REPLICATE	Project no. 691735 REPLICATE PROJECT Renaissance of Places with Innovative Citizenship And Technology	This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 691735

REPLICATE PROJECT

REnaissance of PLaces with Innovative Citizenship And Technology

Project no. 691735

H2020-SCC-2015 Smart Cities and Communities

Innovation Action (IA)

D5.1 Retrofitting in the neighbourhood partnership area of Ashley, Easton and Lawrence Hill

Due date of deliverable: 31/10/2019

Actual submission date: 07/11/2019

Start date of project: 01/02/2016 Duration: 60 months

Organisation name of lead contractor for this deliverable: Bristol City

Status (*Draft/Proposal/Accepted/Submitted*): Submitted

Project co-funded by the European Commission within the 7th Framework Programme		
Dissemination Level		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

Editor/Lead beneficiary :	Bristol City
Internall reviewed by :	Giroa

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1. EXECUTIVE SUMMARY

The document below describes the work that has been done towards the delivery in the Bristol Pilot of the retrofitting implementation in the residential Homes in the neighbourhood partnership área of Ashley, Easton and Lawrence Hill', including the technical aspects of the installed equipment; procurement of contractors to install the works; the recruitment approach within the project areas communities; the marketing approach and techniques; the funding offer to the customer and how funding has been calculated.

The project has created and developed strong links with community energy groups to great effect which helped raise awareness of the project offer within a diverse community and to help include disadvantaged/vulnerable residents who may usually be unaware of this type of project.

The results and methodology of this project will be of interest to those wishing to retrofit traditional buildings with modern energy efficiency measures and renewable technologies like Solar Photo-voltaic Systems to owner occupiers and the private rented sector (PRS) with funding available. It also reflects the successes of working with a strong project team and community organisations can increase the amount of participants involved in the project, and work collectively to reduce barriers residents of the communities may face with a project like this.

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2. REPLICATE

The main objective of REPLICATE project is the development and validation in three lighthouse cities (**San Sebastián** – Spain, **Florence** – Italy and **Bristol** – UK) of a comprehensive and sustainable City Business Model to enhance the transition process to a smart city in the areas of the energy efficiency, sustainable mobility and ICT/Infrastructure. This will accelerate the deployment of innovative technologies, organizational and economic solutions to significantly increase resource and energy efficiency improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas.

REPLICATE project aims to increase the quality of life for citizens across Europe by demonstrating the impact of innovative technologies used to co-create smart city services with citizens, and prove the optimal process for replicating successes within cities and across cities.

The Business Models that are being tested through large scale demonstrators at the three cities are approached with an integrated planning through a co-productive vision, involving citizens and cities' stakeholders, providing integrated viable solutions to existing challenges in urban areas and to procure sustainable services. Sustainability of the solutions is fostered in three areas: economic and environmental and finally, fostering transparency in the public management.

In addition, the Model features the replicability of the solutions and their scale up in the entire city and in follower cities, particularly in three follower cities (**Essen** – Germany, **Laussane** – Switzerland and **Nilüfer**–Turkey) that are involved in the project and therefore, have access to know-how and results achieved on the project so they can apply the developed model. At the moment, there are 2 observer cities, Guanzhou (China) and Bogota (Colombia).

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3. INTRODUCTION

3.1 Relation to other project documents

This document describes the 'retrofitting intervention in the Neighbourhood Partnership area of Ashley, Easton and Lawrence Hill' action.

The aim of this implementation is to improve the energy efficiency of homes in the project areas by installing new energy efficient boilers, Loft Insulation, Solar PV systems and LED lighting; to reduce fuel costs and fuel poverty within the City of Bristol while also reducing carbon emissions. The project also includes installing new energy reducing technologies like Smart White Goods (Washing Machines, Tumble Dryers and Integrated Dishwashers) to further reduce energy costs and consumption. The table below describes the relation of this document to other documents. (Annex 1)

3.2 Reference documents

This document is based in the following projects level documents:

Ref.	Title	Description
REPLICATE Grant Agreement signed 240713.pdf	Grant Agreement	Grant Agreement no. 691735
DoA REPLICATE (691735)	REPLICATE Annex 1 – DoA to the GA	Description of the Action
REPLICATE Consortium agreement signed December 2015 (7th December version)	Consortium Agreement	REPLICATE project – Consortium Agreement
REPLICATE Project Management Plan	D1.1 Project Management Plan (v.1) (29/04/2016)	REPLICATE Project Management Plan
REPLICATE District Management Plans	D1.4 District Management Plan San Sebastian D1.5 District Management Plan Florence	REPLICATE District Management Plans

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	D1.6 District Management Plan Bristol	
REPLICATE Communication Plan	D11.1 Communication Plan	REPLICATE Communication Plan

Where there are contradictions, the documents listed above supersede this deliverable. The Grant Agreement is the contract with the European Commission so takes precedence over all other documents.

