common characteristics exist that the tool needs to take into account;
- A framework to capture traits and elements inherent to smart tariffs, including their pricing structure and non-pricing structure related traits;
- A summary of consumers' understanding of, and attitudes to, smart tariffs.

The methodology followed to achieve the above was:

1. Performed desk-based, secondary research, reviewing the landscape of smart tariffs in the UK and abroad. Tariffs in countries where smart meters have been rolled out (including Australia, New Zealand and North America) were included to ensure that all possible characteristics were identified.

1. Interviewed senior stakeholders[87] at nine suppliers; four themes were explored:

    - How would they define a smart tariff?
    - What characteristics are inherent to smart tariffs?
    - What smart tariffs are in the market now and how do they see this evolving?
    - How would they compare smart tariffs?

[87] Majority of interviewees were either Head of Product or Head of Proposition

2. Circulated a survey to all domestic suppliers;
3. Performed a quantitative consumer researched study with a representative sample of 2,000 people across the UK.

Definition, or not

Smart tariff – no single definition but some consensus

Options: any tariff that is not a flat rate, a tariff that requires a smart meter, a tariff that works well with LCTs and other devices to reduce bills and cut carbon.

Conclusion: formal definition does not matter as long as consumers are not confused. Communication should be that smart tariffs are connected to smart meters and new technologies that support flexibility.

Research confirmed there is no consistent, commonly shared definition of a smart tariff.

The original specification from BEIS provided four categories of smart tariffs used as a starting point:

- EV specific tariffs;
- Smart export/solar tariffs;
- Multi-rate Time of use tariffs (including Economy 7 and Economy 10 tariffs); and
- Tariffs that were bundled with 'smart' technologies.

The categories were shown to be insufficient in defining distinct types of smart tariffs in a useful way for developing a tariff comparison tool; they captured differing elements or characteristics of tariffs, but the categories may themselves overlap. For example, 'multi-rate time of use tariffs' described a pricing structure which may or may not be specific to time of use tariffs, and 'EV specific tariffs' implied that tariffs marketed to EV owners were by default smart tariffs.

The review of the UK market for tariffs that fall under these four categories also showed that suppliers themselves use inconsistent marketing and nomenclature for smart tariffs. During their interviews, suppliers were asked for their own definition of the term. Each interviewee recognised the lack of a standard **definition** for smart tariffs within their own organisations, as well as the market at large. Despite this challenge, there were some broadly consistent views shared as to the **characteristics** of a smart tariff.

Many viewed smart tariffs as those that require the functionality of smart meters as a pre-requisite to enable the design of the tariff and therefore a smart meter is at the heart of all smart tariffs. An alternative view expressed was that it is not the smart meter that is important, but the specific ability for the supplier to be able to measure consumers' demand at a half-hourly (HH) granularity or greater; measurement can be enabled by technologies like smart EV chargers as well as smart meters.

Smart tariffs were often synonymised with TOU tariffs. However, generally speaking, historical TOU tariffs that require two-rate meters (E7 / E10 tariffs) were not described as 'smart tariffs'. There were also smart tariffs that do not have any time variable pricing but still needed smart meters' ability to record HH usage; there is a need to distinguish between the pricing structure of the tariff, and whether the tariff overall is 'smart'.

There is broad agreement of what is **not a smart tariff**:

- Tariffs bundled with 'smart' technologies (e.g. smart thermostats, smart speakers) are not seen to be smart tariffs based on bundling with the technology in and of itself;
- Tariffs designed for EV owners are not necessarily 'smart' if they are standard flat rate tariffs that do not require measurement of when energy is used;
- Tariffs that require the installation of a smart meter to sign up to them and are potentially marketed as smart tariffs or have the term 'smart' in their brand name, are generally not seen to be 'smart' **if** the tariff itself **does not require** the HH measurement functionality of a smart meter to operate.[88].

Smart tariff framework

> *"The tool should be built in such a way that it ensures flexibility, to allow for future tariff types/models but it should not try to second-guess these developments. The tool should allow customers to filter by the complexity of the tariffs they seek to compare. For example, customers could indicate how often they were willing to engage with their energy use, supplier, or change their consumption habits throughout the day. Customisable tariffs, where (like mobile tariffs) consumers can choose their off-peak hours within a specific window should be an early option." (Supplier feedback)*

The tool needed structured inputs for the comparison model; Carbon Trust developed a smart tariff framework to capture the key elements of smart tariffs categorised into both pricing structure and non-pricing structure related characteristics. Highlights of the analysis underpinning that framework are provided below.

Pricing structures

Smart meters open up opportunities to develop tariffs which are underpinned by non-standard pricing structures because they allow suppliers to measure customer energy consumption at

[88] Some suppliers are offering tariffs with discounts when the customer agrees to a smart meter installation

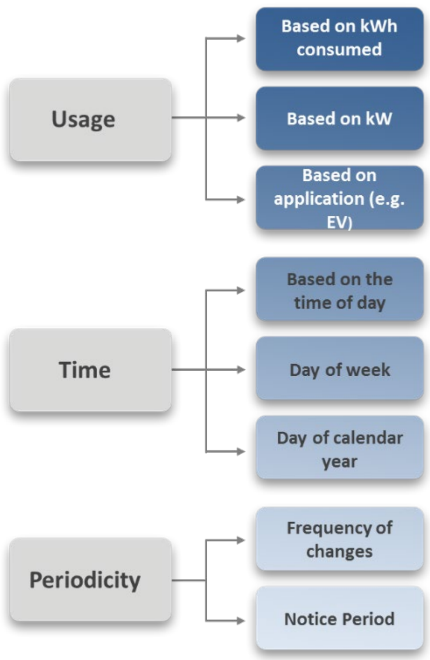
greater granularity (e.g. daily and HH) and thus model new product options based on consumption patterns.

The consortium reviewed tariffs in the UK and internationally to understand what different pricing structures exist that underpin each tariff in the market. The review showed that many different pricing structures existed.

The majority of tariffs in the UK are split into fixed (standing charge) and variable (everything else) elements. (Note: not all UK suppliers structure their tariffs this way[89]). Analysis focussed on the variable element of the pricing structure.

Variable pricing structures were defined across three dimensions: usage, time and periodicity. Periodicity refers to the time interval between revisions of the tariff[90] and can consider how far in advance the customer is advised; it is not a dimension that applies to all smart tariffs.

Figure 9: Pricing structure of smart tariffs



The **usage** dimension captures how rates may depend on the type and amount of energy that a consumer uses. The meter, smart or otherwise, needs to be able to capture information on energy measured (kW, kWh), and potentially use case, to support this pricing structure.

There are tariffs that have tiered rates that depend on **how much energy is used over a certain period of time**. When this is based on kWh used, one rate (e.g. 10p/kWh) may be applied for energy used up to a specified amount of kWh used within a time period, and a second rate (e.g. 12p/kWh) applied for all additional kWh used within that same time period.

[89] Utilita are an example of a supplier that does not include a standing charge in their tariffs
[90] Dynamic Retail Electricity Tariffs: Choices and Barriers, P Bhagwat & S Hadush, Florence School of Regulation

Other tariffs may have pricing related to the peak demand that a consumer uses, e.g. based on the maximum kW used within a specific time **period**.

The final aspect of the **usage** dimension captures that rates may be related to the **application** of that energy. For example, several tariffs have a flat rate in terms of cost on a £/kWh basis from the consumer’s perspective; e.g. where the consumer has a fixed cost but the LCT may respond or change its behaviour based on import or export to the grid like a battery charging or discharging. These tariffs are associated with specific LCT technologies that use automation software to import from the grid.

The **time** dimension captures how rates may vary depending on time. These typically vary according to time of day, day of week or period of the year.

Pricing rates can vary during different **blocks of time** during the day. This can range from a single block throughout the entire day (i.e. a flat rate), to blocks that are as granular as the meter allows, which, in the case of GB smart meters, is 48 HH periods. Other hardware, such as Consumer Access Devices (CADs) or EV chargers, can provide higher levels of granularity (down to second level).

Pricing rates may also differ depending on the **day** of the

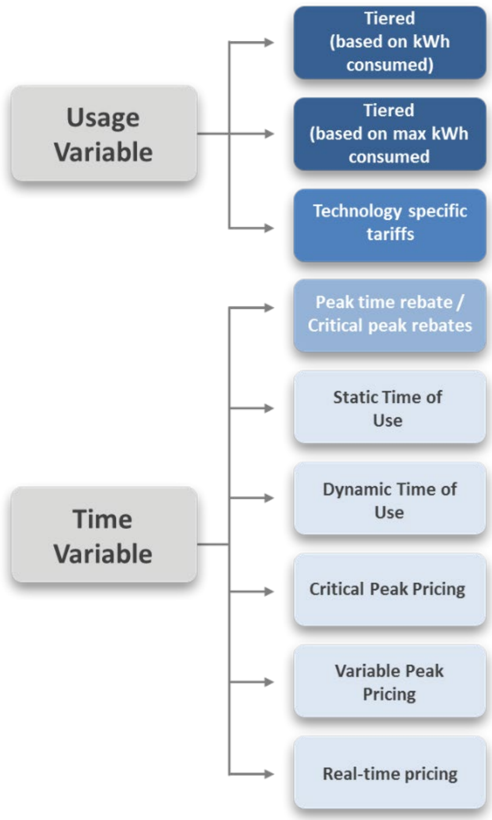
- **week** and recur regularly on a weekly basis – e.g. tariffs with different prices on the weekend to weekday;
- **year** – e.g. tariffs may have higher rates during several days of the year when national demand is particularly high, or rates can vary regularly on a seasonal basis.

One other potential key characteristic of a smart tariffs is **periodicity**. Periodicity refers to the frequency, and length of time in advance, that price rates are communicated to consumers. On one extreme there are prices that are fixed throughout the full length of the contract – conventional fixed rate tariffs are an example of these, as are static TOU tariffs. On the other extreme are tariffs that have real-time pricing. Dynamic TOU tariffs are somewhere in the middle, with fixed rates across different time blocks (e.g. low, medium, and high rates) but the blocks of time in which those rates are applied are defined the day before.

Smart meter dependent

The figure below highlights some examples of types of non-standard tariffs that use the functionality offered by smart meters (or other relevant hardware) to capture information based on the time and usage dimensions highlighted above. This is not a perfect taxonomy; some tariffs exist in the market that are hybrids, for example a tariff in which there are two different rates based on usage (kWh) during a certain time period (daytime), and then a third rate at night.

Figure 10: Non-standard tariffs structures supported by smart meters[91]



There are also tariffs that appear to be flat rate tariffs (from the consumer's perspective) but are more complicated than standard conventional flat rate tariffs. The following examples are both linked to EV or battery technologies:

- tariffs linked to technologies where there is an automated process to import electricity from the grid at times chosen by the automation system on behalf of the consumer;
- peak time rebates, otherwise known as critical peak rebate tariffs, appear to be flat rate tariffs to consumers, but consumers are given rebates based either on time of use or through their supplier's ability to generate revenues from providing services to the grid using the consumer's energy asset.

Static TOU tariffs are likely to have prices fixed long in advance, which may vary seasonally, and the price points and time block associated with them are regular.

Dynamic TOU (also called **real-time pricing**) tariffs offer a different price per unit of energy depending on the time of day; times and rates typically change from day to day[92]. Prices are determined close to the real-time consumption of electricity and are based on wholesale electricity prices.[93] **Negative pricing** can be an element of a dynamic TOU; in this scenario

[91] Analysis based on review of: a) Dynamic Retail Electricity Tariffs: Choices and Barriers, P Bhagwat & S Hadush, Florence School of Regulation b) Ofgem smart 'time of use' (TOU) tariffs qualitative research, Sept 2020 and c) Consumer demand for time of use electricity tariffs: A systematized review of the empirical evidence, M L Nicolson, M J Fell, G M Huebner, Renewable and Sustainable Energy Reviews Vol 97, Dec 2018
[92] Smart Energy GB web site
[93] Time of use Tariffs Innovation Landscape Brief, International Renewable Energy Agency, 2019

consumers are paid to consume electricity. An example of this is the Octopus Agile tariff, which had several plunge pricing events in Spring 2020.[94]

Variable Peak Pricing (VPP) and **Critical Peak Pricing** (CPP) are examples of hybrid static and dynamic pricing. VPP has static rates for off-peak hours, with dynamic pricing for peak hours. CPP tariffs are flat rate tariffs with some periods where prices change for certain periods of very high demand, they increase electricity prices to punitive levels at peak hours on critical days announced beforehand.[95]

Factors beyond price structures

Supplier interviews highlighted that non-pricing elements of a tariff are important tools to help differentiate their offerings, although views differed on the extent to which consumers cared about these non-price related characteristics of the tariff – a topic explored in the quantitative consumer user research.[96]

Hardware dependent characteristics

The key functionalities required of the 'smart' hardware (whether meter or LCT related) are the ability to:

- **measure energy flows** at half-hourly (or smaller) intervals;
- **measure** both **imports** from, and **exports** to, the grid, and;
- for the **meter/hardware** to **communicate** with the supplier.

These 'smart' characteristics include:

- **Complex pricing structure**: Tariffs can be built with complex pricing structures that require the ability to be able to measure consumption at each half hour interval, consumption (both kW and kWh), as well as imports/exports.
- **Rebates**: Rebates can be given to consumers, based on analysing the time of their energy consumption, providing the rewards of a TOU tariff while shielding customers from confusion and concerns around price volatility or higher prices.
- **Customised tariffs**: The ability for consumers to customise their own tariff, for example by specifying a regular 2-hour period in which they are able to receive discounted electricity.
- A tariff **tailored to low carbon technologies** (LCTs): Tariffs can be designed/tailored to support the ownership of different LCTs. Tariffs may be exclusively linked to the LCT, e.g. an EV tariff that only covers electricity used for the EV, and not for the rest of the property. This is possible if the EV is metered separately, potentially through a smart

[94] https://octopus.energy/blog/social-distancing-renewable-energy-negative-pricing/
[95] The effects of critical peak pricing for electricity demand management on home-based trip generation, M Kii, K Sakamoto, Y Hangai, K Doi, IATSS Research, Vol 37, Issue 2, March 2014
[96] See Chapter 5 – Consumer engagement

charger, which in theory would not require a smart meter being installed at the premises if the charger communicates with the supplier independently.

- **Multi-home tariffs**: Tariffs can be non-site specific, with the ability to transfer the tariff across multiple properties/meters in situations where the customer moves between two locations.
- **Smart control / automisation**: Tariffs which involve automation/optimisation of imports/exports by the supplier of a consumer's assets. Examples include:
  - home batteries that are operated by aggregators/suppliers as part of a virtual power plant (VPP) arrangement;
  - EV charging;
- **Innovative digital payment mechanisms**: Tariffs can have one of a range of payment mechanisms that leverage smart meter functionality:
  - smart prepayment;
  - generation of export revenues;
  - enable peer-to-peer trading.

Non-hardware dependent tariffs characteristics

- **Green electricity**: Tariffs are marketed as being ‘green’, however there are differing definitions as to whether this means power is supplied from 100% renewable electricity, 100% low carbon energy, and/or backed by Renewable Energy Guarantee of Origin (REGO) certificates.[97]
- **Discounted energy hardware**: Tariffs can come bundled with discounted hardware, such as a smart EV charger, a battery, a heat pump, or other technologies like smart thermostats.
- **Discounted EV charging outside the home**: Some tariffs provide discounted charging under certain conditions for EV charging away from the home.
- **Exit fees**: Some tariffs charge customers if they seek to end the contract early, others do not.
- **Dual fuel contracts**: Some tariffs are exclusively packaged as dual fuel contracts or are discounted as a result of the customer being in a dual fuel contract, if their electricity supplier also provides gas.
- **Contract length**: Contracts differ in length.
- **Smart meter sign-up**: Whether the tariff require the customer to accept, the installation of a smart meter.
- **Payment mechanism**: Some tariffs have specific payment mechanisms, such as direct debit, the use of prepayment meters, or paying on receipt of bill.

[97] This can be a contentious topic for suppliers; see the discussion Chapter 4 – Stakeholder engagement, Supplier survey

- **Other perks**: Tariffs can be bundled with other offers, such as cashback, gift cards, discounted boiler cover, energy management apps, and consumer goods.
- **Supplier characteristics**: The traits of the supplier responsible for the tariff, such as their ratings on 3rd party consumer trust indices and reviews, and their size.

Consumers and smart tariffs

Smart tariffs have to be accessible to the consumer in both how and where they are promoted. They also need to be understood, particularly for the more complex dynamic tariffs where the timing of cheaper periods may differ from day to day. What that consumer understanding needs to be is likely to be an ongoing research question; does a consumer need to understand what a smart tariff is in full detail or do they just need to be aware of its benefits (and potential risks)?

This project conducted qualitative and quantitative research with energy consumers to better understand their experiences with, and perception of, smart tariffs.[98]

Consumers' perspective

Qualitative research[99] highlighted that although baseline knowledge and awareness of TOU tariffs was low, they were seen as a way to use less energy and be rewarded for doing so.

Smart tariffs specifically held real appeal for three consumer typologies[100]:

- **Green Techies**: Easily saw the 'green' benefits of smart tariffs, could see themselves flexing behaviour to consume less and monitor spend;
- **Super Switchers**: These consumers were keen to make changes to their usage if a saving or incentive was involved;
- **Savvy Enthusiasts**: On the cusp of 'making the leap' into low-carbon and smart technology, TOU tariffs gave them the nudge towards their aspirations.

When presented with different types of smart tariff and given practical examples of how they work, peoples' responses to them were as follows:

- **Dynamic TOU** was felt to have the greatest potential - preferred by people with more overall flexibility and green ambitions;
- **Static TOU** - seen as an initial 'steppingstone' for the less engaged;

[98] Note that Ofgem published their own research on the topic in September 2020: https://www.ofgem.gov.uk/publications-and-updates/energy-consumers-experiences-and-perceptions-smart-time-use-tariffs

[99] In late spring 2020, 24x 45-60 minute one-to-one interviews were held across three key audiences: general potential smart tariff customer (12), existing smart tariff customers/highly engaged early adopters (8), Fuel poor and digitally excluded

[100] See Chapter 5 for detail on consumer typologies identified in research and BEIS Consumer Research Report v1.1 Slide 54 for full detail on smart tariff response

- **Critical Peak tariff** - only appealed to those who travel a lot or are away for long periods;
- **EV tariff** – a niche product although seen as a ‘no-brainer’ for people who own an EV;
- **Export tariff** - only relevant to solar panel owners, respondents said that both cost of installations and related benefits of ‘free’ energy were high.

The qualitative research findings were used to determine the questions to ask in the project’s quantitative research study.[101] The quantitative study found that although there was low awareness of smart tariffs, the idea provoked interest – especially among engaged, green, smart home consumers.

- Only 1 in 5 (20%) energy consumers were aware of smart tariffs but over half were at least fairly interested in the concept and a third were very interested (rising to 56% among the engaged, green smart home consumers);
- Reducing bills was the main driver of appeal but those interested in smart tariffs were also attracted by the idea of helping create a lower carbon, fairer and more efficient network;
- The majority (68%) said they were willing and able to shift their usage of appliances to cheaper periods but over half did not have appliances with timers and only a fifth were interested in buying new smart appliances;
- Smart tariffs made smart meters much more attractive to those already open to the idea of getting a smart meter but not for those who were smart meter rejectors;
- Smart tariffs also made existing smart meter consumers feel more positive about having a smart meter;
- Those not interested (17%) were sceptical that there would be real bill savings and wanted freedom on when they used appliances;
- The new comparison tool was very interesting to one third (33%) of the respondents and a further quarter were at least fairly interested; they saw the main benefit as getting comparisons that were more accurate and tailored to them.

Future roadmap

GB is in the early days of smart tariff development and take-up; most suppliers are exploring how they will integrate smart tariffs into their product sets now that the smart meter rollout and transition to the DCC infrastructure has become more firmly established.

Consumers are often not familiar with smart tariffs and a lot of work has to be done to address even basic communication challenges – for example, EV buyers often do not realise there are EV tariffs designed to optimise when they charge and within a few months of purchase are

[101] Nationally representative sample of 2,004 UK energy customers age 18+ participated in a 15-minute online survey via an online consumer panel

unlikely to change the way they are charging.[102] But when consumers understand smart tariffs they are interested; the research in this project confirmed that people are attracted by the idea of reducing their bills and supporting a lower carbon network. The ability to access smart tariffs through their smart meter also makes some people feel more positive about having a smart meter[103].

The provision of a set of standard characteristics for smart tariffs and a tool that makes them accessible to customers could support the drive towards greater smart tariff availability and take up. By laying the groundwork it is hoped that the tool will facilitate the drive to more smart tariff based products in future to support the adoption of the necessary LCTs to achieve net zero like EVs, electrification of heat, demand side response, storage, solar, export, etc.

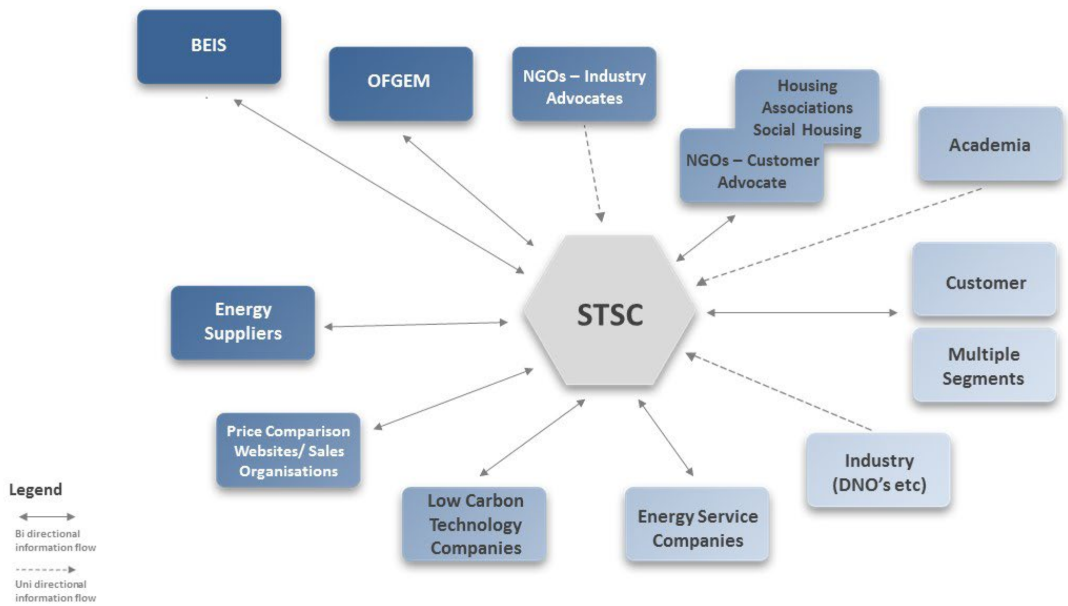
[102] Electric vehicle owner engagement with tariff switching increased by tailored email prompts sent by government shortly after vehicle purchase
[103] See this project's quantitative research findings in Chapter 5.

Chapter 4 – Industry: learnings & requirements

Project approach: offer all stakeholders the opportunity to be part of the journey to the solution to ensure high quality output and industry take up. ***Turn stakeholders into project champions****.*

Project success was underpinned by engaging with a broad range of stakeholders across the industry; all were given the opportunity to play an active role which several took up. Their input was instrumental in ensuring the STSC tool reflected industry and consumer needs.

Figure 11: External stakeholders and the STSC project



Suppliers

In the first phase of the project interviews and an industry survey[104] were used to capture the requirements and views of domestic energy suppliers; early iterations of the STSC tool were included in some of the discussions as a demonstration of intent which helped with gathering early feedback.

[104] Supplier survey was prepared by the consortium and distributed by BEIS to all UK domestic suppliers.

The penultimate version of the STSC tool was shared with suppliers[105] in a supplier workshop held in February 2021 to build engagement and capture further feedback; the outcomes are shared in Chapter 7 Industry requirements.

Suppliers' requirements of the smart tariff comparison tool

In-depth interviews with senior stakeholders at nine suppliers raised common requirements of the solution listed below. Suppliers also flagged challenges they anticipated if successful delivery was to be achieved and gave the consortium feedback on the concept.

- The tool needs to be **simple** and **easy to use**;
- The use of **actual consumption data is critical** to move the market forward and provide a more personalised offering (while minimising the effort required of the consumer);
- Suppliers who offer them said that the ability to **compare additional perks/services** delivered with their tariff was an important requirement although they recognised it would be challenging to compare a broad variety of offerings and communicate these simply to consumers;
- The STSC tool needs to present **insights on the carbon intensity** of a tariff but also recognise the complexities around different interpretations of 'green tariffs'[106];
- Use **appropriate comparison metrics for different LCTs**. For example, the payback period for battery storage, or the operating cost/lifetime running cost for EVs, etc.;
- While the importance of **including supplier ranking tools** in results was recognised, suppliers stated that caution needed to be exercised when they are used;
- The value of an **open sourced tool** was appreciated by suppliers; their request was that **statistics would be shared** on **what people engage with** in terms of tariff selection options as this becomes a valuable dataset in itself when considering tariff design suitable for the suppliers' target market(s);
- Provide a **standard API driven service** for **sharing all tariff details** between the comparator tool and suppliers. Note: this is critical, as currently data transfer between suppliers and PCWs is typically done through standardised, and non-standardised, Excel sheets. Complex (and potentially dynamic) smart tariffs cannot be shared other than via API.

Challenges and considerations

- Smart tariffs can have complex pricing structures that make long term forecasts difficult, for example dynamic TOU tariffs that have pricing rates determined a day in advance of real-time. The service needs to ensure the user does not get confused or put off by

[105] Invitees included all suppliers who participated in the interviews or completed the survey
[106] Some backed by REGOs, others from suppliers who only trade with renewable energy generators, or who build, own or operate their own renewable generators. Additional complexity required when distinguishing between various low carbon energy generation sources, such as nuclear, solar, biomass, and wind.

complexity of trying to compare these tariffs or lose trust in the comparison service as a result of inaccurate predictions;

- Caution is needed if a tariff or supplier switch is executed, because user inputs as they are today on switching sites are not always accurate, consumers can struggle to remember correctly who their current supplier is and input incorrect information.

Responses to the concept

- **Actual data** to **drive match** is a **compelling benefit** and helps suppliers to 'be smarter about recommending the right tariff to the customer'[107];
- It is **appealing** to have a tool which **includes tariffs and offers not currently included by PCW**
- By being open source it is hoped the tool will help PCWs take it up as the tool deals with the higher complexity involved with smart tariff comparison;
- The solution would help **drive the development of smart tariffs** – 'it takes something like this to make it happen, people cannot do it individually'[108];
- The tool could **help drive smart meter take up** (e.g. you cannot get this tariff unless you have a smart meter).

Suppliers' smart tariff proposition development

Suppliers gave no indication that there is an agreed or established roadmap towards a certain type of smart tariff (e.g. dynamic TOU tariffs). Instead, propositions[109] would be developed driven by the supplier's commercial objectives, their customers' needs and their broader strategy around energy services and related products.

Several suppliers noted there would be increasing interdependence between smart tariffs and LCTs and that this process had already started within their organisations. Smart tariffs are being:

- tailored toward LCT owners to help them reduce the cost of ownership;
- bundled with energy efficiency technologies.

Some of the suppliers exploring this interdependence were using consumption information captured from smart meters[110] to better target energy efficiency technologies towards LCT owners who would gain the most value from them.

[107] Comment made during a supplier interview (one of the big five)
[108] Comment made during a supplier interview (one of the big five)
[109] Propositions are business or marketing statement that a company uses to summarise why a consumer should buy a product or service
[110] Suppliers are required to obtain explicit, opt-in consent from customers to access their HH consumption data

Value propositions

Several value propositions were identified by suppliers based on smart meters or other smart hardware enabled tariffs:

- The ability to **reduce the cost of ownership** of LCTs to current or potential owners of the technologies. This includes the ability to generate revenues for customers through providing grid services (ESO and DSO), and/or through peer-to-peer trading in future.
- The ability to **incentivise customers to shift their demand** to times of lower market prices. This is relevant to those with and without LCTs. It was also noted that smart tariffs in the form of static or dynamic TOU tariffs could help reduce some consumers' energy bills without the need for any behaviour change at all.
- Increasing suppliers' **understanding of consumer behaviour**, through which suppliers can examine what their **customers value**, and from this differentiate their offerings through more personalised tariffs or other services.
- The ability to **support vulnerable customers** with smart prepayment and pay-as-you go tariffs with predictive analytics; e.g. letting people know when they need to top up.

Suppliers were developing smart tariffs for different consumer segments reflecting their specific preferences and needs.

Table 4: Smart tariff offerings by consumer segment as classified by suppliers

Consumer segment	Tariff offer / proposition
LCT owner	Automated optimisation of smart charging/exporting could be done behind the scenes, enabling the ability to keep an import tariff's pricing flat which in turn helps maintain consumer confidence and engagement in the tariff itself
TOU rejector Consumers who are concerned about prices at peak times if their demand is inflexible.	Offer a (smart) flat rate tariff with rewards applied retroactively (i.e. peak rebates or critical peak rebate tariffs) for behaviour change or automated-DSR/smart imports with batteries.
Bill reducers	Bundle smart tariffs with energy efficiency technologies and smart prepayment for less affluent customers whose interests may align towards reducing their energy bills.
Highly engaged (small minority)	Dynamic TOU tariffs with near real-time pricing. Seen as the smart tariff poster child although only likely to appeal to a few.

LCT aligned tariffs

The majority of smart tariffs offered by suppliers are based on the LCT sold/operated.

EV: the majority of tariffs favour a simple static TOU pricing structure based on the premise that consumers are comfortable with the idea that charging at night is cheaper. However, other tariffs are emerging with flat rates and automated charging enabled through smart chargers. Suppliers said they are also looking to bundle other EV-related perks through their tariff, for example through discounted charging hardware or discounted charging outside of the home.

Solar and batteries: smart tariffs are being tailored to help reduce the cost of ownership of the assets, reducing barriers to those looking to invest in LCTs. The most advanced of the approaches offer aggregation and optimisation services using distributed assets (via a virtual power plant), sharing revenue from providing grid services to customers.

Electrified heat related tariffs are the least mature. Some large suppliers have been trialling smart heating technologies with tailored tariffs, and the UK's first heat-pump linked tariff[111] was announced during the project.

In general, the suppliers interviewed in this project said they were focusing on developing LCT associated smart tariffs in a priority order, starting with EVs, then rooftop/PV, followed by electrified heat. The rapidly growing EV market and the related additional load borne by EV owning customers makes this a priority area for suppliers. As the market matures and consumers own more than one LCT (i.e. both an EV and a heat pump), it is likely that a variety of asset specific versus integrated energy service approaches to tariffs will evolve.

Suppliers proposed three use cases that combine smart tariffs with LCTs, driven by the supplier's business model and specialisation:

- **Asset-led**: backed by a tailored smart tariff. Suppliers who have existing asset propositions showcase their tariffs as value-add to reduce the cost of the asset. E.g. a supplier who sells rooftop PV panels and then provides an export tariff exclusively to the purchasers of their solar panels.
- **Energy-led**: with assets being sold as value-add services. Suppliers who do not have hardware propositions market their tariffs as a way for consumers to lower the operating cost of assets they already own. E.g. an EV specific tariff that is not bundled with a charger or EV (already be owned by the consumer).
- **Service-led**: more innovative and at a nascent stage of development. Suppliers are exploring how can they use AI and smart meter data to provide Apps or other incentives to consumers to take up tariffs which are better suited to their consumption patterns.

[111] Our new heat pump tariff will make the Green Homes Grant scheme go further and faster, 1 Oct 2020

Engaging consumers with smart tariff propositions

Suppliers identified key factors needed to underpin successful smart tariff propositions:

- **Simplicity**: tariffs have to be easy to understand at the point of decision and thereafter.
    - One supplier, for their EV tariff, keeps import and export flat to give customers certainty and eliminate the stress and complexity that could arise with TOU; they then manage the TOU in the background (by triggering battery charging).
- **Affordability**: For those who cannot afford an LCT investment suppliers see smart tariffs as an opportunity to encourage off-peak consumption to help them save money.
- **Manage complexity**: tariff complexity is an important consideration when positioning tariffs to customers. Where a tariff is more complex, for example Octopus Agile, a consumer will need to be more engaged in order to achieve the full benefits from the tariff. Whereas a lower complexity tariff, like a static or two rate tariff will be easier for a consumer to understand.
- **Asset based**: several suppliers see tariff decisions intertwined with LCT assets within the home, for example extending beyond the home with EV charging. Price comparison websites (PCWs)

PCWs focus on price-based switching and are typically paid commission by suppliers according to the number of switches they facilitate. The user journey consists of basic data input followed by presentation of results, typically presented in price order.

The objective for an effective comparison site is to 'keep it simple to maximise revenue'; PCWs typically keep the number of comparison elements (beyond price) in results low as additional comparison complexity increases the number of required questions which in turn leads to drop out before completing the switch (and therefore reduces PCW income).

The current PCW market

There are currently eleven PCWs accredited by the Confidence Code[112], Ofgem's code of practice to govern independent energy price comparison sites and how they operate their services. Although other PCWs exist, they were not included in the study. The relatively new automated switching sites[113] were also not in scope, including those owned by a PCW accredited under the Confidence Code.

PCWs operate in a competitive market and spend a lot on advertising to attract customers; most use 'white label' suppliers to power their web sites rather than building their own tariff aggregators and comparison algorithms. PCWs are no longer required to include tariffs across the whole of the market but are expected to make it clear when they do not and provide a link

[112] https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/how-switch-energy-supplier-and-shop-better-deal/compare-gas-and-electricity-tariffs-ofgem-accredited-price-comparison-sites
[113] Auto switching sites include: Labrador, Flipper, Look After My Bills, Switchd, Switchcraft, BillBuddy

to the comprehensive Citizens Advice comparison site[114]. They are not required to offer comparison with smart tariffs and none, as yet, do so.

Overview of engagement with PCWs

The consortium approached several PCWs; two agreed to an interview. One was a white label PCW solution provider and the other a consumer facing PCW. The tool was also demonstrated to PCW representatives who attended an Ofgem Confidence Code meeting in November 2020.

PCWs: findings and tool requirements

General findings

The following findings are based on interviews and desk research.

- PCWs have seen much less supplier push than expected on smart tariffs, and therefore have found it difficult to justify taking the leap into smart tariff comparisons;
- As fewer than one in five people switch supplier each year[115] there is a significant untapped market for PCWs in the energy space;
- PCWs stated they did not feel that all customers were engaged with the benefits of smart metering;
- PCWs were sceptical that people would engage with smart TOU tariffs – based on their experience with Economy 7 tariffs;
- The PCW's brand recognition, reputation and trust matter to the customer, the most commonly used sites are the best known[116];
- PCWs appreciated the opportunity offered by basing quotes on actual consumption: they saw the benefit to the customer experience of not having to ask people either for information from a bill, or estimated annual expenditure, and this benefit also meant they could offer more accurate quotes;
- Regulated access to data could be helpful for PCWs.

Tool requirements

During their interviews, the PCWs expressed the following views and requirements of a smart comparison tool:

- The prospect of a centrally produced tool that dealt with the more complex smart tariffs, to have as an industry standard, was attractive in preference to each PCW having to do the development work themselves;

[114] https://energycompare.citizensadvice.org.uk/
[115] Household Consumer Perceptions of the energy market, Ofgem Q4 2020 – 18% of survey respondents had switched in the last year.
[116] Digital comparison tools market study, CMA 26 September 2017

- PCWs said they were interested in understanding whether a PCW should be a DCC Other User (and thus, where they have the consumer's permission, they would be able to retrieve actual smart meter consumption data);
- Everything should be as easy as possible for the customer – e.g. they should not have to do anything more on a PCW than put in name and postcode. Ideally, PCWs would eliminate all questions but there was a need to categorise consumers so there was a dilemma;
- PCWs expressed the view that it would be very challenging for a tool to do comparisons for dynamic TOU tariffs;
- It was seen as a challenge to bring bundled products into comparisons but the PCWs acknowledged that there will need to be an evolution as tariffs and related offerings get more complicated;
- The following advice on the development of the STSC, specific to the customer journey was given:
  - Journey has to be **personalised** and **simplified**;
  - Make the customer feel that it is **their** journey, not **a** journey;
  - **Start** with **simpler smart tariffs** (e.g. static TOU);
  - Tariffs could be developed that are **tailored to consumers based on AI**.

Consumer engagement with PCWs

For consumers, switching is predominantly about saving money and PCWs are the main tool used. Highlights of the quantitative research[117] findings on the topic were:

- A third (33%) of electricity consumers had switched 3 or more times, however a quarter (26%) had never switched. Saving money was the dominant reason people last made a switch (65%) followed by a price/tariff increase triggering the switch (37%).
- Half of those who had never switched or only switched once or twice (52%) said they had not switched more often because they doubted its benefits or saw it as too much hassle. In particular they doubted that the money saving was worth it or that it would be sustained.
- Almost two-thirds (65%) of those who had ever switched said they used a PCW as a source of information on alternative tariffs and suppliers the last time they switched. This was by far the most widely used source of information.
- Half (52%) of those who used a PCW then followed through with a switch; the other half (48%) simply used the information.

[117] See Annex B for full findings.

- PCWs usage was pretty similar across all segments and demographics, except amongst fuel poor consumers, where only 50% used a PCW (compared to 65% overall). Unsurprisingly, usage was highest among the Super Switchers segment[118] (76%).
- Switchers who did not use PCWs said salience (25%), trust (33%) and usability (25%) were the main reasons why they did not use a PCW.

Potential for sector take up of the tool

PCWs indicated that they will explore taking up the STSC tool at the point **when** the smart tariff market becomes **commercially interesting** to them. By doing the 'heavy lifting' required to compare complex smart tariffs, the open source STSC tool will save PCWs time and effort they would have had to invest in building their own solutions.

Some new entrants to the PCW market, focusing on serving niche markets (e.g. EV buyers), have proactively contacted the consortium to explore embedding the tool into their offer.

Suppliers and Price Comparison Websites

For most suppliers, PCWs are an important part of their tariff marketing landscape; one said that around four-fifths of their new business comes through PCWs and their most popular tariff is exclusively marketed through that channel. PCWs are seen by many suppliers as a key channel to scale up tariff adoption with consumers. On the other hand, although important, if not critical, as a sales channel, several suppliers feel that PCWs create 'winners and losers': one supplier did not want to speak to the project due to their feelings about PCWs – they saw the project as being another PCW.

Because PCWs are such an important route to market for many suppliers, their current inability to convey complex and/or bundled tariffs could be seen as acting as a constraint on suppliers continuing to innovate in this area.

Table 5: Suppliers practical PCW challenges and STSC tool role

Suppliers' current practical challenges with PCWs	How STSC tool can address
Designed for standard tariffs only Most PCWs exclude prepay, tariffs without standing charge, bundled, TOU	• Supports smart tariffs • Bundled tariff representation on roadmap

[118] See Chapter 5 for details of the consumer segmentation developed through the research.

Suppliers’ current practical challenges with PCWs	How STSC tool can address
Inaccurate tariff information Requires significant effort to maintain; benefits large suppliers that have PCW dedicated resources	• API interface for automated maintenance of tariff information – supplier maintains tariff name, description, • Common framework for smart tariff structure across all suppliers
Inconsistent data sharing techniques across PCWs Varies by PCW, can be csv file, Excel sheet, API	• Single API interface for all suppliers
Limited ability to describe full service offering Suppliers want to include incentives, bundled services, etc. and get beyond price alone.	• Factor in additional benefits; both in results weighting and presentation

Suppliers felt that PCWs’ emphasis on price rather than non-price related elements of tariffs was seen to have impacts on the tariff market itself, it skews the market, so that suppliers now focus on designing tariffs that have almost no perks, as these perks are not successful in winning over customers through the channel which in turn leads to a lack of personalisation/tailored tariffs on PCWs.

The issue is particularly relevant for the prepayment section of the market, where tariff costs are less variable there is little competition between suppliers based on a price metrics alone, they therefore compete on offering useful perks to potential customers, but the PCWs do not adequately compare these perks.

Examples of supplier offers that are not presented in PCWs that were raised by suppliers include:

- Tools and apps that help consumers manage their energy use, pay bills, take meter readings, etc.;
- Energy efficiency offers;
- Added value solutions (e.g. insights about their smart energy products);
- Perks & incentives (tickets, gift cards, etc.);
- Carbon reduction metrics achievable with a tariff - ‘lifetime carbon savings’;
- Lower tariffs if purchase LCT through the supplier;
- Incentives to export;
- Discounted energy hardware (e.g. EV chargers);

- Services (boiler cover, pay-day credit);
- Percentage of renewable energy within the tariff.

Other organisations

The consortium met with BEIS, Ofgem, Smart Energy GB, National Energy Action and Citizens Advice. The organisations' contributions were an important contributor to the final tool and helped ensure a good understanding of some of the key challenges to be addressed, particularly for the fuel poor and those less able to engage in the market.

The smart tariff comparison tool was seen by all as a positive opportunity to encourage consumer take up of smart tariffs and LCTs.

Key points from industry

To conclude with a summary of findings from our industry engagement:

Suppliers and smart tariffs

- Several suppliers indicated that while they were exploring smart tariffs, the implementation of market-wide half hourly settlement in 2025 was stated to be the key element that would drive new product and service developments;
- Indications were that some suppliers are actively considering embedding the STSC tool into their own websites (though they need to be offering more than a single smart tariff for the tool to be relevant).

Their goals

- Learn about the market and consumer responses / engagement through their own research and industry developments as they build their own propositions;
- Find better ways to profile consumer demand and align with network costs;
- Explore how flexible consumers can be about when they consume;
- Use Artificial Intelligence tools to suggest appropriate tariffs;
- Potentially offer personalised tariffs – calculate cost to supply at household level and determine tariff;
- Ultimately incentivise consumers to use energy during prioritised times of the day.