3.3 Abbrevations list

GA	Grant Agreement
BCC	Bristol City Council
CA	Consortium Agreement
DoA	Annex I-Description of the Action
EC	European Commission
H2020	Horizon 2020
PC	Project Coordinator
PL	Pilot Leader
PMP	Project Management Plan
TC	Technical Coordinator
WP	Work Package
WPL	Work Package Leader

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4. DELIVERABLE DESCRIPTION

This deliverable describes the approach we have taken to deliver energy efficiency measures to traditional buildings as part of the Bristol Pilot.

Section 5 sets out the project summary and delivery method and customer journey processes used, and the technical specifications of the measures installed.

Section 6 describes the recruitment approach by Bristol Energy Network, Energy Champion volunteer case studies and the benefits of working this way

Section 7 covers the procurement of contractors

Section 8 describes the marketing approach and tools used throughout the delivery of the project

Section 9 describes the lessons learnt throughout the project

Section 10 describes the issues occurred during delivery and lessons learnt

Section 11 covers innovations, impacts and scalability

Conclusions can be found in **section 12**

Section 13 Appendices

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5. Delivery

The delivery of the retrofitting implementation in residential homes retrofitted in the Neighbourhood Partnership area of Ashley, Easton and Lawrence Hill.' ran from November 2018 until October 2019 and was managed by Bristol City Council's Energy Service Operational Delivery Team.

Domestic energy efficiency measures have previously been delivered in Bristol through Warm Up Bristol (Energy Service Operational Delivery Team). In previous years, Warm Up Bristol (WuB) delivered External Wall Insulation, Loft insulation, Cavity Wall Insulation, Boiler Upgrades and other energy saving measures during the UK Government's Green Deal Scheme which gave financial incentives to help with the cost of installation.

This experience of delivering energy saving measures meant the retrofit project built upon and improved existing processes to maximise the funding available to residents of the partnership area.

The customer journey for the delivery of energy saving measures for REPLICATE was created from the aforementioned existing processes and lessons learnt during the smart appliance delivery.

To help prioritise harder to reach, underrepresented groups within the partnership area, Warm Up Bristol worked closely with the Bristol Energy Network, a key community group who created and developed 'Energy Champions' to engage the community and be on hand to help at all points of the customer journey. The 'Energy Champions' were volunteers recruited by Bristol Energy Network to help promote the project at community events as well as door-to-door promotion within the partnership area.

This was effective in engaging the community in the project and made it easier for people to be involved with an energy saving measure installation.

5.1 Project Summary

The Bristol Pilot has built on existing processes to deliver energy efficiency measures to the domestic properties in the Partnership Area. Co- funded by REPLICATE project committed to eligible homes for loft insulation, boiler upgrades and solar PV. Warm Up Bristol was able to provide 160 energy saving measures to 151 homes equating to **14,766 m2.**

In order to target the eligible homes for the delivery of the different measures a questionnaire was prepared. The project received 770 completed 'eligibility questionnaire' entries and sent out 412 Quotations (including reQuotations) to eligible homes in the area. The breakdown by measure can be seen below:

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Stage	New Boilers	Loft Insulation	Solar PV
Enquired (elibility questionnaire)	229	237	285
In Home Technical Survey	142	196	(Desktop Survey) 122
Quotation	126	115	161 (including reQuotations)
Accepted	65	65	36
Installed	65	65	30

In total, the Retrofit project achieved 160 energy measures in 151 homes in the partnership area which is estimated to save **69,015 co2/kg/yr** and equates to **2,929 kWh/m2/yr**.