Their challenges

- Some suppliers have IT systems which require change to handle complex tariffs;
- Supplier access to HH data is not mandated – they need the customers' permission;

Price Comparison Websites

- When market conditions (enough demand) are in place, PCWs will integrate smart tariffs into their tools.

Industry bodies

- Key players have engaged and been constructive supporters of the project;
- New entrants in the LCT space, offering consumers advice on LCT and related service selection, see the tool as an opportunity to get a ‘step ahead’ of traditional PCWs.

Chapter 5 – Consumers: learnings & requirements

A successful smart tariff comparison tool will be determined by its value to the consumer and their eventual take-up of the solution. Success will be achieved through understanding, and then meeting consumer needs through research.

Overview of methodology

Research agency davies+mckerr were responsible for the qualitative and quantitative research throughout the project. An initial phase of qualitative research[119] was used to:

- build learnings on consumer attitudes to smart meters and smart tariffs;
- develop detailed attitudinal and behavioural consumer profiles to support energy consumer segmentation;
- begin the process of building a list of consumer requirements of the comparison tool underpinned by user segmentation learnings;
- frame the subsequent quantitative study.

The quantitative study[120]:

- provided representative data on consumer attitudes;
- delivered findings that were used to underpin design and functionality considerations;
- defined quantified energy consumer segmentation.

Subsequent qualitative research studies focussed on the development of the STSC tool; assessing each iteration's success with prioritised consumer segments to drive ongoing development. Research findings influenced both the front-end design and back-end implementation decisions and are presented in Chapters 6 and 7.

Notes:

- The research documentation across all phases (including methodology and sampling) is published separately and cross referenced in the following narrative.
- All consumer research excluded brand and tariff names to remove bias; the goal was to test the efficacy of the tool, not the tariffs and brands.

[119] In late spring 2020, 24x 45-60 minute one-to-one interviews were held across three key audiences: general potential smart tariff customers (12), existing smart tariff customers/highly engaged early adopters (8), Fuel poor and digitally excluded (4)
[120] Nationally representative sample of UK energy customers, 2,004 respondents, delivered online via consumer panel in late July/early August 2020

Qualitative research: discovery phase

The first wave of qualitative research had four objectives:

- Understand engagement with the smart tariffs and how this differs by audience, exploring awareness of smart meters and interest and motivation in green and renewable propositions.
- Gauge current levels of understanding and awareness of smart energy tariffs to determine both triggers and barriers to adoption.
- Explore how different audiences currently navigate the sector to identify any learnings that could be taken from other categories.
- Identify consumers' goals and understand what they need to hear in order to maximise their engagement:
    - Can smart tariffs be made 'understandable' and engaging?
    - Are there myths and misnomers that need to be dispelled?

Depth interviews drilled down into the detail of the consumer experience to inform the development of the smart comparison tool.

Findings

Many consumers **approached shopping for energy with trepidation**; they were aware it is better to switch energy providers regularly to get the best deals, but their lack of engagement / trust can lead to stasis – especially if consumers felt happy with the service received and their energy costs were within budget.

There were several barriers to engagement including mistrust of energy companies; consumers were concerned that they would always come off worst in any deal and that they were better not to waste time trying. Energy sector jargon was considered to be daunting and off-putting and people felt that energy providers were all the same. Consumers had low awareness of the evolution of the market and any new tariffs / providers available and expected that finding a deal that worked for them would be time-consuming and frustrating. Even when a deal was found, there was some belief that switching would be a hassle and (in some cases) would also require a smart meter installation to access the tariff.

PCWs could take some of the hassle out of 'energy shopping' and were used by almost all participants across multiple categories, not just energy (e.g. home / car insurance, mobile phone tariffs etc.). They offered an overview of an entire category, making comparisons as simple as possible and good deals easy to find. Cross-category use of PCWs bred a confidence and familiarity that was easily transferred when searching for energy tariffs. Almost all participants used PCWs as their primary (and sometimes only) point of reference when looking to switch / searching for new deals and the preferred PCWs for energy were: moneysavingexpert (Cheap Energy Club), Uswitch and GoCompare. The general perception of these three was that they were all unbiased, market-wide and reliable.

Cost remained the primary driver for switching, it was focused on over and above other criteria. PCW incentives (e.g. soft toys / cinema deals etc) could act as additional pull to purchase through a specific PCW versus another. Consumers' current monthly/quarterly energy cost was used as a benchmark to judge potential energy deals against. For consumers who were more engaged with energy there were some additional drivers (beyond price) – for example filtering providers by those which offered green energy or specific deals for smart-home technology, solar panels and electric vehicles.

Baseline knowledge and awareness of TOU tariffs was low but, when explained, TOU tariffs were seen as a positive step forward. They were primarily seen as a way to get consumers to use less energy and get rewarded financially for doing so but they were not viewed as a 'green initiative' in themselves. The notion of 'green energy' was seen by mainstream consumers as very 'futuristic' and linked to solar panels and electric vehicles.

Smart Tariffs held real **appeal for** three consumer typologies identified in the qualitative research:

- **Green techies**: easily saw the 'green' benefits of smart tariffs and could see themselves flexing their behaviour to consume less and monitor their spend.
- **Super switchers**: these consumers were keen to make changes to their usage if a saving or incentive was involved.
- **Savvy enthusiasts**: on the cusp of 'making the leap' into low-carbon and smart technology, TOU tariffs gave them the nudge towards their aspirations.

When presented with examples of different types of smart tariff, consumer feedback in the qualitative research was as follows:

- **Dynamic TOU** was felt to have **greatest potential** - preferred by people with more overall flexibility and green ambitions.
- **Static TOU** - seen as an **initial 'steppingstone'** for the less engaged.
- **Critical Peak Tariff** - only appealed to those who travel a lot or **are away for long periods.**
- **EV + other technology-based tariffs** - **niche**, though seen as 'no-brainer' for people who own the technology.
- **Export Tariff** - only **relevant to solar panel owners** but cost/benefits high.

General requirements by energy consumer segment

Within their reporting, davies+mckerr presented development considerations by energy consumer segment drawn from the qualitative research findings, summarised below. These helped frame and prioritise the user requirements.

Table 6: Development considerations by energy consumer segment

Energy consumer segment	Development considerations
Energy innovators	Feed them with data Keep them abreast of new technologies and plans Focus on self-sufficiency
Savvy enthusiasts	Show them what could be possible Excite them with personalisation Engage them at key switching moments
Super switchers	Show both short and long-term savings Excite them with personalisation Frame energy conversations around cost
Green techies	Myth busting Help them get the most of what is already available Provide them a vision of the future
Prioritisers	Simple solution to make energy changes easy Seed ideas of renewables and low carbon tech Unable to make massive behavioural changes
Traditionals	Allow them to feel in control Make it easy Digital simplicity
Fuel poor	Engage support network Low engagement solutions Discuss energy use in pounds and pence

Quantitative research

A quantitative survey with a nationally representative sample of 2,004 energy customers was conducted in late July/early August 2020. Survey questions were designed based on the findings from the qualitative research stage. The quantitative research was used to assess key emerging themes and size the energy customer typologies identified in the qualitative research; it provided a detailed and nuanced view of the consumer energy market. Findings are published below and discussed within relevant sections of the report (attitudes to smart tariffs in Chapter 3, PCWs in Chapter 4).

The complete survey method and results are published separately in Annex B to this report.

Market segments

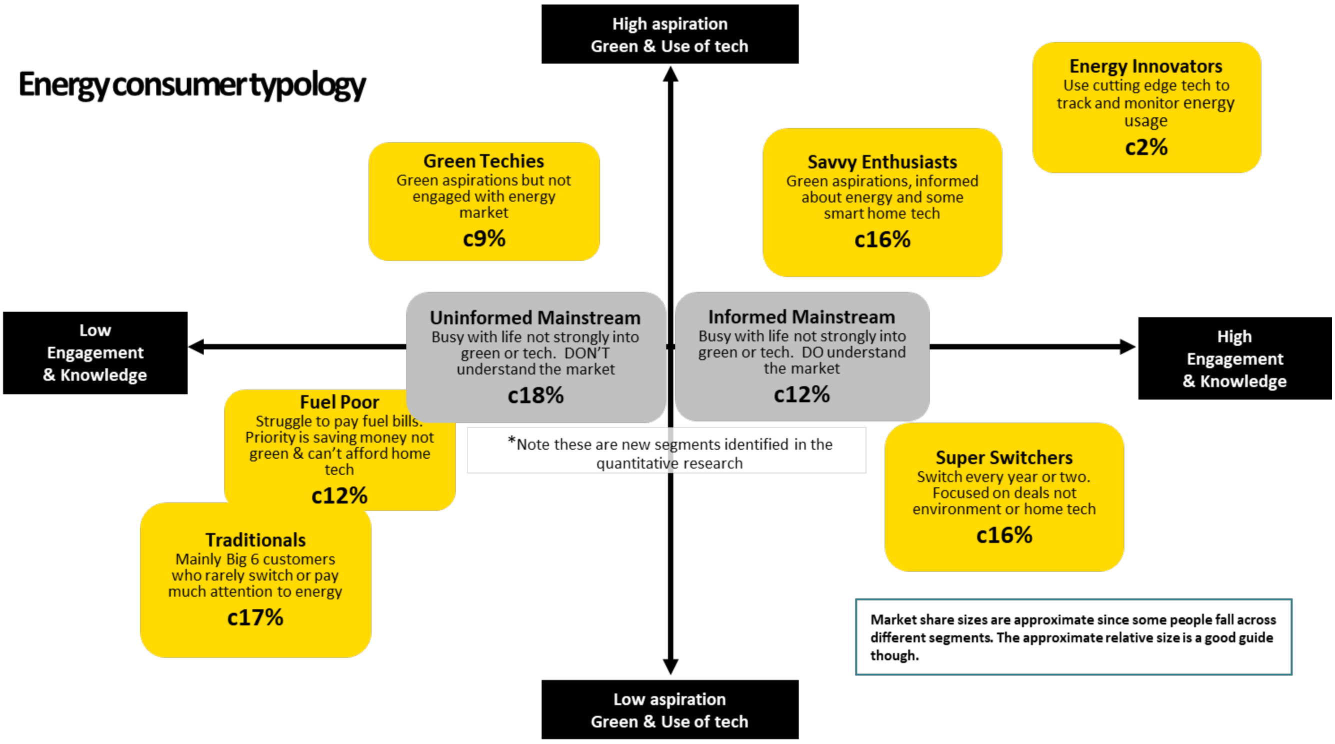
The quantitative research was used to test and refine the initial seven consumer segments identified in the qualitative research. Responses to questions on three key topics were used to segment the respondents, including:

- Engagement with the energy market e.g. how often monitor energy usage and how often switched;
- Attitudes to energy and aspirations e.g. how important being green was and engagement with using technology to achieve household goals;
- Household income ease of bill paying (mainly to identify fuel poor and low income consumers).

Respondents were asked to state the strength of their agreement or disagreement with multiple statements about their attitudes and relationships with these topics. Each respondent was then allocated to a single segment based on their responses. Full details of the segmentation methodology can be found on pages 8-9 of Annex B.

This process identified eight distinct energy consumer typologies and their prevalence in the population.[121]

Figure 12: Energy consumer typology map



[121] Note that the segmentation method placed respondents into typologies on a best-fit basis and each was assigned to only typology. In reality, the typologies would not be mutually exclusive. Some respondents share some characteristics with those in other typologies.

Figure 13: Typology profiles described

Energy consumer typology – profile summary

With the exception of the Fuel Poor, each segment includes a wide demographic range ie segments do not correspond neatly to one age group or lifestage. However, most segments do **over-index on certain characteristics.**

Savvy Enthusiasts	Green Techies	Super Switchers	Informed Mainstream	Uninformed Mainstream	Traditionals	Fuel Poor
• Under 35 & young kids • … or over 55 no kids • Have smart meter • Early Adopters • Influencers • Multiple smart devices	• No kids • Under 45 • Above average income • London	• Married • Over 55 • Men • Home owners • 3+ bedrooms • Above average income • Northern • No smart meter	• Demographic profile in line with overall population	• Over 65s • Home owners • Middle income	• No kids • Late adopters • One or no smart devices	• Under 45s • Low income • Single households • 1 or 2 bedrooms • Have a disability • PPM • One or no smart devices

NB Energy Innovators are too small a sample for accurate profiling

Functional requirements were scored against these typologies (see Chapter 6).

Findings

There was **no single 'energy consumer'** in the market. Although their goals were common - most people wanted to save money, get a good deal and receive good customer service - there was wide variation in energy market understanding and engagement.

- 32% said they paid little attention to their energy use while 49% said they tracked and controlled usage and cost;
- Just over a third (38%) strongly cared about being as green as possible while almost as many (35%) said it was not important to them;
- A quarter (25%) valued being able to use technology to control their home whereas twice as many (53%) did not value that ability;
- The nearest there was to consensus was the belief that energy companies were focused on profits, not on offering customers the best deal. Only 16% agreed that 'energy companies care about giving customers the best deal'.

The majority (63%) of smart meter owners were **satisfied** with their meters; 39% of those without one said that they would seek an installation in the next six months or accept one if offered.

- 40% had a smart meter, rising to around half of those with smart technology[122] (55%) or an EV (52%);

[122] Smart lighting, heating or security.

- 71% of smart meter owners said they had an In-Home Display (IHD).
- Those without a smart meter (60%) divided fairly evenly between those very receptive to an installation (39%) and those who said they not accept one if offered in the next six months (43%) with attitudes to technology and trust in energy suppliers the key differentiators;

The research findings provided quantified data and was key to the ongoing building of the rich consumer understanding necessary to develop user stories and begin the user experience and development cycles (see Chapters 6 - 8).

Priority segments

Appreciating that no solution works for every consumer, a decision was taken to select two priority segments for ongoing development so that design and implementation decisions could be assessed against the priority segments' needs. The decision on which energy consumer segments to select was based on project goals (a tool that would work for a broad cross-section of consumers and ensuring consumer protection) and based on typical product lifecycle and diffusion patterns (in which early adopters are very influential in driving broader take-up). The priority segments were:

- **Savvy enthusiasts** – represented key influencers who would be likely to build awareness through word of mouth;
- **Fuel poor** – highly price sensitive and a group who could financially benefit from switching to tariffs that align with their lifestyle.

These segments were chosen because consumers in these segments were generally found to be the most distant from each other in regards to their engagement in the energy market and needs from a tariff comparison tool.

Prioritised requirements

An initial set of over 200 potential features for the tool was assembled based on 1) Love Experience and Hildebrand's sector expertise and 2) Discovery phase research findings. The quantitative research responses were segmented by the eight consumer typologies and used to score each of the features in parallel with technical and operational feasibility. Features that scored well for the two priority segments formed the 11 features to be delivered in the first iteration of the prototype. The priority features (expressed as user stories) were:

Table 7: Priority features for first prototype iteration

I want	So that
To balance a good deal with customer service	I feel confident I will get support if needed
I can track my usage and costs	I know I am making the savings predicted
To know if another smart tariff becomes available that will save me money whilst I'm in contract	I can decide whether it's worth the penalties in switching
To understand the impact of being green on tariffs	I know how the cost may change
To see the level of expected customer service as a rating	I can decide to trust the supplier in case I need support
See links to online reviews for providers	I can perform my own research and feel satisfied with recommendations
Understand in context what something means	I do not have to navigate away from the current page to understand the item
Be able to read energy terms in more details	I can educate myself on what these labels means
See pricing in monthly and annual amounts per tariff	I can understand at a glance what the service offering is without needing to view the detail page
Easily change my attitude to green, customer service and price	I can understand the impact on recommended choices

Chapter 6 – Consumer solution

Developing a demonstrator of the user interface driven by consumer research with constant iteration based on feedback.

The remit for the front end of the Smarter Tariff Smarter Comparison prototype was to provide an interface that could be used for consumer testing and demonstrate feasibility of core functionality:

- Capture key information and permission from consumers registering to use the service;
- Retrieve consumption data with permission from smart meters via the DCC;
- Integrate and present smart tariffs – include pricing and non-pricing characteristics;
- Accurately calculate cost of tariffs in conjunction with consumption data;
- Present results.

The design was not intended to provide a showcase of what a future tool provider should adopt. It was intentionally kept neutral in terms of both visuals and content to ensure that research findings were focussed on the process and functionality and not biased by emotional reactions to strong visual expressions.

Service and user experience design were delivered by Love Experience. The design evolved through four iterations (described as Proof of Concept 1-4) with each version determined by prioritised functional requirements and refined based on user feedback.

User interface

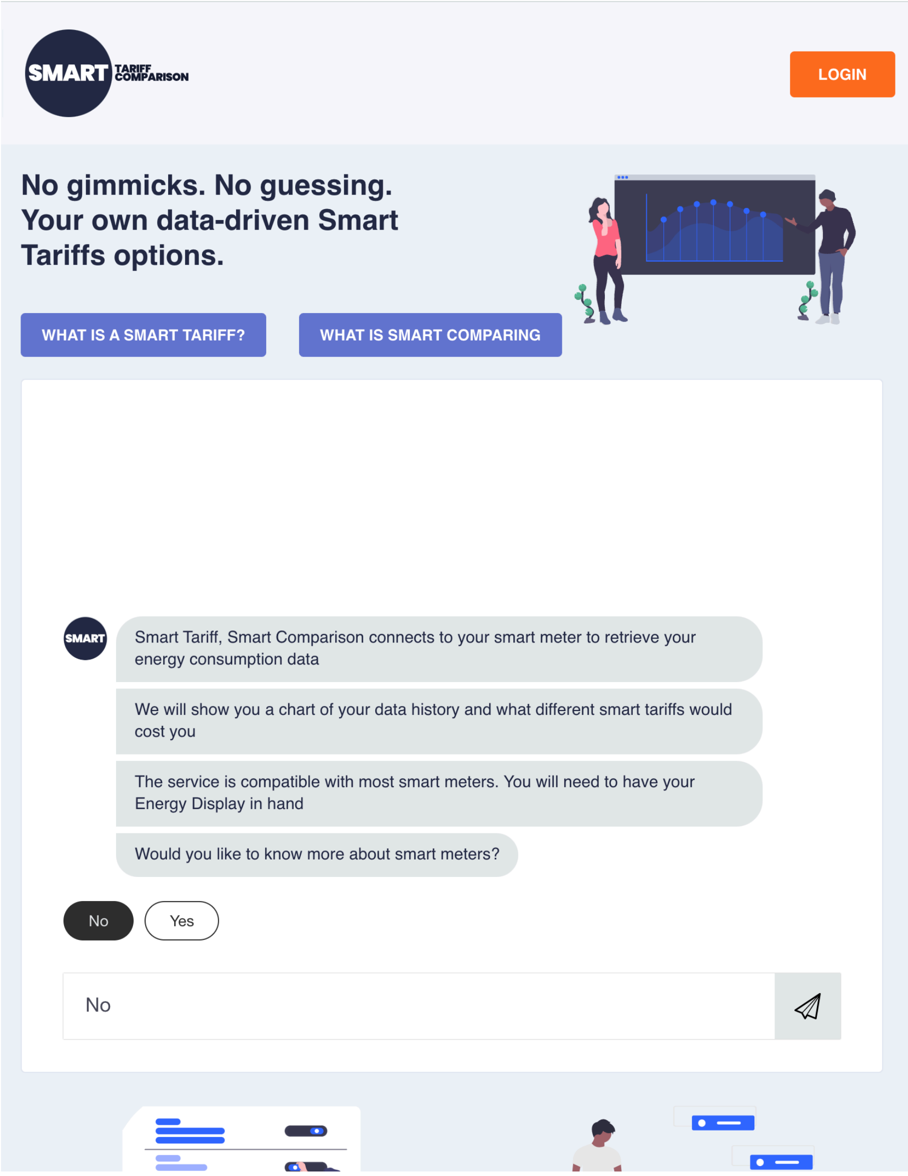
Presented below are screen grabs of the final iterations of the prototype to provide context for the reader. The user experience is a two-step journey:

- Step 1: Registration – capture the consumer's details required to retrieve their consumption data;
- Step 2: Present results in the context of the consumer's own consumption data.

Screen grabs are extracted from the Technical Report of the Proof of Concept which is published separately.

Registration

Figure 14: Initial chat interface for registration



Dialogue was intended to engage and be friendly while directing the user through complex informational input.

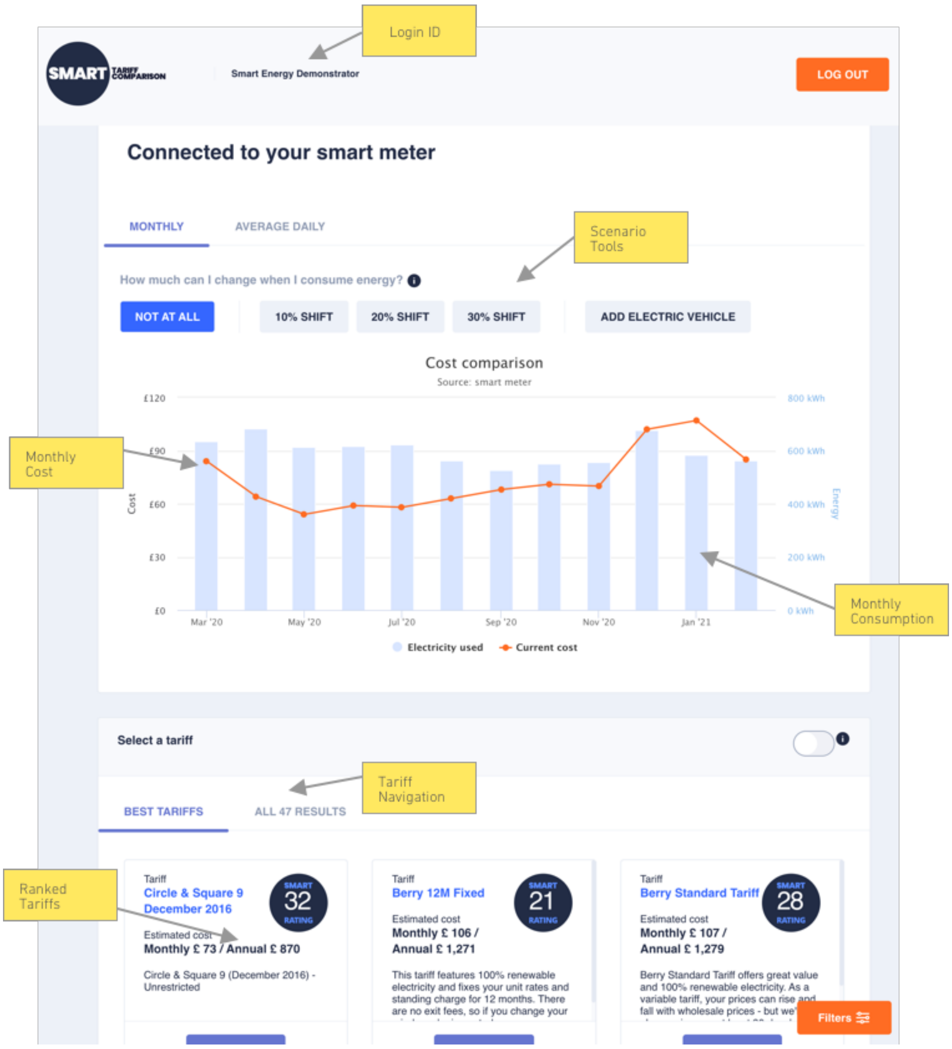
The chat process included having the user provide their postcode and the EUI/GUID[123] of their IHD (in line with SECAS guidelines for a DCC Other User to confirm identity); they also had to accept the tool's Terms & Conditions (forced walkthrough) before the data capture begins.[124]

Users also created an account (email and password) as data retrieval can take anywhere from a few minutes to over an hour (dependent on DCC response times when data request is made); registered users were sent an email when their data was ready at which point they logged into the tool.

[123] A globally unique identifier used to identify the IHD that is permanently displayed on the IHD
[124] More detail on technical process is provided in Chapter 8 Industry solution.

Results

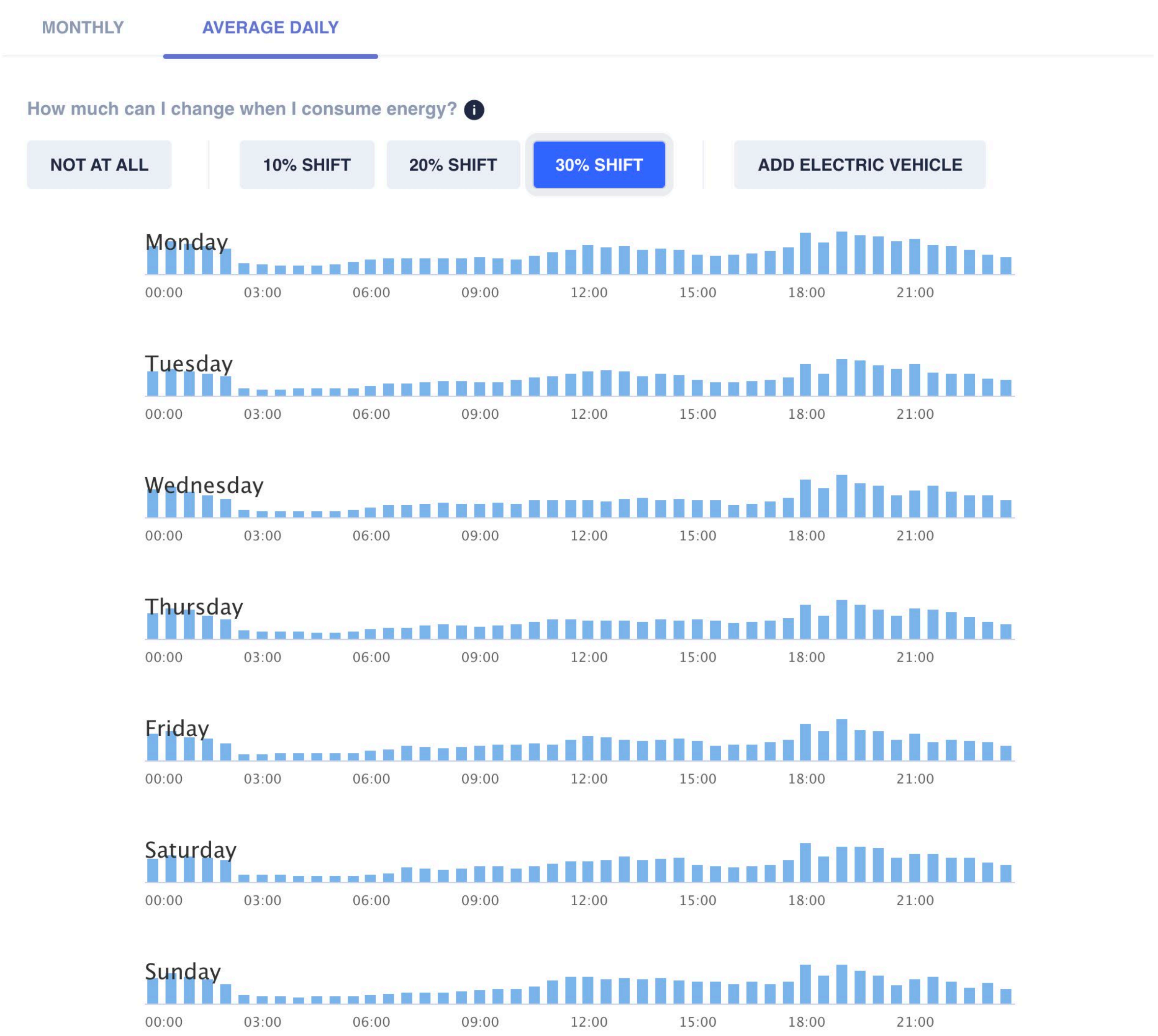
Figure 15: Comparison dashboard for Proof of Concept 3 – monthly data view



Buttons and areas were made overly large to test the response to different features with the user segments.

Cost for each tariff is calculated and presented on the main graph next to the current cost.

Figure 16: Comparison dashboard for Proof of Concept 3 – daily data view

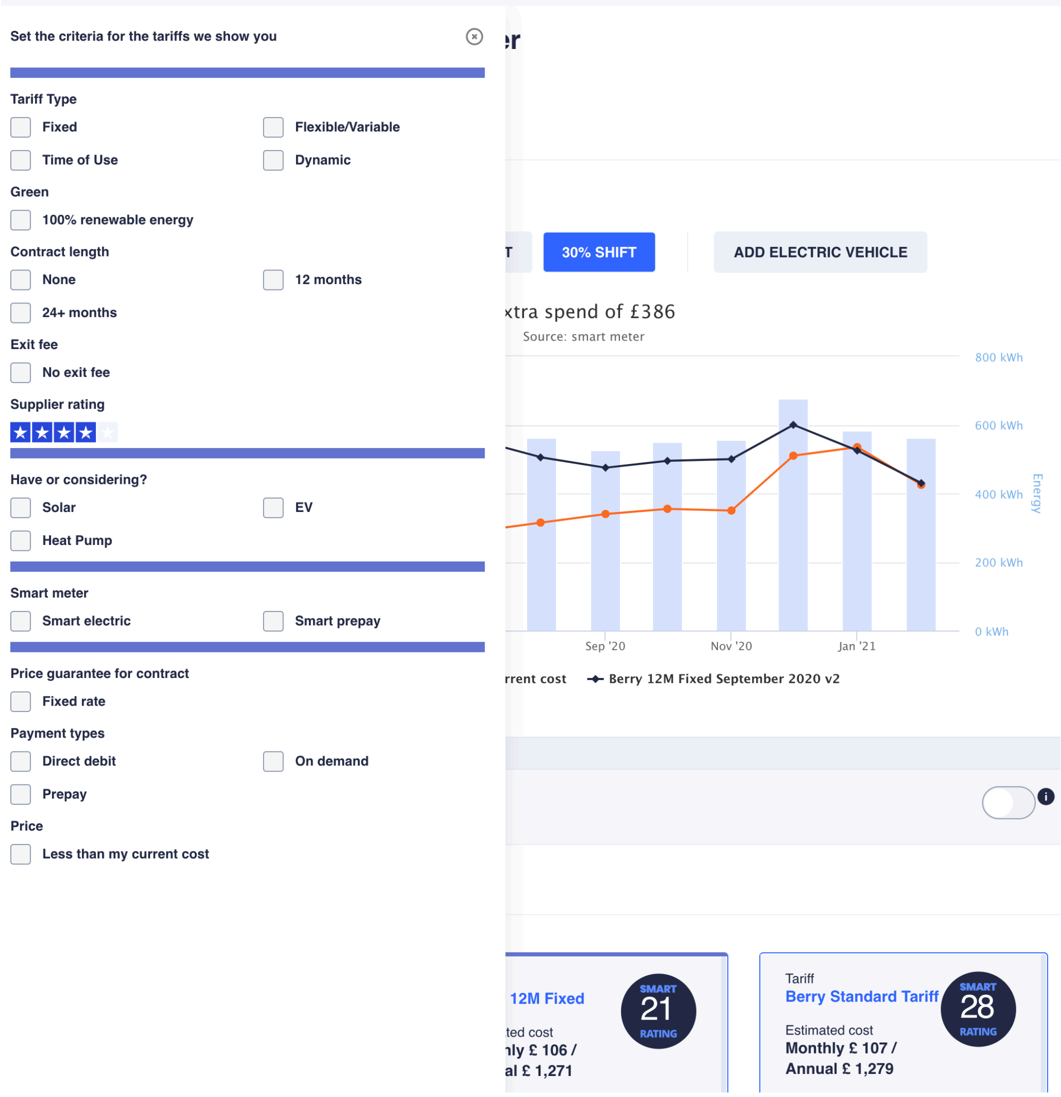


Days of week convey the consumer's average consumption for each half hour over either the previous year, or since the smart meter was installed (if less than a year).

Scenarios (triggered by selecting % shift or Add EV) change the energy profile at a 30-minute level for the entire year of data. The average daily view depicted above shows shifting a percentage of the peak load to the overnight hours, with related movement of the time series data.

Note that Daily view was an addition to Proof of Concept 3 from version 2 (research findings drove this addition, see below).

Figure 17: Comparison dashboard for Proof of Concept 3 – Tariff and supplier filter options



The user was able to set filters based on tariff type and other criteria.

Consumer research

Research performed a different role with each iteration of the Proof of Concept. Initial qualitative research during the discovery phase[125] framed the first iteration of the solution. An off the shelf design library[126] and development framework[127] were used to expedite prototype development for the second iteration. From the third iteration on, the solution was fully live and

125 See Chapter 5 for details of the method
126 Eva Icons
127 Nebular, an Angular UI library

continued to evolve based on research findings, technical learnings (see Chapter 7) and end user feedback.[128]

Table 8: Iterations of the User Interface solution

Iteration	Research type and role
Proof of Concept 1 **Based on qualitative findings and desk research on current PCWs** **Sketch files**	• Qualitative research – 1:1 interviews with three audiences (potential smart tariff customers (12), existing smart tariff customers/highly engaged early adopters (6), fuel poor and digitally excluded customers (4) • Inform the initial Proof of Concept work
Proof of Concept 2 **Registration functionality live** **Results presentation Sketch file mock-ups**	• Qualitative research (20) – 1:1 interviews with individuals from savvy enthusiasts (10) and fuel poor segments (10). People went through a series of pre-tasks prior to interview. • Goal: assess response to the UX approach and overall solution • Capture learnings on key challenges: o Would people supply their information (sign up requires postcode and GUID off IHD) o Response to seeing their own consumption data • Explore interest in smart tariffs and exploring flexibility
Proof of Concept 3 **Fully functional site hosted at smarttariffsmartcomparison.org** **Supports registration and data presentation**	• Qualitative groups (8) of three people per group representing broad population: had to have SMETS2 meters (to test end to end registration process) • Complemented by Google Analytics findings based on 640+ people using the tool
Proof of Concept 4 **Final release within the project scope** **Updated to include prioritised feedback from Proof of Concept 3**	• Hildebrand's direct customers asked to comment on final iteration (time limitations meant no further formal consumer research could be done)

Proof of Concept 2: Methodology and findings

Research focused on understanding levels of awareness, digital / energy literacy and user needs. The second iteration (Proof of Concept 2) of the tool was used as stimulus material:

[128] In addition to qualitative consumer research, people completed the Feedback form within the site and sent comments and suggestions via email

registration functionality (via a chat interface) was live, results screens were presented as mock-ups. Full findings are documented in Annex B.

Methodology

Twenty one-hour, one-to-one interviews with Savvy Enthusiasts and Fuel Poor[129] were conducted (ten representatives of each segment). The focus of the interviews was to have participants experience and feedback on the work in progress prototype and guide the moderator through their experience. The prototype was comprised of an interactive 'live' first half followed by 'static' results pages for users to comment on.

All participants had a smart meter installed and were a mix of age, gender, location, payment type (credit and prepay) and a mixture of technical ability/savviness (within appropriate Savvy Enthusiast boundaries meaning they did not qualify as Energy Innovators).

Topics explored with respondents were:

- Brief Energy profile: including supplier they were with and why, as well as how they went about switching;
- Engagement with Smart Meters;
- Engagement with Green / Renewables;
- Introduction to STSC tool which included a walk through the tool pointing out anything that they liked / did not like or found confusing;
- Understanding of Smart Tariffs;
- Needs sorting exercise where they were presented with a list of needs which could be turned into potential features and asked to rank them.

Findings

Key highlight for **Savvy Enthusiasts**: the **prototype had genuine potential**; overall response was positive from all Savvy Enthusiasts:

- Participants felt the tool represented the future of comparison tools, geared at new, more complex Smart Tariffs;
- Stand-out features tended to be those that felt new or different to current PCWs:
  - Use of real smart meter data to get accurate quotes, recommendations that were tailored to individual needs;
  - Charts that allowed detailed projection of tariff performance;
  - Chat functionality was described as feeling intuitive and different to other PCWs;

[129] Savvy enthusiasts were recruited from Hildebrand customers lists and screened using statements developed from quantitative research. Fuel poor were recruited from Free-find sources and screened to fit the category of 'low income' and 'fuel poor'. (Free-find sources are the opposite of customer lists. They are comprised mostly of recruiter databases, but also 'cold' recruits found through recruiters' means of reaching out to the general public).

- The static pages (representing the Results screens) had potential to organise what could otherwise be complex tariffs in a way that was simple and clean

Savvy Enthusiasts **require more guidance** than the tool currently[130] offered:

- They understood their personal energy consumption and were familiar with the energy market, but less so with the concept of Smart Tariffs;
- In addition to the tool being seen as quite innovative for a PCW, there was often confusion around certain terms, language and descriptions;
- Whilst labelling and signposting was due to come later in development, the research highlighted that even apparently simple terms such as ‘Smart Tariff’ required explanation;
- As the tool was so new, participants often looked for guidance or descriptors for less familiar features such as ‘flexible payment’ or ‘EV compatible’.

Graphs were **<u>the</u> stand-out feature** for many:

- Forecasting pricing on a new tariff against historical usage was innovative and compelling;
- Even those who did not normally engage with graphs saw the benefits, as they opened the doors to really understanding energy usage and Smart Tariffs;
- The option to come back and compare real usage against projected was liked by the more engaged and/or price driven who said they’d create an account to be able to do this;
- More tech savvy users were intrigued to know what more could potentially be done with the charts – e.g. access to more advanced settings or data breakdowns, comparisons between different tariffs or providers, etc.

Other **preferred features reflected the need for something new** – something you cannot get on traditional PCWs:

- Easy behaviour changes to lower costs were key – not seen as intrusive if kept simple and realistic;
- Choosing whether you own or want to own low carbon tech – as many are on the cusp of or thinking about doing this in future;
- Calculating running costs of new low carbon tech, which plays to the point above.

Key highlight for **Fuel Poor**: they wanted **simple ways to make genuine savings**:

- Fuel poor participants generally reported lower engagement with the energy market;
- Many had been with the same energy supplier for a number of years preferring to stick with ‘what they know’, or lacking confidence to switch supplier;

[130] As of the prototype version in Autumn 2020

- They had an overall need for simplicity and stability as they were juggling life, work and other bills where money is tight;
- For this segment, the knowledge that a set amount would come out of the bank every month often more important than making a small saving.

Two **distinct typologies** of Fuel Poor based on engagement and personal energy use emerged – described as **energy engaged** and **energy disengaged:**

- Energy disengaged tended to keep their IHD in a drawer and did not pay attention to it;
- Energy engaged had higher engagement, were more in-tune with their usage and were always on the lookout for savings.

Energy engaged were **encouraged by the idea of savings** but **wanted to maintain the certainty** they have:

- The challenge would be convincing them to make changes to their energy routine;
- They might be expected to be switching frequently looking for the best deal, but in reality, whilst they might 'shop around', they rarely switched unless there was a real, tangible benefit;
- They were already doing a lot to save money, so they needed evidence of what savings will be and what behavioural changes would make a true difference;
- What they needed from the tool therefore is a way of seeing real savings and advice on how to achieve these in a simple way;

Overall there was a **positive response** from all **Fuel Poor** participants:

- The tool stood out for its simplicity and accuracy and for giving personalised results;
- It encouraged and engaged even the less engaged, helping overcome some fears of low understanding or making the wrong choice;
- Areas for development very much mirrored those highlighted by the Savvy Enthusiasts – mostly to do in this case with security and simplicity.

The **forecast charts stood out** for the Fuel Poor:

- Most were intrigued to know more about how they worked and what they could do with them;
- It would be useful if they could see chart broken down by days or weeks (as well as months) – as this was how they currently viewed and tracked their spending on their In-Home Displays.

Their preferred features played to the segment's **need to see tangible savings**, **ways** in which **they can save, simplicity** and **reliable reviews**:

- Making small changes and being able to visualise the impact of these;
- Ensuring decent customer service in case of payment difficulty in future;

- Understanding different terminology and context to feel more confident;
- Reassurance around re-selling, or passing on, of data.

Proof of Concept 3: Qualitative research methodology and findings

The consumer research findings informed the next iteration of the tool. Proof of Concept 3 went into testing as a fully functional site and included front end registration, model calculation and results presentation.

Two separate research studies were conducted:

- Qualitative consumer research to capture feedback;
- Google Analytics to demonstrate what people were actually doing as they interacted with the site.

Research focused on full prototype testing with the objective of assessing success of the registration process, engagement with results and understanding of comparison and specific elements of the results dashboard.

Full findings are provided in Annex B.

Qualitative research methodology

Eight one-hour groups sessions were held with three consumers in each group. Participants were a mix of age and lifestyle, from 25-65+ and from pre-family to empty nesters from the South East, Scotland and the Midlands. Some energy consumer segments were excluded as they were covered in detail within the previous phase of research: Energy Innovators, Savvy Enthusiasts and the Fuel Poor. Prepay customers were excluded as they too had been covered in earlier research. Every participant had to have a SMETS2 meter or a SMETS1 meter that had been migrated/enrolled to the DCC Infrastructure.

All participants were asked to visit the STSC tool before the session (on the live site at https://smarttariffsmartcomparison.org/home) and input their information ahead of the session; they were instructed to not view their results until the actual research session.

The discussion guide was structured as follows:

- Energy engagement and potential to be flexible with energy use;
- First impressions of the tool and their experience with submitting In-Home Display details; their expectations for the results;
- Log-in and view results. Time given to explore their results before they were prompted to have a conversation around key topics (e.g. comprehension of data / tariffs);
- Asked ‘what they would do next?’ (prototype did not encourage further action as that was not in scope);
- Potential refinements and future development opportunities were discussed.

General findings

The tool **delivered** a lot of **real positives**; participants saw **real benefits**:

- Enabled deeper consumer engagement with their energy use and the market;
- Increased decision-making confidence – removed guesswork by providing quotes based on actual use;
- Helped monitor performance beyond switching/renewal time by providing a simple platform to look at home energy use and tariff progress;
- Brought transparency to a low-trust category with the potential to build confidence.