- Loft Insulation – 65 installed
- Boilers – 65 Installed
- Solar PV Systems – 30 installed

Table key
Enquired: number of people who completed the elibility questionnaire
In-Home Technical Survey: on eligibility, a home survey was conducted
Quotation: if homes were still eligible following the technical survey, a quote was issued for works. As homes were required to contribute to works, quotes were not always accepted
Accepted: number of homes that accepted the quote
Installed: number of homes that had accepted the quote, booked their installation date and paid a deposit

Annex 1: Smart Homes

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6. Recruitment Delivery

6.1 Customer Journey

Funding for the project had some criteria which homes were required meet to be eligible. The first step of the customer journey was to complete the 'Eligibility Questionnaire' which enabled the project team to have a clear and fair way of identifying possible participants to the project. Created as an online questionnaire on the website Smartsurvey.com, residents could complete this at a suitable time for them and the results would be sent to the project team once completed. A hard copy of the questionnaire was available to residents without internet access as well as being used for referrals at community events.

To be eligible for the project, homes were required to:

- Have been in the property for at least 12 months and be able to provide energy bills from this time
- Live in the property until the end of the project (January 2021)
- Live in an eligible postcode
- Require an eligible energy saving measure

While the above was the key information to determine whether a household was eligible or not, the remaining questions on the questionnaire were important to help understand the property's current energy efficiency when calculating how much funding could be applied to their quotation.

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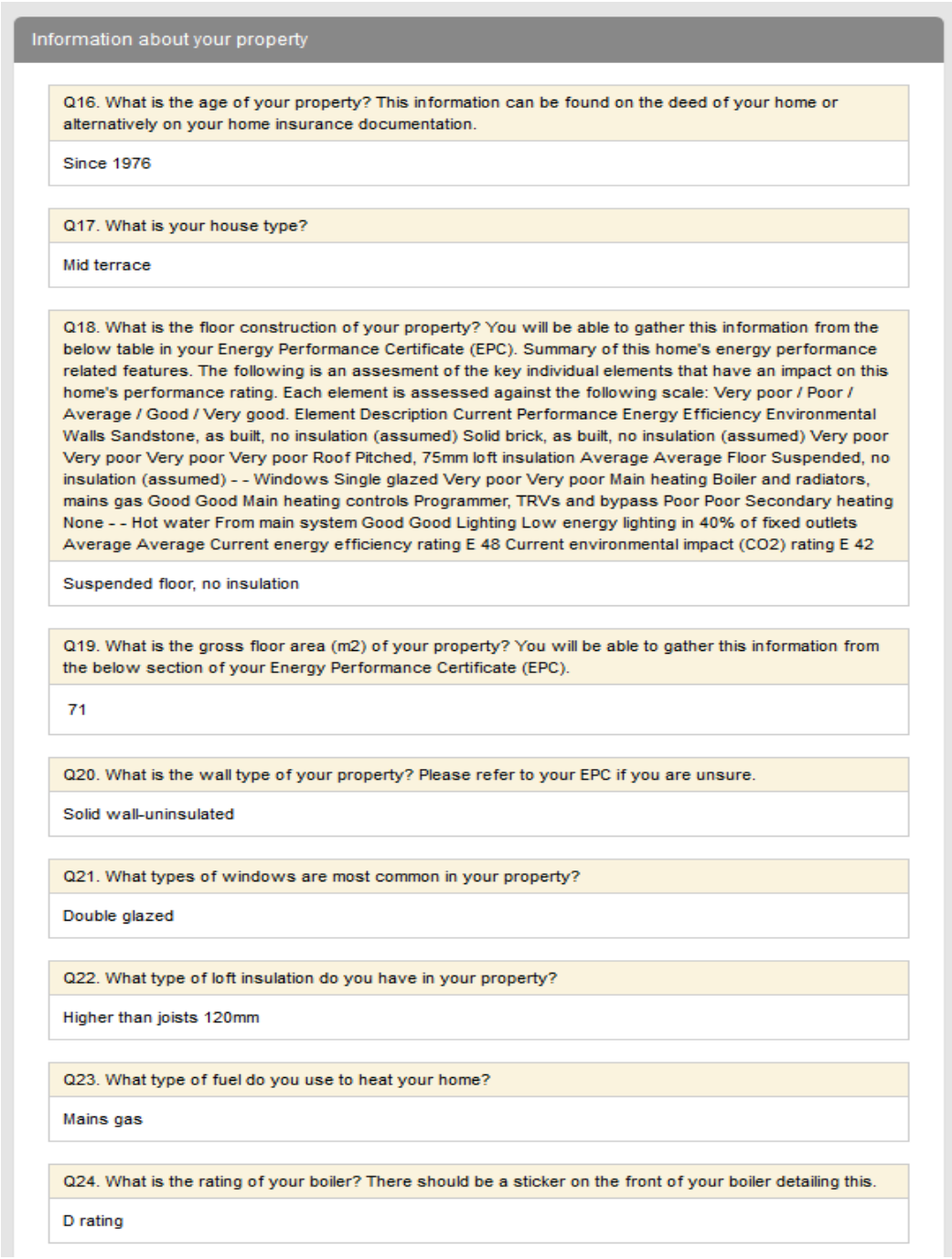

Information about your property

Q16. What is the age of your property? This information can be found on the deed of your home or alternatively on your home insurance documentation.

Since 1976

Q17. What is your house type?

Mid terrace

Q18. What is the floor construction of your property? You will be able to gather this information from the below table in your Energy Performance Certificate (EPC). Summary of this home's energy performance related features. The following is an assesment of the key individual elements that have an impact on this home's performance rating. Each element is assessed against the following scale: Very poor / Poor / Average / Good / Very good. Element Description Current Performance Energy Efficiency Environmental Walls Sandstone, as built, no insulation (assumed) Solid brick, as built, no insulation (assumed) Very poor Very poor Very poor Very poor Roof Pitched, 75mm loft insulation Average Average Floor Suspended, no insulation (assumed) - - Windows Single glazed Very poor Very poor Main heating Boiler and radiators, mains gas Good Good Main heating controls Programmer, TRVs and bypass Poor Poor Secondary heating None - - Hot water From main system Good Good Lighting Low energy lighting in 40% of fixed outlets Average Average Current energy efficiency rating E 48 Current environmental impact (CO2) rating E 42

Suspended floor, no insulation

Q19. What is the gross floor area (m2) of your property? You will be able to gather this information from the below section of your Energy Performance Certificate (EPC).

71

Q20. What is the wall type of your property? Please refer to your EPC if you are unsure.

Solid wall-uninsulated

Q21. What types of windows are most common in your property?

Double glazed

Q22. What type of loft insulation do you have in your property?

Higher than joists 120mm

Q23. What type of fuel do you use to heat your home?

Mains gas

Q24. What is the rating of your boiler? There should be a sticker on the front of your boiler detailing this.

D rating

Fig 2. Image of the online 'eligiblity questionnaire' completed by the customer. This images shows the section on house information.

Figure 2 (above) outlines the questions asked on the 'eligibility questionnaire' to understand the properties existing energy efficiency and which retrofit measure(s) would be most suitable. This