The **results dashboard** with charts of historic energy consumption **provided an engaging window into personal energy use**:

- It was the first time most people had seen their energy data represented in this way;
- Most people were at least initially curious to see whether the data they saw matched their perceived behaviour;
- Being presented with their own data drew (most) people in and because it was personal to them, they were keen to investigate further;
- Even if participants were not data literate / data interested the use and presentation of personal energy information validated decisions.

Findings by energy typology

Interest in the tool varied across the consumer typologies:

Figure 18: Energy typology and interest in the tool

Informed Mainstream:	Green Techies:	Super Switchers:	Uninformed Mainstream:	Traditionals:
Open to spending time engaging in both their usage and the tool. Willing to be flexible where possible. Similar outlook to Savvy Enthusiasts.	Digital and data savvy. Open to new tariffs (and brands) that are beyond the big six. Willing to be flexible if environmental / financial gain	Financially focused. Data acts as 'proof' that informs good decisions. More interested in macro savings than usage detail	Most interest in savings / good deals. Lack time & desire to spend time in category. Want tool to make recommendations and share data headlines.	High levels of confusion stem from low levels of category engagement and digital savviness. Prefer their 'normal' ways of navigating the sector

Data driven segments include Savvy enthusiasts, Informed mainstream and Green techie segments: they were **excited to engage with their data** and were prepared to spend time finding a tariff perfectly tailored to their needs. They were the most excited by the tool.

- Prominence of the chart and data appealed; they were content to see the tariff selections below the charts;
- Being served lots of information appealed to typologies looking for detail rather than headlines;
- Required engagement with the category to understand terminology / tariffs;
- Worked best if time was spent with the tool to find the right tariff for their needs.

To get the most out of smart tariffs consumers will need to be open to being flexible with their energy use; this openness was generally found in the most engaged typologies.

Finance focused segments included Fuel poor, Super switchers and Uninformed mainstream: they were **seeking savings and good deals rather than deeper engagement** with their energy use / the category as a whole. These segments want the tool to do more leg work for them. (Reminder: the prototype hid supplier and tariff names which made it harder for the financially focused to compare potential savings).

- Segment was particularly excited that they would not have to guess which tariff will offer the greatest savings and the fact that they would be able to see actual data;
- Made decisions on headline annual saving figures and did not feel they needed detail beyond that;
- Younger / busy participants were less likely to make a behavioural change and do not have time to work through data to find the perfect tariff;
- Would like a dashboard that would allow them to quickly view key headline information at a glance;
- People were happy to provide the tool with more data so it could make recommendations / assumptions (e.g. household composition, in-home technology etc.);
- Tool was described as feeling 'dry'; ways to increase engagement were suggested by the participants including gamification / comparison with other users' data.

'Traditionalists' may be a difficult segment to reach. They are mainly customers of the large incumbent energy suppliers and rarely switch or pay much attention to energy. They tend to avoid risk and are content with their current set-up with low energy aspirations. They want to feel in control, be with supplier and tariff they feel comfortable with. They prefer digital simplicity and simple, direct and tailored information. Generally, they are less interested in switching and engaging with the tool.

The potential for the tool with this segment is limited by their low energy engagement:

- The segment was the least engaged with the tool;
- When discussion was pushed, some saw potential value as prefer phone / familiar websites for their energy needs;
- Generally struggled with basic navigation of the site;
- Finding and uploading IHD codes proved a significant barrier to use;

- Lacked the technical savviness to engage with many of the features and often needed to be supported when using the tool.

Specific feedback by tool functional area / stages

Because the front-end design was intended as a framework for research learning, the findings provided below are limited to those which may be useful for organisations considering adopting the solution and building their own front-end; design treatment specific feedback has been intentionally excluded.

Registration and sign-up:

- **Support material** (About, FAQ, Privacy policies, etc.) was **not usually explored** but was appreciated as being there if required;
- **Clear signposting** about the steps that the user will follow is **important** to give users guidance on what is an unfamiliar process;
- **Chat functionality**, if used, **needs to keep narrative content to a minimum** – although for some (Finance Focused) they would be happy to provide more information at the data capture stage if it helped tailor their results;
- **Entering IHD information** was a **stumbling block** for some, particularly older people and the less energy engaged users:
    - Confusion between the IHD and their actual smart meter – some even found the GUID printed on their energy meters rather than the IHD;
    - Although example photos were offered within the chat interface, these were only helpful to those who had the same or similar devices131;
    - Some failed because their meters were not compatible (SMETS1 that had not yet been enrolled into the DCC);
    - Less engaged would not be motivated to look for the information (usually the same people who would not find a bill to add information on a PCW).
- **Delay between setting up account and getting results** was **not a big issue** for most:
    - Having provided information and set-up an account, most segments were happy to wait for a notification that their data is ready (note: email notifications were not working during this phase of development);
    - Some users, particularly pre & young families in the uninformed mainstream segment, were less likely to return to the site. When looking to compare energy tariffs, they had set aside a limited time period to complete the task. Setting up an account and returning later does not fit that preferred approach to switching;

[131] There are a limited number of IHDs on the market in the UK from three major manufacturers; how they are specified can vary by supplier and they do not always appear to include their unique GUID/IHD. Further research on this topic is recommended.

    - Waiting for results sets an expectation that the results are going to be worth it; so compared to instantly getting the results there is an increased risk of disappointment if there is an error or results were not found.

Results:

- **Initial prominence of the chart** was potentially **off-putting:**
    - Initial view of results page was quite cold;
    - There was a lot of visible data but little sign-posting or information about what users were seeing;
    - Tariffs were all presented 'below the fold' but users expected to see tariffs first when they enter a tariff comparison site. This was a particular issue for the Finance focused who wanted simplicity and to quickly and easily see the tariffs that were recommended for them;
    - Some also said they would like to just see key headlines relevant to their usage instead of a chart (e.g. 'your peak usage times are between 6pm-9pm').
- **Chart** was **easy to understand** but surrounding options needed more description and guidance on what was being seen and how to use the information;
- **Amount** of **potential savings needed** to be more **prominent;**
- **Filtering options** were **not visible** enough and often missed;
- The **daily data view** was **very interesting** across all typologies but people **struggled to decipher the information** when they chose the option to see what happened if they shifted the time they consumed energy and/or add an EV to their results;
    - No savings information was provided on this screen if people said they could shift their consumption time which was seen as a gap;
    - Many expressed interest in seeing comparison with 'people like them'.
- **Detail on tariff results**, below the fold, content visible only after scrolling down, in this phase of research, was of most interest to Finance focused but they wanted to see much more detail at a glance, for example, was the tariff fixed or variable, was it for electric, gas or both, would there be exit fees;
- **Sliders** (used to indicate where, on a scale of five, preferences lay for Green, Customer Service and Lowest Price) **work well** and **could be more prominent** / come earlier on the page;
- Neither Smart nor Star ratings were understood but could enable users to find appropriate tariffs (Smart rating is discussed in Chapter 7, Star rating was based on Citizens Advice supplier rating);
- EV tab made it look as though having an EV loaded cost on the energy bill; people did not realise while using the tool that electricity charging spend replaces petrol spend.

What next?

Based on this research, davies+mckerr recommended five factors for future consideration:

Table 9: Five recommended factors for the STSC tool

Factor	Consideration
Solutions	How to reduce / flex energy use in real, practical terms. Whether suggesting LCT to purchase or provide examples of energy loads that could be shifted.
Suggestions	Potential to foreground the suggested tariff that were taking second place to the data in the results presentation.
Sign-posting	There was a lot of information for people to take-in. Clear signposting needed to ensure ease of use and help the less savvy people navigate the site quickly.
Simplicity	Busy families and the less energy engaged want headline results, simplicity and clarity.
Selection	Offer an onward journey when a tariff is selected to ensure that people can easily find the tariff they've chosen when they leave the tool.

Key next step is to **provide a journey** to **find** the **selected tariff**:

- Users wanted to be able to simply and easily find the actual tariff they selected (to decide if they wanted to make the switch);
- Worry was expressed that due to the complexity of tariff names and confusing provider sites they would not be able to easily find the exact tariff they selected;
- Ideally they wanted to have a link straight through to the tariff on the supplier's web site – as often found on PCWs;
- People do not want to have to input their information again on a provider's website because they have already provided it within the tool.

There was **some interest** from participants in **learning** about ways they could **reduce / shift** their **consumption**:

- Potential to be served links and information that can help them manage their energy so they can maximise the tariffs;
- Would like to learn more about solar panels / home batteries etc. and be taken to reputable sources they can trust.

The **Data driven** segments would **revisit the tool** to **monitor their energy use** and **check tariff performance** versus what was suggested on initial results:

- It is hard to predict on-going engagement with the tool at this stage;
- Data driven segments were the most likely to engage beyond renewal / switching time; there was limited appetite for this functionality from the less engaged Finance Focused segments;

- There was little spontaneous mention of checking back on ‘favourited’ tariffs over time however there was a sense that some more engaged users may do this if the tool had proved its usefulness.

Proof of Concept 3: Google Analytics research methodology and findings

To complement the qualitative research findings, analysis of actual usage of the site was performed by analytics and conversion specialist firm, We Are Crank.

Research methodology

We Are Crank worked with Love Experience and Hildebrand to identify the key areas of the site to be measured and tags were embedded throughout the site.

All site visitors had to accept cookies (a forced walkthrough on landing on the site) to be included in the measurement.[132]

The data capture period ran between 20 February 2021 and 24 March 2021. Two groups of people were invited to test the site and were separately identified within the analysis:

- Consortium partners, BEIS and others sent an invitation to try the tool to a broad range of contacts and organisations including those who are not experts in the energy industry;
- Hildebrand’s own retail customer base who could use their existing app credentials to login to STSC without going through the registration step.[133]

The number of people who successfully created an account during the analysis period was 33% higher than those counted by Google Analytics, indicating that a fairly high percentage of people rejected cookies but continued to use the tool.

643 people accepted cookies and could be tracked. There was a fairly even split between new users and existing Hildebrand customers. As a reminder, for new users, approximately 40% would have a smart meter (based on recent Ofgem research) and some of those would not have a qualifying smart meter (a SMETS2 meter or a SMETS1 meter that has been migrated into the DCC meter).

Three elements of the user journey were the focus of the study:

- **User recruitment**: understand the user sign up journey and identify key areas to improve;
- **User behaviour**: identify the key areas which users interact with the most and asses how they evaluate smart tariffs;
- **User support**: know which areas of support were most used and relevant to the users.

---

[132] Users were still able to use the site and the prototype even if they rejected the collection of cookies.
[133] 792 Bright users (Hildebrand’s consumption data app) were invited, 182 logged in to STSC.

Findings

An executive summary of the findings per journey phase with recommended actions was put forward by We Are Crank.

Table 10: findings by journey phase of the STSC tool, with recommendations

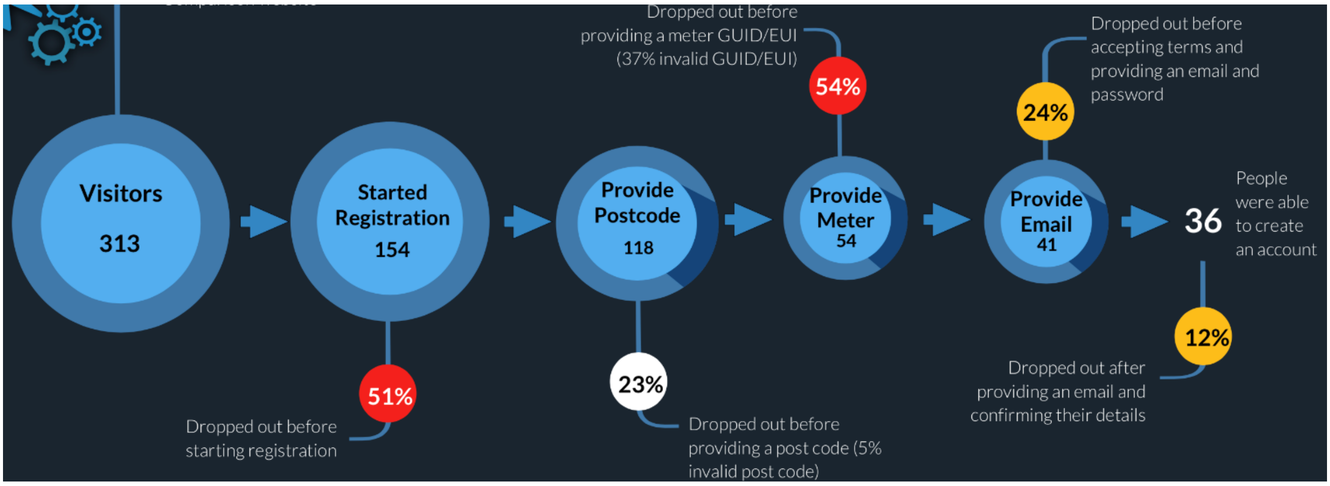
User journey phase	Findings	Recommended action
Recruitment	The registration process had three key barriers. 1. Getting people to start the process (51% dropped out before starting), 2. Providing their meter details 3. Completing the registration	Clearly sign post the start of the process and the benefits of doing it. Review IHD GUID capture, this caused a blocker with 37% inputting the wrong information. Resolve the password and email activation stages as users are close but not succeeding at the last step.
Behaviour	User engagement was high and had a good level of engagement and time on the website. The graph visualisation functionality was the most used at 80% and 77% of people engaged with their data looking at the daily breakdown.	Focus on visualisation of the data for uses as this proved to be a winner. Preference sliders were most focused on price and tariff filters were on contract terms, so aim to have these two options front and centre in the results pages.
Support	Smart meters was the most viewed definition in the Glossary gathering 47% of all engagements, but only 5% of users viewed the Glossary. See how users can be helped during the sign-up process as 19% of users viewed FAQs. There was no clear winner in FAQs with 4 options sharing most of the views.	Look at other more interactive options to support users such as live chat. Focus on smart meter content only on the glossary and enhance this before creating other content. Build out further FAQ information or more detailed information for current FAQs to support users.
Devices	The mobile audience represented 40% of users. The overall mobile experience is challenging for users across the board. The registration sign-up rate was half of desktop at 7%. Mobile users also engaged less overall with all functionality compare to desktop users. For example, preference slider use was 17% for mobile vs 42% for desktop users. Mobile users also struggled with Password creation (75%) and 72% needed more IHD information.	Review the mobile experience across the board and key parts of the sign-up journey as this is directly impacting adoption of a great service experienced by a desktop user.

Overall registration journey

The registration journey has many steps, but the critical drop-out points are 1) getting people to start the registration process and 2) to provide their IHD GUID/EUI[134] which is a major blocker on the journey. 24% could not perform a simple registration due to the password requirements. 12% of people who provided all their data, still could not register due to the additional step after receiving the email where they are required to verify their account.

Note that users already registered with Hildebrand's Bright App did not need to go through the registration process, the 313 people who did so were sourced from the general invitation to test.

Figure 19: Registration journey metrics



Recommendations:

- Provide very clear sign posting to the registration page, perhaps a landing page;
- Additional help and advice in the area where the IHD GUID/EUI is requested would also be useful without having to leave the process;
- Explore alternative methods to get the GUID/EUI e.g. camera recognition QR Code or Scannable ID;
- The critical, yet simple password and email validation mechanics, need to be reviewed and improved.

Results dashboard:

- On average people spent an average of 9 minutes reviewing the results dashboard; desktop users spent 10 minutes on average whereas mobile users 5 minutes;
- 33% of people used the preferences sliders and engagement was distributed fairly consistently across the slider options (price (25%), green energy (22%), customer service (20%);

[134] 37% provided an invalid EUI number but it is not possible to determine whether this was because they incorrectly transcribed the number or they may have a non-qualifying SMETS1 smart meter.

- 23% engaged with tariff filters;
- As qualitative research highlighted that people said finding the filters and sliders was not obvious these usages figures are higher than expected;
- Note that most popular tariff selection was not measured as the information was not relevant for anonymised tariffs.

Addressing the needs of consumers with additional barriers to engagement

Before closing this discussion of the consumer solution there are recommendations as to how ensure consumers who face additional difficulties in engaging in the market can engage with the STSC tool. The tool will need to:

- **Address access barriers**; i.e. those who are digitally excluded;
- **Use simple language** for a clearer understanding of energy terms and the complexities behind them;

Switching energy supplier can be seen as a difficult action for many low income consumers. They are less likely to want to switch, are less likely to have strong understanding of the market, and those who do want to switch are less likely to use PCWs.[135] [136]

Other risk factors are the potential for bills increasing or being unable to leave a new tariff that is not suitable for them. Households with night storage heating systems (and legacy Time of Use tariffs like Economy 7) are twice as likely to be fuel poor.[137] As such, they are dependent on direct electric heating[138] in homes that are more likely to be inefficient and therefore they may not be able to be as flexible with their energy use and as able to benefit from a smart tariff. Such considerations could be used to flag where a consumer may need additional support and has all the information they need.

Trust in the switching process (or lack thereof) is also an important factor for these consumers A new option for consumer protection enabled by smart metering and the STSC tool and worth consideration is for ex-post assessments. Where consumers agree to participate, this feature could check whether households are actually better or worse off on smart tariffs (one or two months later for example) and make it easy for them to switch away from the smart tariff if it is not.

[135] Ofgem Research report on vulnerable consumers' engagement with the energy market, March 2008
[136] CMA Digital comparison tools market study, 26 September 2017
[137] Chapter 2 covers this topic in detail.
[138] Electric heating is currently more expensive than gas at current gas pricing, particularly for direct electric versus heat pumps.

Conclusions

This research consistently demonstrated that trust is crucial for energy consumers; by virtue of showing people their own data (consumption and cost) in easy-to-understand charts the tool delivered more confidence.

All phases of consumer research confirmed that a significant challenge is the lack of basic understanding of smart meters, smart tariffs and all the related terminology; any organisations adopting the tool will need to ensure they use clear and consistent language, good signposting and provide a glossary of terms for the consumer using the tool.

Our research theory at the start of the project was that need for a smart tariff will be most motivated by an LCT purchase decision or lifestyle fit; preliminary results indicate this is the case.

The research identified a risk that the effectiveness and impact of the tool may be limited by the tariffs on offer and the savings available through 'manual' flexibility/DR (changing the time of appliance usage behaviour). For many consumers, it is currently not worth the effort of shifting energy usage to make a small annual saving. Some further points can be made here. Firstly, the available savings are much larger when storage and automation technologies for electric vehicles and heating are brought into play; these technologies enable the shifting of much larger loads and do so more conveniently and reliably (see Chapter 2). Secondly, smarter comparisons can also show consumers the large savings available by switching from an internal combustion engine to an electric vehicle with EV-tariff. Finally, as discussed in Chapter 9, policy and regulation, for example the introduction of MWHHS could increase the market value of residential flexibility, thereby supporting more rewarding tariff design and new business models that make investing in LCTs more cost-effective. Targeted support to make storage and automation devices more affordable would also make flexibility more accessible, and smart tariffs more rewarding, for more households.

Chapter 7 – Industry requirements

Potential adopters of the smart tariff comparison tool have a set of requirements that are distinct from those of consumers. Consumer findings will help tool adopters design unique user journeys in line with their organisation's strategy; technical needs will be common.

Suppliers via their licence conditions, and price comparison websites voluntarily accredited under the Confidence Code are required to provide a consumer with a comparison estimate that:

- Is personalised to the consumer, based on information that is reasonably available to the supplier or comparison site, and on reasonable assumptions where actual data is not available;
- Is based on actual historic consumption wherever this is available (and a best estimate of consumption where it is not);
- Includes non-contingent discounts and non-optional bundled charges, and excludes contingent discounts and optional bundled charges;
- Is applied consistently when used to provide the consumer with a comparison of different tariffs, such that the same assumptions, where relevant, are made for all tariffs that are being compared; and
- Is transparent, and accompanied by a description of the estimate that makes clear to the consumer what it is, what it can be used for, and any assumptions that have been made in its calculation.

There are further obligations in the sourcing of data, cost calculation and presentation of tariffs.

As discussed in Chapter 3, energy suppliers are beginning to offer products that bundle tariffs with low carbon technologies (LCT)[139] with large contingent discounts such as EVs sold with free electricity. This technology adoption results in significant changes to the consumer's energy volume and usage patterns; it also requires standardised smart tariff frameworks and comparison models that can cope with non-price characteristics.

In order for an energy supplier to gain access to historical half hourly data (they must obtain a customer's explicit permission to access half hourly meter data.

Price comparison services have similar requirements for offering a comparison as suppliers with the assumption that a price comparison service may offer a wider selection of tariffs. Price comparison services must also obtain a customer's explicit permission to access half hourly meter data. LCT providers, such as EV, heat pump and battery manufacturers are seeking

[139] Examples include: Good Energy's heat pump tariff, British Gas / Vauxhall owner 30k worth of free miles, Octopus Tesla Energy Plan for customers with solar and Tesla powerwall

additional functionality to help consumers' match a suitable tariff with their technology and understand the financial return on investment.