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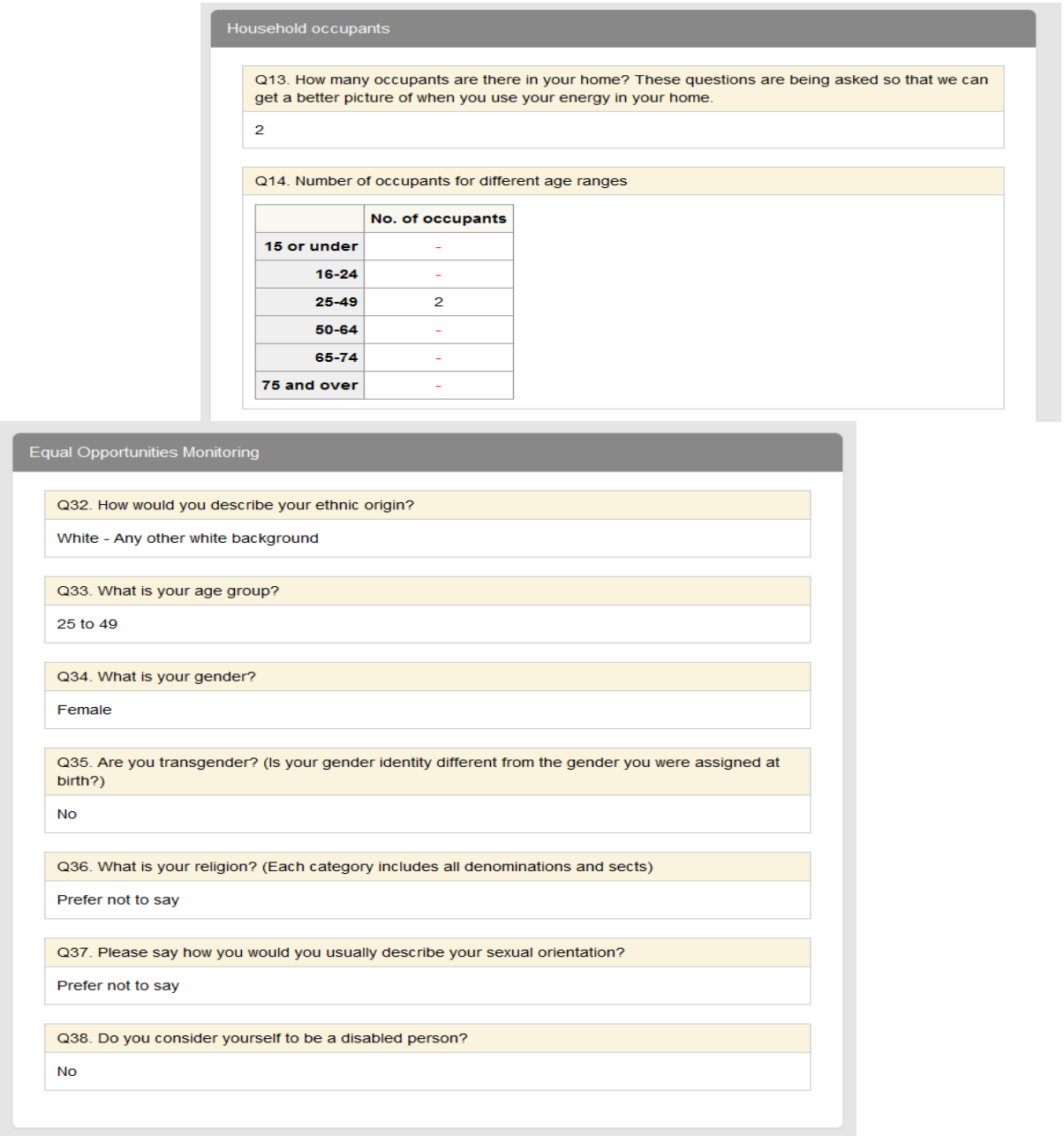
information was then entered into the funding calculator to generate a funding figure to be applied to the quotation.

The questionnaire also asks for the number of occupants in the household and demographic information of the participant. (See Fig 3. below)



Household occupants

Q13. How many occupants are there in your home? These questions are being asked so that we can get a better picture of when you use your energy in your home.

2

Q14. Number of occupants for different age ranges

	No. of occupants
15 or under	-
16-24	-
25-49	2
50-64	-
65-74	-
75 and over	-

Equal Opportunities Monitoring

Q32. How would you describe your ethnic origin?

White - Any other white background

Q33. What is your age group?

25 to 49

Q34. What is your gender?

Female

Q35. Are you transgender? (Is your gender identity different from the gender you were assigned at birth?)

No

Q36. What is your religion? (Each category includes all denominations and sects)

Prefer not to say

Q37. Please say how you would you usually describe your sexual orientation?

Prefer not to say

Q38. Do you consider yourself to be a disabled person?

No

Fig 3. Occupants and demographic information

Annex 1: Smart Homes

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The demographic information (Fig 3) was critical for the project team to understand the types of people who were participating which shaped our marketing approach to those communities which were harder to reach.

Using the questionnaire as the first step in the customer journey was an efficient way for the project team to keep on top of all new enquiries and work on a first-come-first-served basis for interested homes.

Letter Drop

To generate awareness of the project and the funding available for energy saving measures within the partnership area, the decision was made to directly contact all homes with a letter drop in November 2018. The first letter was sent to the Ashley area on 16th November and the residents of the two remaining areas, Easton and Lawrence Hill, received the same letter two weeks later.

This was chosen as the best way to reach as many people as possible in the shortest time period to understand the levels of interest. This method of directly contacting homes proved to be very effective with roughly 75% of all completed questionnaire entries stating they heard about the project due to 'letter from the council'.