Industry requirements can be grouped into five areas which are discussed in this chapter:

- Accuracy of comparison
- Robust data and models
- Scalable – in terms of both data volume and addition of further capability
- Integration with supplier or price comparison offering
- Discovery and innovation

Accurate comparison

Today's price comparisons are based on a single estimated annual consumption (EAC) figure provided by industry databases or determined from asking the consumer a series of questions about the property and its occupants. One widely used database[140] reported the STSC test home[141] annual electricity consumption as 6,482 kWh whereas the typical domestic consumption value (TDCV)[142] for a medium sized home is 2,900 kWh. Desk research indicated that many of the suppliers and price comparison websites used the TDCV figure and tariffs on offer to generate a cost quotation even when the service user selected the 'already have a smart meter' option.

For the STSC test home, when the actual consumption was retrieved from the smart meter, the annual consumption was 7,149 kWh for the previous 12 months. A test was run with an energy supplier's quotation tool – it presented the test home's annual cost as £537 (2,900kWh) when it should have been £1,324 (7,149kWh at a kWh rate of 18.53p). These example calculations demonstrate the value of the actual consumption input data retrieved from the smart meter; consumers will benefit from more accurate quotations.

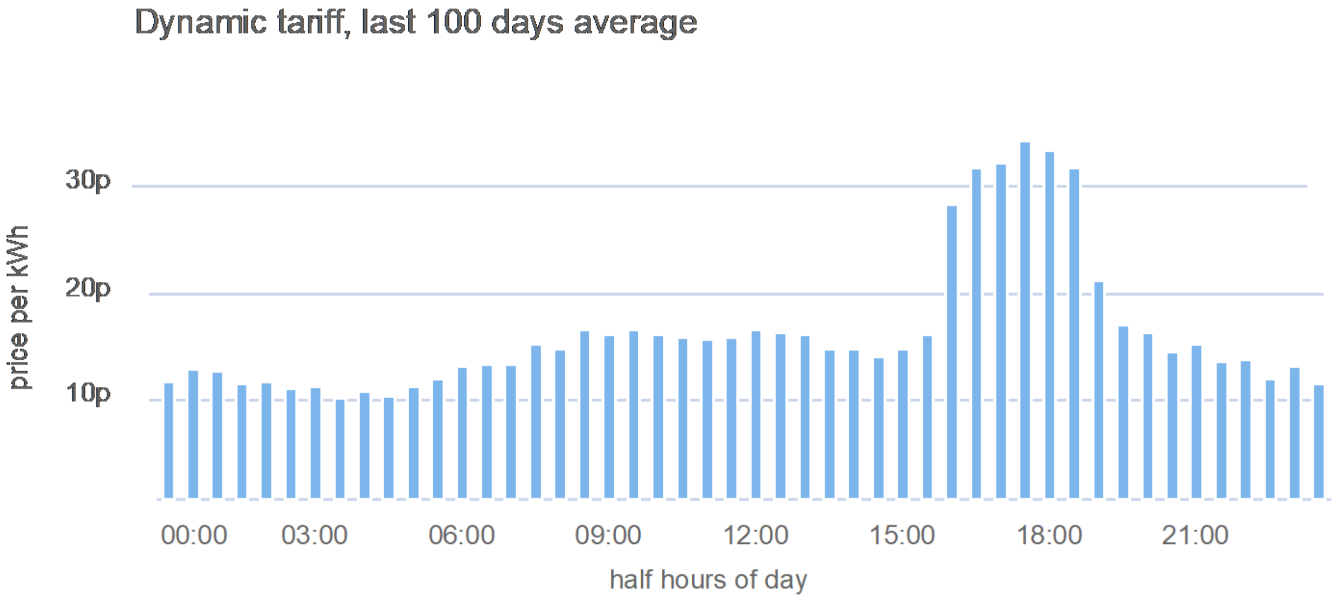
Dynamic tariff challenges

Using Estimated Annual Consumption (EAC) to quote dynamic tariff energy products has limitations due to the obvious lack of granularity. It was interesting to demonstrate the magnitude of the error if a simple annual figure was used. The test home has a dynamic tariff and paid approximately £900 for electricity over the year in question. With an average half-hourly (HH) rate over the last 100 days of 15.07p per kWh the annual cost would be presented as £1,077.

[140] Electralink
[141] Hildebrand staff member's home, no LCTs in situ. Property would be defined as a 'medium home' according to TDCV definition.
[142] https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/typical-domestic-consumption-values

Given the future price of a dynamic tariff is not known, there are further opportunities for inaccuracy. To illustrate the pricing risk, within the last 100 days of April 2021 the lowest unit rate was 9p per kWh with the highest rate at 32p per kWh. This would be the estimate extremes if half hours were misaligned or there was the most optimistic/pessimistic view of future prices based on historical prices.

Figure 20. Average HH rates for dynamic tariff for the last 100 days as of 14 April 2021



The range of figures demonstrated nearly a 400% span from the lowest cost to the highest. This had two effects:

- Presentation of real figures became less attractive as an accurate quote appeared more expensive and
- There was difficulty in presenting dynamic rates due to large variation between achieved rate (12.3p), timeweighted average rate (15.07p) and possible range (9p – 32p).

Table 11: Data from April 2020 through March 2021, quotations given on 14 April 2021 for 3 bedroom, 4 occupant property (the STSC test home)

Source (rate)	Estimated annual electricity consumption in kWh	Estimated annual cost
Large supplier 1 (18.53p)	2,900[143]	£ 537
Large supplier 2 (19.684p)	4,310[144]	£ 848
Actual (achieved 12.3p)	7,149	£ 879
Electralink (15.07p – 19.684p)	6,482	£ 976 to £ 1,275
Smart meter (15.07p – 19.684p)	7,149	£ 1077 to £ 1,407
Dynamic range (9p – 32p)	7,149	£ 643 to £ 2,288

Impact of LCT acquisition

Accuracy is made more difficult with changes in consumption that are due to the purchase of an LCT. Forecasted electricity consumption can clearly benefit from the historical consumption plus the increased/decreased demand or demand shift as a result of an LCT.

For instance, an average EV will consume 0.306 kWh/mile[145] or 3,060 kWh for 10,000 miles. New petrol cars in the UK average 917 litres[146] of fuel for the same 10,000 miles with a pump price of 124p per litre. Directly comparing energy costs between electricity (£567) and petrol (£1,137) is interesting, with electricity costs dropping further if smart charging is used to get the lowest overnight rates (£275) using the dynamic rate example from above.

[143] Did not allow for entering an annual kWh figure, only allowed for selection of number of bedrooms
[144] Allowed for the entry of an annual figure and produced a corresponding higher figure
[145] https://ev-database.uk/cheatsheet/energy-consumption-electric-car (April 2021)
[146] ENV0103 - https://www.gov.uk/government/statistical-data-sets/energy-and-environment-data-tables-env and Weekly road fuel prices, https://www.gov.uk/government/statistical-data-sets/oil-and-petroleum-products-weekly-statistics

Uncertainty

Switching tariffs is based on the promise that costs will be lower, or product features will be better in the future as a result of adopting a new energy supplier or tariff. These future costs are based on future consumption volume and patterns as well as unpredictable future prices of energy.

Energy suppliers play a role in making the future price predictable, which is evident in the way single rate, long term contracts are structured and presented to customers. The energy supplier takes 'bumps' out of the energy price road by aggregating demand, balancing a portfolio, purchasing their own future wholesale supply and assuming the financial risk for predictions. It is a legitimate argument that the 'smartest' tariff is the one that works this out for consumers as a single time invariant rate.

Today, at an annualised level, most electricity usage is stable and predictable, but this certainty will be challenged in the coming years with increased electrification. It is the adoption and integration of this new or radically changed demand that will present the largest challenges and opportunities for smart tariff comparison. A new tariff must be chosen **before** the consumption has occurred; in effect prediction of new consumption patterns creates the financial benefit.

Summary of accuracy requirements

- Use of historical data to inform the future consumption is very important, but should not necessarily be used verbatim or at the very least make sure the user understands how historical data is being used;
- Dynamics of the present and past consumption should be understood, for example, has the consumer significantly changed consumption due to the addition of a low carbon technology somewhere in the past data stream?;
- The ability to work with future estimates and get user input to inform future personalised energy system model;
- Tariffs that have longer term contracts can be applied as future rates, however, there needs to be adequate provision for future price risks in dynamic tariffs.

Robust data sets and models

Data sets must not only be widely available for energy data, tariffs and modelled results, there needs to be confidence in how they were collected, treated and that the tariff offers can be contracted. To better understand where this data could come from and its limitations, each of the major data types, the typical source and possible alternatives are discussed below.

Consumption history – up to 13 months of HH data is stored on a SMETS smart meter and accessible through the DCC; this includes imported active and reactive energy in kWh as well as exported energy in kWh. Currently EV demand, solar generation and battery energy must be sub-metered outside of a standardised system. Consumer access devices (CAD) can collect more granular data, including power demand and have a memory of historical price changes. Similarly, gas consumption data is available with configuration information such as calorific value being important to some meters. The project generally found historical data can be accessed and was of high quality.

Tariffs – the tariff rates, current and scheduled changes, are stored on a SMETS smart meter, however dynamic tariffs and contingent discounts are not practically able to be placed on the meter. Tariffs on the meters do not have identifiers that correspond to Tariff information labels (TILs) published for regulatory purposes. It has been the experience of the project that tariffs on meters were often missing, incorrect or not well maintained. This may be solved with supplier operational improvements. Local tariff information is necessary in the case of prepayment, therefore dynamic prepay is unlikely to be implemented on the meter.

Cost information – a smart meter calculates cost for time periods as well as performs the accounting functions for prepayment. For credit customers, it is likely that due to local tariff quality, supplier discounts and other product bundling that this local cost information will not be the amount paid to the supplier by the consumer.

LCT performance data – manufacturers of LCTs typically self-report performance metrics of their products, in-use performance may deviate significantly both initially and over time[147]. Measurement standards, product maturity and consumer's understanding of performance will contribute to better comparison metrics. Solar panels for instance are now well understood whereas battery storage is not yet such a commodity.

Carbon reporting – supply side carbon reporting for tariffs is done by the supplier with National Grid publishing carbon intensity for each grid service point (GSP) region at half hourly intervals. Other sources of carbon data will be needed to account for embedded carbon and other elements such as lithium within technologies may play a role when accounting for environmental impact.

Cost allocation

Smart tariffs can complement investments in renewables and storage. When analysing a new tariff or LCT the capital cost of solar panels or other distributed generation technology needs to be considered. The accounting for payback and operating costs is historically difficult to determine and very difficult to project forward. A consumer will not receive a bill for energy they have generated, but that does not mean the unit rate of self-generation is zero. To avoid making renewables appear to be free and demand realistic the following requirements should be kept in mind:

- When displaying renewable energy and its impact on cost, it should be framed as either a unit rate expressing the cost of plant, materials and operation for the unit of energy or allocated for the time period being considered e.g. annual cost to run solar panels;

[147] This could be an area for further research; LCT actual performance characteristics versus claimed.

- When analysing self-produced energy, make sure to allocate the avoided expense of grid energy at the market rate for that time period;
- When estimating potential for savings, be careful not to use an inflated future rate, including issues with using average rates or double counting consumption and export as avoided expense and income;
- In an ideal analysis stored energy would remember its unit costs when the energy was "consumed" to charge a battery;
- Make sure the efficiency and capacity of production and storage technologies are considered – they do not perform at 100% and have upper and lower bounds of operation including time to charge, discharge;
- Procurement of energy may be outside of the consumer's domestic energy bill, for instance charging an EV at work, it should be clear if this is considered as free or as a cost;
- For some consumers a carbon metric may be more important than price; using a carbon cost ratio may be a more useful way to allocate resources for these people.

Use of time

With the flat rate tariffs that currently dominate the energy market, a unit rate is sufficient information to compare tariffs but with smart tariffs time becomes a major factor in the overall cost calculation. LCTs also often require the use of time as they have time-based constraints such as: when the consumer wants to charge an EV or the need to align with events, e.g. produce solar energy when the sun is shining.

Summary of requirements to ensure robust data sets and models

- Underlying software capability needs to support time alignment, resampling and aggregation of time series data;
- Relationships between energy sources, demands and prices should be able to be represented through operations **between** time series such as addition and multiplication and **joining** independent data sources in time, such as weather data;
- Visual representation of time is important; use familiar labels and units like 'weekend', 'weekday', 'morning', 'evening', etc. to avoid overwhelming users;
- Data quality is important, if there is missing data it should not invalidate overall results; models and methods should be sympathetic to missing or erroneous data points;
- Future times should be represented for prediction and other potential uses.

Scalability

There are a wide range of data sources that need to be considered in the STSC; dynamic tariffs, exported energy, self-generated energy, data streams associated with energy storage, and finally basic imported energy. It becomes necessary to work with time series data captured at 30-minute intervals which further increases the volume of data used in describing the personalised energy system.

Data is best abstracted into **accounting** and **modelling** functions.

Accounting is the final cost of the energy and forms the basis of the purchase transaction with the energy supplier or calculation of return on investment for low carbon technology.

Modelling explains energy use. It is used for prediction and matching technology for carbon savings.

More data benefits modelling while also increasing accounting work. Processing and managing large accounting data sets increases the administrative costs of energy companies.

Large, granular data sources need models and processing to reduce dimensions so that useful features can be realised. For instance, statistical features like daily average and variance are single values that describe larger sets of data. With a large data set the options for analysis increase.

Summary of scalability requirements

Consider the following functional and non-functional requirements:

- **Performance**, particularly load time, needs to be considered with large data sets not to overload or delay results for the end user;
- STSC relies on **accounting style calculations** when **presenting cost** information, however the tool needs to be able to change model parameters that will then translate quickly into accounting terms - i.e. ranking tariffs based on annual cost;
- **Metrics** need to be **easy to follow** and relatable;
- **Visual presentation** of trends and changes in model data need to be **clear** with cues and summaries of the changes, e.g., an additional spend of £300 per year showing the current spend in relation to the new spend;
- **Precision** should be **reduced** (to make results scanning easier for the consumer), but **accuracy** should still be **high**; do not overwhelm the user with many decimal places or small unmanageable units of time but make sure aggregated results day, month, year are accurate and correspond to comparable billing periods they would find on a printed bill;
- **Bring out** the **relationships within** the **data** in a modelling context and in real-time show the accounting impact.

Integrating the solution

Suppliers have operational systems to support smart metering but typically run separate systems for sales and/or rely on PCWs to market their tariffs.

Operational and technical feasibility may limit suppliers' ability to integrate the STSC tool into their own infrastructure. Limited access to tariff information and the lack of commercial incentives to 3rd parties may limit others from developing solutions. In theory, incentives and capability would sit with PCWs although this may trend towards LCT manufacturers or specialist service providers (as in the case of the solar market) to drive adoption, such as the "free miles" offer from a car manufacturer.

The open source approach supports any interested party with the motivation to adopt smart meter data and model calculations into their solutions.

Integration assumptions

- The consumer must clearly understand where their data is stored and who has access to it;
- In many cases an adopter of the STSC code may only need a snapshot or aggregate figure to produce a good result;
- Data privacy and security compliance cost and complexity needs to be considered; where there is reliance on 3rd party data, quality, integrity and traceability must be maintained to comply with these regulations;
- Data should be able to be easily loaded into the STSC solution from many sources as source data should be able to be provided through whichever technical solution is commercially viable for the adopter;
- If available, models should be able to extend to sub-metered or other granular data (for example, from an EV charger);
- Source data and results should be portable across service providers with enough descriptive information to understand the context of any prior processing of the data, for example GSP code;
- There should be flexibility in how the solution can be implemented with tool adopters taking all or only some of the functionality, in essence the solution is a toolkit.

Innovation

Because of the maturity of smart metering infrastructure there needs to be scope for innovation in tariffs and iterative development based on consumer's changing needs, for example increasing LCT adoption. Traditional sales channels may change, localised energy schemes and distributed generation may require non-traditional pricing models.

Some of the areas that present technical challenges are:

- Provenance of tariffs with a consumer wanting assurance they can first find the tariff at the point of contracting with the supplier and second achieve the cost predictions that were given;
- Model standardisation is costly and is usually compromised so that it can be more widely applied. With smart comparisons, highly personalised modelling may perform well for the individual but may be unable to gain acceptance as a standard;
- Integration with the switch to a tariff or purchase of an LCT will be a key driver; this operational innovation must be considered for successful adoption.[148]

To conclude this chapter on industry requirements, below is a set of feedback received from suppliers specific to the STSC tool that may be informative for the potential tool adopter.

Supplier feedback

Towards the end of the project a workshop was run to show all the suppliers that had given their time[149] during the discovery phase the tool in action. Attendees were asked their thoughts on a series of questions which are listed below. Responses were captured on a virtual whiteboard and are provided below to help potential adopters understand where suppliers' thinking was at the time.

What opportunities do you see for the tool?

- STSC was seen as a way to exploit industry data and could help facilitate improvements to the data quality (for example, tariff data on the meters); it could (should) help facilitate improvements to industry data i.e. DCC;
- The tool was seen as a demonstration of BEIS' support for the smart meter rollout and efforts to showcase the benefits / opportunities of smart meters;
- Suppliers stated that the tool would help demonstrate to PCWs where the market is going and the fact that it is open source and available for suppliers and PCWs to adopt was appreciated;
- The view was that the tool encouraged greater visibility of the benefits of smart tariffs which would, in turn, encourage smart meter and smart tariff take up.

How could this tool be used to support consumer engagement?

- Suppliers said that the tool offered a way to help consumers see how they could save more money (e.g. by shifting their consumption time on a smart tariff);
- STSC could be used after the customer switches as a tool to provide ongoing HH data feedback (carbon intensity, ways to save money);

[148] For clarity, the STSC tool does not initiate any switching mechanism
[149] Either with interviews or responding to the survey and providing their contact details

What barriers need to be addressed for opportunities to be realised?

- Some practical elements of using the tool were flagged as potential challenges including: the need to set up and account (email and password) as extra steps may reduce the conversion rate, the time required for the user to retrieve their data[150];
- It was noted that explaining in understandable terms what adjusting consumption habits look like – 20%, 30% etc. – was confusing as currently depicted;
- Supplier tariffs and rates frequently change – feedback was that the tool needs to include a disclaimer that the rates shown may be subject to change for example, if the user saves the results and comes back at a future date.

What additional elements are required to unlock these opportunities?

- Suppliers suggested that AMR meter data or manual uploads of HH data should be included and that business energy data was an additional opportunity to demonstrate smart tariffs to the non-domestic sector;
- The suggestion was that the tool should use standardised approaches towards estimating some data (such as using MCS for solar generation estimates).

[150] Qualitative consumer research found that people did not mind waiting to get their results and some saw the wait as an indication that it really was their own data being retrieved, not an estimate.

Chapter 8 – Industry solution

The solution delivered was documented in detail to support any tool adopters and code was published – all available and maintained online. Independent technical assessment provided assurance that the tool was robust and met BEIS's standards.

An overview of the technical solution is provided below – readers with interest are recommended to read the following detailed material:

- Project Technical Report (Annex A) available at https://www.gov.uk/government/publications/smart-meter-enabled-tariffs-comparison-project-smarter-tariffs-smarter-comparisons
- Source code and documentation: https://bitbucket.org/LDNSFO/stsc-tsc
- JavaScript library release: https://www.npmjs.com/package/stsc-tsc

Many examples of the implementation, that can be reused, are provided at https://observablehq.com/collection/@joshuacooper/smart-tariff-smart-comparison including the basic operation of the model, product and cost structures, tariffs and data export.

Technical approach

There were key objectives with the technical solution:

- Demonstrate that smart meter data could be used to inform the comparison model (if available and consumer's consent provided);
- Make ease and simplicity the priority to deliver a streamlined process;
- Support the ability to predict the impact of LCT investment in conjunction with appropriate smart tariffs to demonstrate Total Cost of Ownership;
- Deliver a solution that was open source, fully documented and ready for use by suppliers, price comparison services, researchers or individuals.

The following content explains how that solution was delivered with illustrations that are technical but can be understood by the lay reader.

The model / mathematical process

There are three steps to the mathematical process behind the comparison model.

Step 1: **Future consumption estimation** to predict future supply / demand. Smart meter data is historical data that estimates future consumption. This historical data is used directly in quoting forward costs / benefits although other data and models can be used. Use of LCTs may be a significant component to the prediction.

Step 2: **Apply tariff** run the algorithm to calculate a cost/benefit given a tariff structure and apply the consumer's current tariff for counter factual. In the case of dynamic tariffs, a future estimate (in our case historical prices have been used) is required.

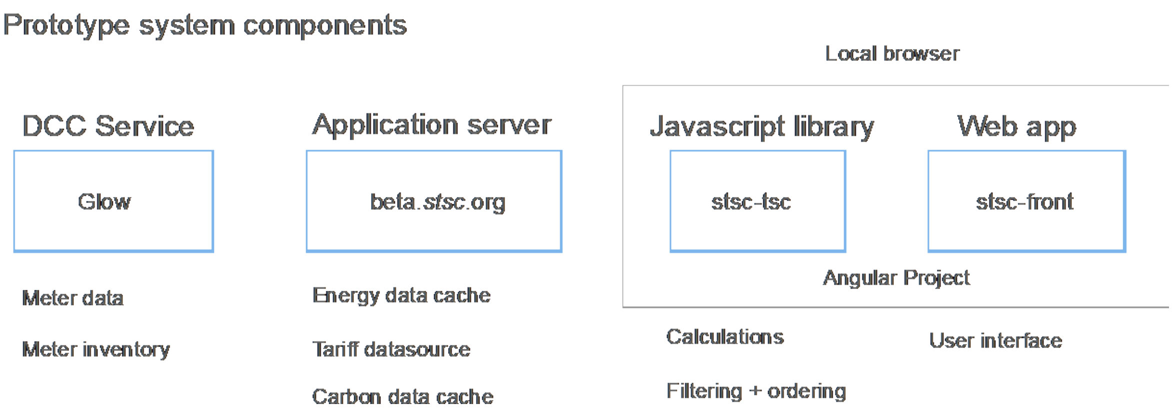
Step 3: **Compare or recommend** with the ability to filter results based on supplier and product characteristics.

Components

The model implementation is in JavaScript providing a library that will execute in either a browser or on a server. Model data can be loaded from servers or defined programmatically with an open data approach. The design supports several architecture patterns, including cloud based deployment, serverless applications and publishable worksheets.

The model is distributed as a component through npmjs.com[151], a node package manager registry used in the development of JavaScript applications. The source code is distributed as open source through Bitbucket[152], an online source code repository for version control. The projects are named to reflect the use of Typescript, a language that is transpiled to JavaScript.

Figure 21. Smart tariff smart comparison prototype stsc-tsc model library[153]

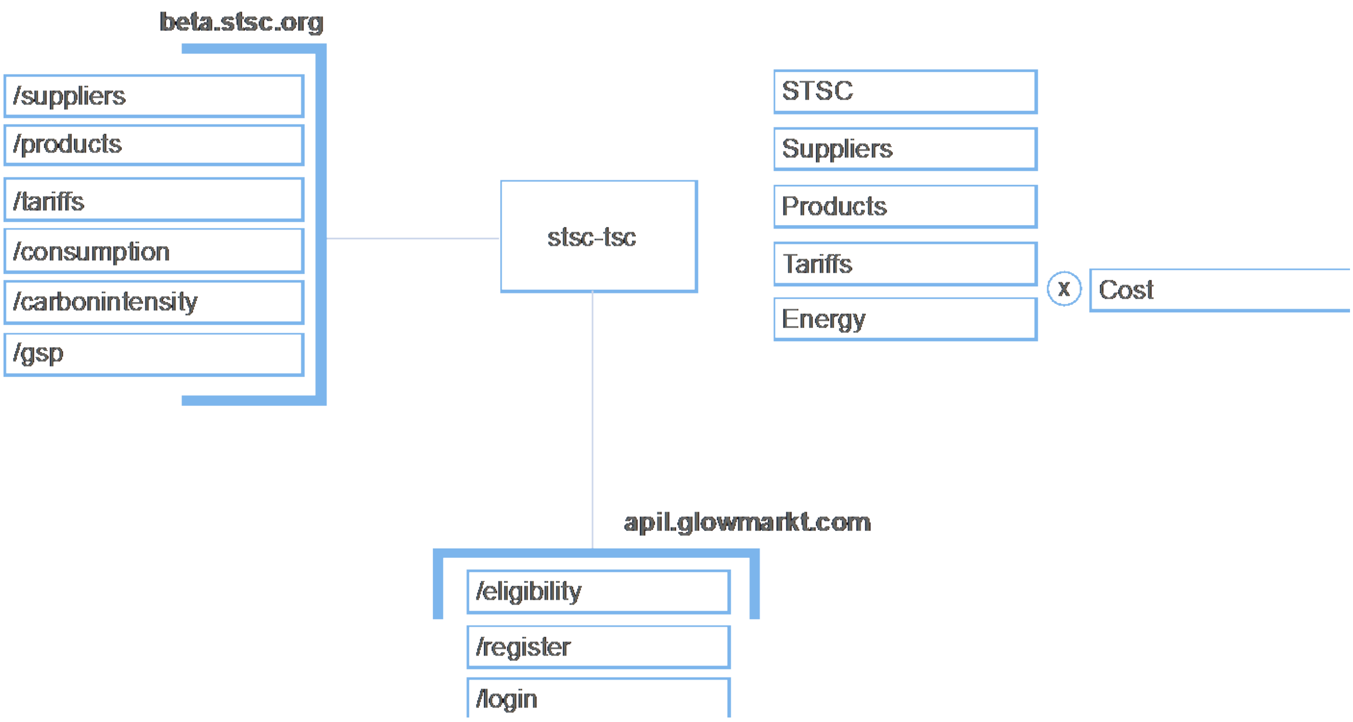


[151] https://www.npmjs.com/package/stsc-tsc
[152] https://bitbucket.org/LDNSFO/stsc-tsc
[153] STSC is an Angular project demonstrating the use of the model library depicted

For the Smart Tariff Smart Comparison prototype the Hildebrand Glow service[154] was used to provide consumers with energy data from the DCC, while some lightweight server application components were developed to distribute sample supplier, product and tariff data. The application server also created and cached the STSC formatted half hourly electricity data. Other supporting data such as half hourly carbon intensity was compiled into a usable format so that extended functionality could be demonstrated.

The Glow service can access imported/exported electricity and gas energy as well as tariffs that are loaded on the meters. Glow has a database of these readings with a calculation of the historical cost, reflecting any tariff changes since the user has been registered with the service. Glow also receives more granular data, every 10 seconds from Glow compatible consumer access devices (CADs). All data is accessible via the application programming interfaces (APIs), the Bright mobile or partner applications. These are provided free to the consumer.

Figure 22. STSC system architecture



Model objects relate and interact with remote functions and data services to provide the calculation of product costs with the ability to filter supplier and product characteristics of interest. A full background[155] of the design accompanies the source code documentation, this will be kept available and up to date as the software progresses post project completion.

Reference documentation of the model is generated and available within the /docs directory of the source code. There are some object attributes that are mandatory for the model to function, however attributes can be appended to Suppliers, Products and Tariffs such that filter criteria can be customised through the data source in appreciation of the fact that, for example,

[154] Hildebrand is a DCC Other User; they deliver smart meter data to their customers (individuals, suppliers, research projects, etc.) via their Glow platform. See the Technical Report for further details on the Glow service.
[155] https://bitbucket.org/LDNSFO/stsc-tsc/src/master/ModelDesign.md

suppliers will only want their own tariffs included. For instance, Tariffs must have a type of ‘flat’, ‘tou’ or ‘dynamic’ cost otherwise they cannot be calculated with the appropriate method; whereas a new attribute of { evsize: ‘large’ } will be available for matching with a results filter.

Suppliers – for the STSC prototype, a list of suppliers was sourced from the Citizen’s Advice supplier rankings[156] and their names were anonymised for research purposes. The list included service scores with the overall score displayed within the prototype’s user interface. The list is refreshed quarterly from original research. Future extension of the model would include suppliers of other goods and services, such as low carbon technologies.

Products – organise goods and services that are bundled. Products may include features like rebates, earned income for export and requirement of other linked tariffs such as gas. The products may have one or more suppliers, tariffs or services within them, and calculate the summed benefits and obligations. Products also take into consideration custom configuration, for example the grid service point (GSP) attribute is used to then present appropriate regional tariffs. Using Products as a construct in the model is meant to view choices as total cost of ownership with return on investment and net present value calculations in the future. Other metrics such as carbon can be calculated at this level.

Tariffs – represent the price structures of goods or services. STSC supports flat, time of use and dynamic tariffs along with recurring standing charges; a selection was taken from UK suppliers’ websites for the prototype. There will be additional structures to support modelling of solar, battery storage, electric vehicles and heat pumps where capital costs exist. Electric and gas tariffs support regional variation based on GSP. At the moment tariffs are independent of generation, however further work could be done to explore dynamic pricing based on demand profiles – this could be particularly useful for small scale community generation projects or for optimising a more complex home energy system.

Energy – HH kilowatt hour energy, measuring imported electricity from SMETS smart meters. Historical energy data is sourced from the Glow service. Annual historical energy is used as the predictor for future energy demand, with a system limitation that consumers must have one year of history. Future work includes estimating annual consumption from less history, e.g. one month of data. For efficiency in calculation, predicted energy is attached to Products so that all tariffs use the same single data stream to calculate cost. The predicted energy can be edited using scenarios that change the consumption patterns with detailed costs being recalculated in real time.

Cost – a calculated object from energy and tariff objects. This is a timeseries object that uses the energy time boundaries (start, end) to represent the HH cost due to use of a commodity. Standing charges are calculated and presented within the Cost object separately. Cost is a general data structure so it can be used at an Energy x Tariff level or a Product level as a sum of all costs. For clarity, any actual historical cost found from prices on the SMETS meter come from the Glow service if the consumer is already a user of that service as changes in cost over time are captured while the consumer is using that service.

[156] https://www.citizensadvice.org.uk/api/customer-service-rating/get-latest

The application server directly provides source data for the model but it does not perform any calculations. The design is such that the data sources could be replaced by a supplier's own data sources or distributed as files with the model code. The consumer could even upload their data from another source (submeter or other service provider) to use the model. Similarly, scenarios could be coded so that LCT manufacturers could use the model. For clarity, the consumption endpoint in the application server is an STSC binary representation of HH electricity consumption using a Glow token for authentication and access to that data.

The Glow service calls are shown for completeness as the token that is provided with a login provides access to energy data, historical cost and grid service point reference from the MPAN.

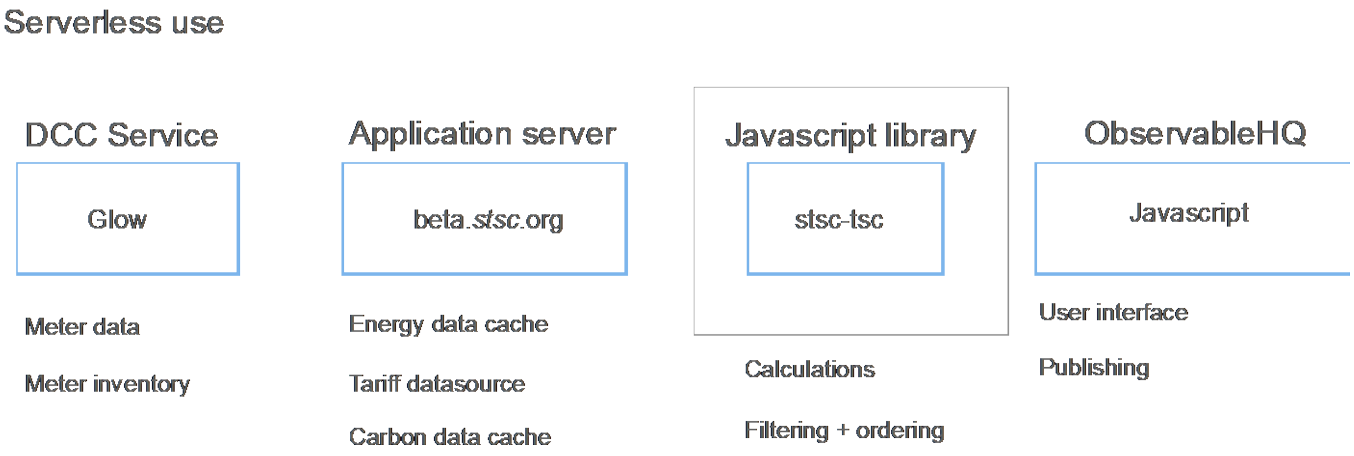
Further application examples

From discussions with industry stakeholders there were a variety of use cases. Integration within a supplier or price comparison website would require knowledge of that specific system. Below there are some basic extended examples to show how, in principle, the stsc-tsc model could be used.

Worksheet example

To illustrate the library use in a serverless environment, ObservableHQ will be used to find the best tariff for a given size of electric vehicle. The user will be asked to input their STSC username and password, select from a vehicle size and see the cost of tariffs.

Figure 23: Example using the library in serverless publishing environment on ObservableHQ



The stsc-tsc library is loaded from the public repository and by default includes suppliers, products and tariffs that are published through the STSC application server. Locally configured suppliers, products and tariffs could be used. Another key aspect is the awareness of energy data from the Glow service using a token either provided by the consumer or created from a login session.

The user interface on ObservableHQ is basic with a slider control and table of results.

Figure 24: Example from ObservableHQ: EV as slide input and realtime calculation of an ordered list of tariff costs, slider controls and table format are single lines of code

Select EV size

To calculate the cost of each product, select an EV size

2,600

Change the size of your EV in kW

With EV Added 1 2 3 4

name	annualcost
Dynamo Pear February 2018	1,036.60
Pear EV Faster (5H from 0130) December 2019 v1	1,166.12
Pear EV Faster (5H from 0030) December 2019 v1	1,179.07
Pear EV Faster (4H from 0130) December 2019 v1	1,188.64
Pear EV Faster (4H from 0230) December 2019 v1	1,224.48
Pear EV Faster (5H from 2330) December 2019 v1	1,252.26
Pear EV Faster (3H from 0230) December 2019 v1	1,254.08
Fair & Square 9 (December 2016) - Unrestricted	1,255.05
Fair & Square 9 (December 2016) - Unrestricted	1,255.05
Pear EV June 2018	1,255.42
Pear EV Faster (4H from 0030) December 2019 v1	1,255.42
Pear EV Faster (3H from 0130) December 2019 v1	1,272.26
Pear EV Faster (3H from 0330) December 2019 v1	1,328.04
Pear EV Faster (5H from 2230) December 2019 v1	1,335.26
Pear EV Faster (4H from 2330) December 2019 v1	1,348.55

Example code and explanation

The code to power the table above illustrates the structure:

```
my = require('https://bundle.run/stsc-tsc@1.0.13');
let mystsc = new my.STSC();
await mystsc.login({ username: myusername, password: mypassword });
await mystsc.loadgsp();

let energy = new my.Energy();
energy._token = mystsc.token;
await energy.load();
myAnnualEnergy = energy.range({
        from: '2020-02-01T00:00:00.000+00:00',
        to: '2021-02-01T00:00:00.000+00:00',
         interval: 1800000
      });

evEnergy = {
  return myAnnualEnergy.addEnergy({
      start: 1,
      end: 10,
      amount: evcapacity
```

```
    });
}

let suppliers = new my.Suppliers();
await suppliers.load();

let products = new my.Products();
products.gsp = mystsc.gsp;
products.setSuppliers(suppliers);
await products.load();

products.predictedEnergy = evEnergy;

await products.loadtariffs();

products.calcCosts();
```

The first line pulls in the stsc-tsc library from public source. The Bundle service, a third-party public service, repackages the code for use within the browser. A version number can be specified as well using the @ sign.

A new instance of the STSC administrative object is created to support login and creation of a token for energy data access.

Historical energy is loaded and then trimmed locally with a range operator. Timezone information is included in the time string.

The slider value is bound to a variable called evcapacity, which is in turn assigned to the amount of energy to add over a set number of the HH time slots [1-10) formal notation of inclusive of slot 1 and up to slot 10. Midnight is slot 0 with 00:30 being slot 1 in this case. Slot 10 or energy demand from 05:00 – 05:30 is not included. When the slider is moved the value will change and all of the subsequent calculations are updated.

The remaining lines of code load Suppliers, Products and Tariffs. Notice the assignment of the varying EV energy to the predicted energy attribute of products. This is the energy used when calculating costs.

The full example can be found at: https://observablehq.com/@joshuacooper/electric-vehicle-selector. Note, a valid STSC or Bright username and password is required to access the smart meter data provided by Glow. The errors on the page will disappear on successful authentication.

Adjusting design in light of technical and market constraints

Translating the front-end design into code was the point at which external technical constraints became an important driver of user experience decisions.

Table 12: Technical and market constraints with implementation response

Technical and market constraint	Implementation response
DCC response times Initially we envisaged a seamless transition for the consumer from the data capture conversation to the results screen Actual DCC response times for [13 month's of half-hourly consumption data], were typically 30-60 minutes. Within the 5,600 second SMETS2 meter required response time	Added a process step to the user journey After registration, the consumer receives an email telling them results are ready to be viewed. Consumer logs in to the site If their data is not 'ready', an onscreen message indicates how long the tool expects the data load to take
Some displays do not have a unique identifier, or not having a display Consumers with some displays have been unable to find the unique the identifier on the device[157]	Use an alternative verification method, for example a manual app-based verification.
People do not know if they have SMETS1 or SMETS2 meters DCC sourced data powers the results; DCC inventory powers the interrogation of suitability Only **migrated** SMETS1 meters supported	Integrate additional data sources to actively check meter compatibility. The Citizen's advice smart meter checker for consumers is an example, launched in spring 2021: https://smartmetercheck.citizensadvice.org.uk/
Smart meter roll out currently at 44%[158]	Solution needs to integrate a journey for people without smart meters to demonstrate the benefits of smart tariffs Some suppliers offer tariffs that are smart meter installation dependent; these could be featured

[157] Unclear if this is inherent to the product or the installing supplier's specification
[158] 35% of domestic meters are in smart meter mode: https://www.gov.uk/government/statistics/smart-meters-in-great-britain-quarterly-update-march-2021

Independent technical assessment

At the end of the project, BEIS engaged Cambridge Energy (CE) as an independent external technical assessor to provide assurance that the comparison model implemented was accurate and suited for the purpose. CE reviewed the code structure and clarity as well as the results of calculations. They also reviewed the implementation of the price comparison service that is based on the model.

There were two significant limitations identified in version 1.0.15 of the code that have since been fixed[159].

In addition, CE identified some minor bugs, some of which are still outstanding, and made some recommendations for improvements. CE commented that "doubtless the model will be developed further in due course, but it already implements the main functions identified in the requirements with reasonable performance. The price comparison service prototype needs a good deal more refinement[160] before it can be used as a live product, but CE do not foresee any fundamental problems."

[159] 1) Model did not model TOU tariffs that have different rates on different days, except inefficiently as fully dynamic tariffs and (2) the model assumed that all TOU tariff rates are in Greenwich Mean Time; it did not allow for British Summer Time.

[160] Reminder: the front-end implementation was for research purposes and was not written to be adopted as a fully functional solution.

Chapter 9 – Maximising impact and ongoing development

An open-source tool with potential for adoption by a range of stakeholders to deliver benefits for consumers and industry. There are further potential use cases as a tool for RD&D and policy design and opportunities for greater impact with further progress in awareness, policy and by adding more functionality to the tool.

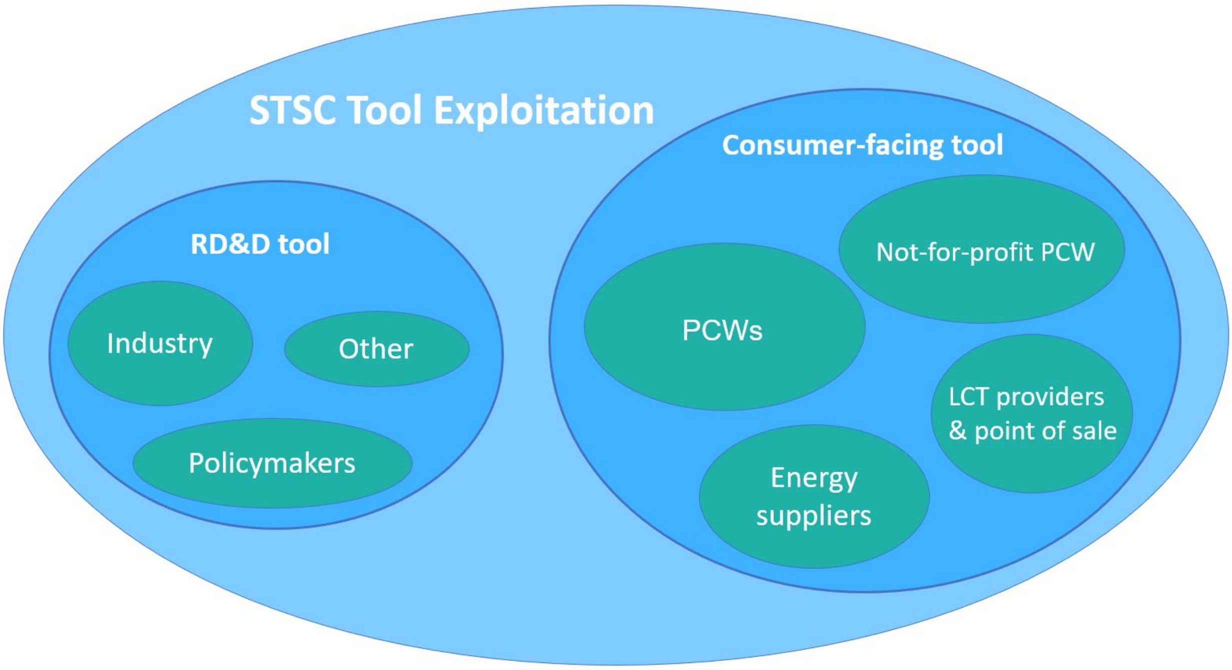
Opportunities for stakeholder adoption and impact from the STSC tool

The code for the tool is available to any organisation that wants to adopt it. During the project expressions of interest on integrating the solution were received from three suppliers, an innovative LCT comparison solution and a not for profit. This interest serves as demonstration that the tool's potential is not limited to take-up by PCWs.