Sending the letters out before Christmas gave the project team the opportunity to test internal processes with a small number of homes and help identify any areas which needed improving to make the process as smooth as possible for participants. This was a useful approach as initially the project team was completing the funding calculator with customers during a call however, this was time consuming for the project team and the customer. The decision was taken to direct all new enquiries to the online questionnaire for the customer to complete in their own time. This meant the project team was able to focus on contacting all the completed questionnaire entries and working through the high volume of interest much quicker.

At the time of sending the letters to homes, the project was not in a position to proceed with the Solar PV offer as a contractor was still being procured. Rather than exclude this from the letter a waiting list was created of everyone who had shown an interest in receiving a Solar PV quotation with the view to proceed with a desktop survey once available.

Throughout the project, regular analysis of the number of participants within the three areas showed a lower number of homes accepting energy saving measures from Ashley and Lawrence Hill wards. As the first letter drop to all three wards proved to be an effective method of generating interest, a second letter promoting the retrofitting project and funding was sent to these two wards only. This was intended to improve the amount of participants in the project overall but more specifically Ashley and Lawrence Hill.

Annex 1: Smart Homes

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6.2 Technical Survey

After understanding the energy needs of the customer and their home, a technical survey of the requested measure/s was required at the customers home. The technical survey was a home visit by our contractor to assess the viability of works and provide the project team with an accurate quote (rate card).

During the technical survey, the contractors were required to gather the following information:

Loft insulation

- Multiple photos of property and loft areas
- Photos of any existing insulation and depth
- Deemed Score Survey
- Data Sharing agreement
- Loft Survey
- Risk assessment
- Privacy Notice
- Rate card

Boiler

- Photos of existing radiators
- Photos of existing Boiler
- Photos of Boiler Flue
- Photo of existing Boiler power supply
- OFGEM approved boiler checklist form (E-Serve)
- Boiler deemed score survey
- Rate card

The technical survey information is essential to understand the current efficiency of the existing measures and ensure accurate information was inputted into the funding calculator. Also, the pre-install photos of the work areas were required as this would highlight any existing issues that would need to be taken into consideration when doing the work.

Solar Photo-Voltaic (PV)

The technical survey process for Solar PV systems differed slightly to the above as, firstly, a computer 'desktop survey' was undertaken by our contractor to see if the property was viable for

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a PV System. Viability of the system was dependent on roof orientation (due south 180 degrees will produce the best results); roof area – whether a full PV System could have fitted on the roof of the property; none or minimal shading issues.

If a property was deemed viable from the initial desktop survey a bespoke report of the system was created using the industry standard software PV SOL. This was used to align the PV system on a model of their home and provided technical information and expected results. A copy of a PV Sol report used for the Lawrence Hill Bus Depot community PV work and can be found in Annex 2.

As well as the PV Sol report the contractor also provided a rate card (cost of works) for the designed system which the project team turned into an accurate estimated quotation for the customer.

If a customer accepted the estimated quotation, a physical technical survey of their home was undertaken to confirm the property could proceed to install. The contractors provided the project team with a full technical survey report of the property – see Annex 3.

6.3 Quotations

The quotation letter for the Retrofit project was developed from the existing 'Warm Up Bristol' quotation form as this was used for previous domestic energy efficiency project. The terms and conditions were updated to reflect the REPLICATE project requirements of the research phase.

The quotations are produced using a variety of information sources. This includes the questionnaire, the technical survey checklists, Energy Performance Certificates (house m2) which are inputted into the Best table funding calculator to generate an estimated carbon saving and the funding amount the customer is eligible for.

6.4 Funding

Funding towards the cost of installing the required energy saving measure was available to eligible homes. The funding offered differed per property to reflect the estimated kWh/m2 savings expected after installation. To calculate this, the project team used the BEST Table funding calculator which asked questions about the current house make-up – levels of insulation, type of windows etc – which generated an existing efficiency and energy consumption needs. After choosing which measure the customer would be installing, the calculator generated an expected saving in kWh/m2 and provided a funding figure to reflect this. This figure was then applied to the cost of works for the customer.