Figure 25, below, identifies a range of stakeholders who could take-up and exploit the STSC tool for consumer-facing services. These include PCWs (whether commercial or not-for-profit transactional services) as well as also energy suppliers, LCTs providers/manufacturers and point-of-sale (e.g. car dealerships).

This figure also shows a second group of stakeholders who might adopt the tool for a different use-case as a tool to support research and development in industry and policymakers. This chapter will discuss this range of stakeholders and use cases and the opportunities for maximising impact of the tool across them.

Figure 25: Opportunities for STSC tool exploitation[161] by different stakeholders



Using EV purchase as an example, the tool could:

- be used to present EV and EV-tariff bundled offerings on a PCW;
- be used at point of sale to raise awareness of tailored EV-charging costs;
- play a role for the tool in educating EV dealerships on EV-charging costs, especially since dealerships' knowledge has been identified as a weakness[162] and interactions with sales personnel have been identified as a critical barrier to EV adoption.[163]

> *"Industry must develop and implement best practice standards for information provision at the point of sale" - Electric Vehicle Energy Taskforce.* [164]

The design of the model and the tool allows for the addition of other low carbon technologies, such as heat pumps and solar PV and can be used to judge the cost of ownership both pre and post purchase.

[161] The term 'exploitation' is used here in the sense conventional in ICT projects, i.e., how the results will used by stakeholders for specific commercial or non-commercial purposes.
[162] Matthews, L., Lynes, J., Riemer,M., Del Matto, T. and Cloet, N. (2017) Do we have a car for you? Encouraging the uptake of electric vehicles at point of sale, Energy Policy, Vol.100.
[163] Zarazua de Rubens, G., Noel, L. & Sovacool, B.K. (2018) Dismissive and deceptive car dealerships create barriers to electric vehicle adoption at the point of sale. *Nat Energy* 3**,** 501–507.
[164] Electric Vehicle Energy Taskforce (2019). Energising Our Electric Vehicle Transition. p.64

Table 13: Tool impacts, end-users, and delivery stakeholders

User benefit and impacts	End users engaged	Stakeholders for delivery
Makes tariff comparison easier and more accurate by using smart meter data Drive use of DCTs and switching behaviour Drive adoption of smart meters	Households with smart meters Households without smart meters Disengaged consumers	PCWs, energy suppliers, other hosts for DCTs, LCT buyer guides
Adds smart tariffs in comparisons Drives awareness of, and normalises, smart tariffs and LCTs Drives adoption of smart meters Drives adoption of smart tariffs	Households with existing lower peak-time consumption Households with ability to be flexible (via behavioural flexibility or via storage/automation technology) Non-switching consumers who do not want to change supplier but might change to smart tariff	PCWs, energy suppliers, other hosts for DCTs, LCT buyer guides, LCT POS information
Adds EVs and other LCTs plus smart tariffs to comparison tools Drives awareness of, and normalises, smart tariffs and LCTs Drives adoption of smart meters Drives adoption of smart tariffs Drives adoption of LCTs	Existing LCT-owners Early adopters of EVs and LCTs	LCT producers; innovative energy suppliers; PCWs, LCT buyer guides, LCT POS information
Can be used as tool to support design of innovative products & services Tool could give insights into affordability, running costs of new products and services at design stage	Suppliers LCT-producers	Any provider of tool; suppliers & LCT-producers themselves
Can be used as a tool to support design of policy & regulation Tool helps communicate price signals to consumers thereby increasing policy impact Tool could be used to explore affordability and distributional impacts to inform new policy/regulation	Policymakers/regulators	Any provider of tool; suppliers & LCT-producers Policymakers/regulators themselves

Below we summarise a number of stakeholders that could be involved in delivering STSC services to end-users with some of the pros and cons in each case.

Table 14: Pros and cons of who hosts/delivers the tool to end-users

Who hosts/ delivers tool	PROS	CONS
PCWs	Could rapidly engage many consumers who already use PCWs Whole market comparison	May not improve consumer trust in PCWs More challenging to ensure consistency of offering across different sites
Energy suppliers	Could broaden engagement to loyal (sticky) customers and those currently sceptical of PCWs due to profit motive. May incentivise more suppliers to offer smart tariffs (to remain competitive)	Not whole market comparison
LCT providers manufacturers and point-of-sale for LCTs (EVs, heat pumps, and storage and automation behind-the-meter devices)	Broader reach of tool to more consumers (including those not using PCWs) Drive LCT uptake Drive tech-focussed consumers to smart tariffs May incentivise suppliers to offer smart tariffs (to remain competitive)	Not whole market comparison Wider number of sites offering STSC may be more challenging in the long term.
Not-for-profit transactional PCW	Whole market comparison Greater consumer trust More able to collect and use data for research e.g. better understand impact on switching rates (Explore learnings from state-supported not-for-profit PCW in Australia https://compare.energy.vic.gov.au/)	
Auto-switching services/sites	Potential to reach different users to PCWs	Would perhaps have greater need for having ongoing access to smart meter data Could be even more price-focussed than other PCWs Some are less likely to likely to support bundled offerings as their business model relies on regular switching

Maximising the impact of the tool

As discussed in Chapter 2, smarter comparison tools could play an important role in supporting greater engagement across smart tariffs, smart meters and LCTs. They also provide practical support for consumer switching and adoption decision-making by greatly simplifying complex cost projections.

Smarter comparisons alone cannot remove all existing obstacles or barriers for energy consumer switching and technology adoption. Adding additional functionality to STSC tools should help to some degree here and some suggestions are given below. But consideration of the wider landscape for consumer engagement suggests further actions that could amplify the impact of STSC tools. This wider context includes consumer awareness, policy and regulation.

Consumer awareness

While the STSC tool makes the financial costs of energy services and products clearer to consumers, in general UK consumer awareness and understanding of 'smart tariffs' and 'flexibility' is low, as confirmed by the quantitative research. It is expected that the impact of smarter comparison tools will grow as the broader context for energy consumer awareness and engagement evolves and a range of self-reinforcing and inter-connected positive feedback effects (discussed in Ch. 2) begin to kick-in. These will include: rising consumer confidence in as-yet novel technologies and services due to first-hand experience (a familiarity effect and ladder of engagement[165]); social influence/learning/contagion effects and shifting norms; and falling technology costs will also support greater engagement.

Policy and regulation

Anticipated developments in policy and regulation could also help to both reduce barriers to consumer engagement with energy products and services and smarter comparison tools. Some planned policy changes that can be expected to improve the impact of smarter comparison tools are noted below:

- The number of households able to access and benefit from STSC tools will expand as the **smart meter rollout** continues to progress and as more households have a longer baseline of smart meter data. Government has confirmed it will implement a new smart meter policy framework with fixed annual installation targets for energy suppliers that will continue to drive rollout momentum.[166]
- Similarly, as **other non-financial barriers** to adopting or trying smart technologies improve, this will provide a better context for greater use of STSC tools, for example, as access to EV-charging networks expands.

---

[165] Carmichael, R., Gross, R., and Rhodes, A. (2018) *Unlocking the potential of residential electricity consumer engagement with demand response*, Energy Futures Lab Briefing Paper, Imperial College London.

[166] Smart meter policy framework post 2020: minimum annual targets and reporting thresholds for energy suppliers, https://www.gov.uk/government/consultations/smart-meter-policy-framework-post-2020-minimum-annual-targets-and-reporting-thresholds-for-energy-suppliers

- The anticipated introduction of **market-wide half-hourly settlement** (MHHS) by mid 2025[167] will also provide the right 'incentive framework' for suppliers and other organisations to bring forward new products, services and business models that help consumers to manage and shift their consumption to cheaper periods.[168] This will include smart tariffs, storage devices, bundled offerings and tariff comparison services.
- The introduction of **faster and more reliable switching** is also planned and, when implemented, will lower barriers to trying a smart tariff and enable consumers to quickly and easily switch away from a smart tariff if unhappy, thereby lowering the risk of higher bills. In a UK survey with participants in a dynamic TOU trial, 87% of respondents indicated that being able to "instantly and easily switch back to your old tariff if you were not happy with it" would make a TOU tariff more attractive.[169]

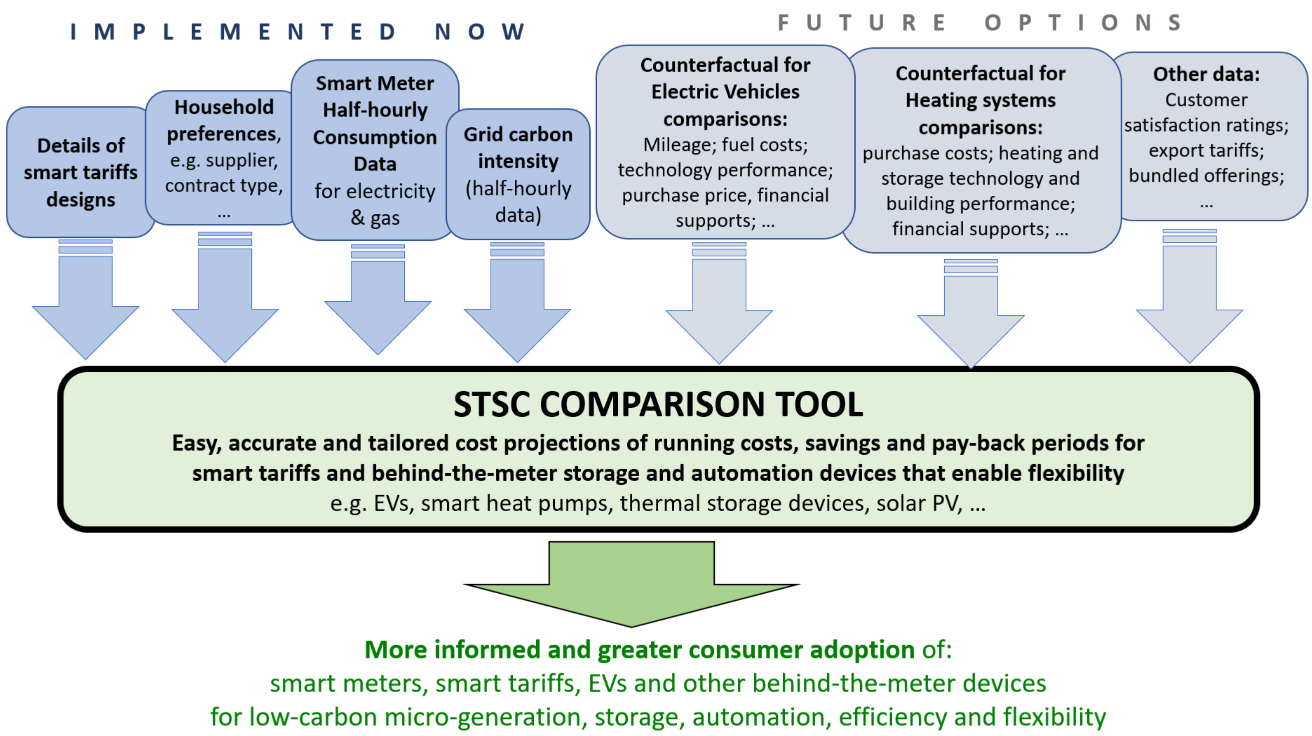
[167] https://www.ofgem.gov.uk/publications-and-updates/electricity-retail-market-wide-half-hourly-settlement-decision-and-full-business-case
[168] Ofgem (2018) Market-wide Settlement Reform: Outline Business Case.
[169] CEPA (2017) *Distributional Impact of Time of use Tariffs.* Report by Cambridge Economic Policy Associates Ltd. for Ofgem,

Additional tool functionality

The design of the tool and decisions about additional functionality will evolve with the benefit of ongoing user feedback, data sets, technical development and external stakeholder involvement. Some of these potential additional functionalities are outlined here and all will, to some degree, require or benefit from further research (see Chapter 10 Conclusions and recommendations for suggestions).

The figure below shows the core functionality that has been implemented with the data required to deliver it and provides examples of additional data required for future functionality.

Figure 26: STSC tool current and future data inputs[170]



170 Adapted from Carmichael, R. (2019) *Behaviour Change, Public Engagement and Net Zero*. A report for the Committee on Climate Change.

Table 15: Possible additional functionality for the STSC tool

Functionality	Examples	Impact
Broader range of tariffs	Export tariffs, Heating as a Service	More informed adoption of micro-generation and innovative service offerings
Broader inclusion of LCTs	Comparing options for heating systems	Support commercialisation of smart products and services
Reducing risk and barriers	Automated post-adoption assessments and alerts: functionality could both reassure people that risk is low and help them switch away from smart tariff if unaffordable	Lowers risk, and perceived risk, to adopting or trying a smart tariff. This is important given the evidence that first-hand experience with TOU leads to acceptance.
	Automated alerts when a better match between consumption and service is available (similar to auto-switching sites but using smart meter data and smart tariffs)	Better match between consumer and products. Greater consumer confidence that they are on the right tariff for them.
	'Tariff ghosting': Allows consumer to virtually 'try' a smart tariff – receiving price signals and seeing how flexible they might be – in order to see what they would pay on the tariff without actually risking higher bills	Increases the 'trialability' of smart tariffs with no risk (associated with more rapid innovation adoption)
	Include link to request a smart meter installation	Reduces barriers to smart meter adoption Potential to collect data on STSC driving interest in smart meters
Customer reviews for tariffs		Reduces uncertainty about unfamiliar services and products and leverages social influence effects (e.g. shifting norms)
Adding a tariff-specific 'green' (carbon intensity) rating		Leverages environmental motivations. Raises awareness about benefits of smart tariffs
Functionality to support end-users beyond domestic consumers	E.g. use of STSC as a research tool by policy-makers/regulators to provide insights into affordability of products and services and as a 'sandbox' for testing impacts of proposed policy.	Better-informed design of policy, regulation and industry offerings Educates stakeholders dealing with public (e.g. EV dealerships).

Key points

- The STSC tool could be exploited by a range of stakeholders for consumer-facing services to **drive engagement with smart meters, tariff switching, smart tariffs, and smart low-carbon behind-the-meter energy devices** such as EVs, heat pumps, smart controls and other energy storage devices.
- The model underpinning the STSC tool also has **potential to be used as a tool supporting Research, Development & Deployment** (RD&D) activities. Industry, policymakers and consumer advocates could gain insight into: distributional impacts, energy affordability, optimal bundling of tariffs and technologies, and the design of innovative products services.
- The **impact of smart comparison tools will increase** as wider developments occur, including:
  - Growing consumers awareness that smart meters, smart tariffs, and flexibility-enabling technologies work best as a package (or 'technology cluster'), delivering greater benefits for householders, the grid and the environment together when combined;
  - Planned developments in policy and regulation including: the growing penetration of smart meters; the introduction of market-wide HHS, faster and more reliable switching;
  - Additional functionality in smarter comparison tools that support both consumer-facing use cases and use of the tool in RD&D.

Chapter 10 – Conclusions and recommendations

Key findings

Suppliers were very supportive and said that the STSC tool would help drive both the development of smart tariffs and the take up of smart meters.

> *"It takes something like this to make it happen, people cannot do it individually."*
> *(Source: Supplier interview)*

Consumers have a low awareness and understanding of smart tariffs, but when they are explained to them consumers can see the potential benefits smart tariffs offer and become more open to having a smart meter installed. Communication should present consumers with concrete propositions (e.g., "an EV and an EV-tariff could save you this much and is greener too") and offer solutions to their concerns (e.g., "I have night storage heaters, can a smart tariff reduce my heating bills?"). Rather than having conversations with consumers about smart meters, smart tariffs, EVs, and 'flexibility' as separate issues, concrete scenarios and personalised smarter comparisons should be able to communicate simply, and in meaningful terms, the benefits of combining these elements and help to normalise these technologies and services.

The STSC project has delivered a tool ready for adoption by a range of industry stakeholders to provide consumers with smarter comparisons. There is an excellent opportunity for tools like the STSC tool to unlock greater and more informed consumer adoption of smart tariffs, smart meters and low carbon technologies that enable flexibility and deliver benefits for households, the environment and grid management. Smarter comparison tools could play a role in supporting positive feedback loops to accelerate change in consumer engagement and the products and services offered by industry. The impact of the tools could be further increased by complementary policy and by adding further functionality to these tools.

In addition to consumer-facing services, the STSC tool also has the potential to be used to support Research, Development & Deployment (RD&D) activities in industry and policymaking: insights into how different consumers approach and engage with various technologies and services, y helping inform the design of products, services and policy.

Effective messaging: a challenge to be addressed

The challenge for suppliers, LCT providers and PCWS will be how to convey the key concepts and messaging about 'smart tariffs' when they communicate with consumers; there is a need to ensure that best practice is followed to eliminate potential areas of misunderstanding. Questions that easily arise from consumers when they do not understand the nature of the tariff they purchased need to be addressed as part of the tariff selection and decision process;

successful messaging will mean that consumers understand, before switching to a TOU tariff, what the impact could be of using appliances at peak times compared to off-peak times.

Suppliers, and the energy industry as a whole, will need to establish a common understanding among consumers of the relationship between smart meters and smart tariffs and their potential benefits:

- Smart meters permit consumers to access smart tariffs;
- Smart meters with smart tariffs give access to other smart products and services – e.g. smart charging of EVs, smart controls on appliances that optimise running costs with changes in electricity prices.

Recommendations

Further research

There are a number of opportunities for further consumer research in connection with smarter comparison tools, including:

- Assessing whether smart tariffs and smarter comparison tools encourage the take up of smart meters;
- Assessing whether offering monitoring of predicted energy costs reinforces trust and suitability of tariff and technology selection for consumers;
- Further exploration to identify groups of households who could benefit most from smart tariffs and storage and automation devices, or who may need support with technology adoption costs. This would be especially valuable for heat.

The STSC tool

This report has discussed several possibilities for stakeholders to add functionality to the tool, some of which could be informed by further consumer and or industry research:

- Develop a customer satisfaction scoring system for smart tariffs and bundles;
- Extend the model to include bundled offers;
- Explore how to assess and integrate comparisons not based purely on price, particularly for bundled services as described in Chapter 4;
- Structure a smart tariff comparison tool user journey to start with lifestyle scenarios or a specific consumer question. For example, asking users to choose what they would like to explore:
    - *"I just bought my first EV and am trying to work out how to find a supplier that suits my new energy supply needs"*
    - *"If I invest in a heat pump, what will my energy bills look like?"*

- Develop a variant of the tool for consumers who do not currently have smart meters, as a demonstration of what is open to them when they have them.
- Offer 'reverse auctions': consumers upload their actual consumption history and suppliers who find their tariff profiles align with the customer's consumption make offers to supply them for a year.
- Integrate community tariffs; encourage access to local community energy projects outputs.
- Offer ex-post assessments to check if energy costs match predictions/expectations and automated alerts if not.

See also Table 15, Chapter 9.

Industry

- This project identified that a significant amount of effort is currently invested by suppliers in tariff presentation for PCWs because tariff information is not uniformly structured across the market. Standardisation could reduce this effort, for example through a collaborative project with a complementary single repository of tariff data. The repository could be made available to all PCWs, the STSC tool, and innovators offering EV, heat pump, solar and other bundled solutions.
- Further explore how the benefits and exposure to potential risk from tariff fluctuation are shared between consumer and supplier/ for various smart tariff structures and its impact on the supplier offerings and consumer acceptance. Suppliers may take on more of the complexity and risk for consumers[171] – for example, suppliers being able to offer a simple, no-risk flat-rate tariff at lower rate by relying on dependable flexibility from smart storage devices.
- Tools like STSC rely on correct tariffs (standing charge and unit rate) being on the meter – current cost of consumption is a critical comparison factor for a consumer. Project experience has shown that tariffs are sometimes incorrectly loaded onto meters by suppliers, resulting in issues like requests failing Parse & Correlate or being off by a factor of 100).

Supporting research, development and policy design

The STSC model could also be used as a tool for RD&D within industry and by policymakers, regulators and other organisations.

- **Industry**: Energy suppliers and LCT manufacturers might use the STSC tool to inform the design of their products and services (e.g. tariffs, heat as-a-service, LCTs) using the

[171] Hardy, J., Sandys, L., & Green, R. (2018). Reshaping Regulation: Normalising the energy sector. Presented at BIEE Conference, Oxford Sept 2018

tool to gain insight into their affordability for households with different demand profiles. It could help identify, quantify and mitigate consumer risks for innovative products.[172]

- **Policymakers / regulators**: The model underpinning the tool could be extracted and used as part of other projects to generate data of interest to policy makers. For examples, it could be used to explore the impact of policy/regulation on the affordability of energy products and services for different consumers, and potentially inform the design of new policy.
- **Other stakeholders**: Organisations such as housing associations might find the tool helpful with their research and planning: e.g. if considering refurbishment of heating systems in their housing stock, the tool could provide insights into residents' energy bills for different technologies (e.g. smart heat pumps vs smart storage heaters).

[172] Energy Systems Catapult (2019) Smarter Consumer Protection Manual

This publication is available from: https://www.gov.uk/government/publications/smart-meter-enabled-tariffs-comparison-project-smarter-tariffs-smarter-comparisons

If you need a version of this document in a more accessible format, please email smartmetering@beis.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.