During the planning of the project the funding was expected to be in the region of:

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- Loft (and initially Cavity Wall) Insulation – up to 90%
- Boiler upgrade – up to 25%
- Solar PV Systems – up to 25%

Once the project started delivering, the funding provided to customers was higher than expected, especially for boiler upgrades and solar PV systems.

During the planning stages, the project team expected most existing boiler efficiencies to be around 80% which would have provided roughly 25% funding towards the installation cost. In reality, the existing efficiencies of boilers ranged from 66% – 84%. This meant much more funding committed to those homes with old inefficient boilers with funding up to 90% in some instances.

The funding for Loft and Cavity Wall Insulation was similar to the expected levels during the planning stages. The majority of homes with 100mm or lower of existing loft insulation received a fully funded quotation, whereas those homes with around 200mm existing usually required a small contribution from the participant. Originally, the project was to offer Cavity Wall Insulation alongside the other measures, however, during the pause of the project, the decision was made to exclude this measure as it was not a viable option for the expected house type of pre-war mid-terrace.

The solar offer was available to residents of the partnership areas from May 2019. As there was a high volume of interest in solar PV from the initial letter in November, our contractor was able to start the 'desktop surveys' of the homes on the waiting list. Once received and quotations were being raised, the project team found that the funding offered was higher than expected during the early planning stages. The majority of homes received between 40-60% of funding towards the installation costs and in some cases this was higher. Funding levels for solar PV installations were affected by the orientation of the roof, the peak size of the system (more panels and a bigger sized system would produce more carbon savings), shading issues and output size of the solar modules.

6.5 Bill data

Gathering energy consumption information as evidence was important for the research of the expected savings. As energy meters are not readily available throughout the UK, the chosen method was to collect monthly energy bills for the previous 1-2 years from properties. This made clear the amount of energy consumed annually pre-intervention. In general, this was suitable for most homes participating and data was received in the correct format. However, this was a barrier for residents interested in installing energy efficiency measures who had lived in their property for less than 12 months as they were not eligible for funding. On some occasions residents waited

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a couple of months until they had been in their home for a year so they could take part and supply the necessary information before proceeding on the customer journey.

Billing data has been transferred to the University of the West of England who will conduct interviews and request post-installation bill information until January 2021 to compare the estimated savings to the real bill savings and the Best tables.

6.6 Installation and Handover

After accepting a REPLICATE quotation the project team raised an invoice for 50% of the customer contribution as a deposit for the installation, which was required to be paid before the installation date was arranged. This was clearly stated in the terms and conditions of the project and is standard building practise in the UK.

Once the deposit payment was confirmed internally, the project team instructed the relevant contractor to contact and arrange a suitable installation date with the customer directly. Regular communication between contractors and the project manager enabled all parties to have a clear understanding of the upcoming installations as well as the opportunity to discuss any expected issues.

Photo evidence of the installation was required for all energy saving measures and these were provided to the project team with the handover documents. It was important for our contractors to document the installation as these photos can be referred to if any issues develop in the future since the energy saving measure was installed.

After the contractor confirmed the installation as complete, the project team contacted the customer to confirm they were happy with the work. Once confirmed by the customer, a final invoice was sent with any outstanding costs to be paid. Upon paying the invoice, the customer received:

- An LED Lighting voucher
- Warranties (product and workmanship)
- Gas safe certification (Boiler installation)
- Electrical Certificate (Boiler installation)
- Microgeneration Certification Scheme (MCS) certificate (Solar PV)
- Photos of installed measure
- Conformity of Install Complete Form

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6.7 Bristol Energy Network

Bristol Energy Network (BEN) is a network of community organisations established to develop grassroots energy projects across the city. It is recognised as a leading organisation in community energy in the UK. BEN has extensive experience in developing community-led projects and engaging a broad range of local people in community energy. The network provides a unique role in supporting community groups across the city and has helped build capacity for energy understanding in organisations. BEN has a strong track record of engagement and delivery.

BEN worked with the REPLICATE project team to help shape the bid for funding and advocated to engage harder-to-reach groups in the Ashley, Easton and Lawrence Hill wards of the city. Having had extensive experience of working in these areas previously, the network was a trusted organisation through established links with community groups. This approach, adopted for the first Smart Homes stage of the REPLICATE project won an award for Citizen Engagement at the Smart Cities UK conference in 2019.

BEN's role in REPLICATE was to engage the local community in the REPLICATE offer, particularly those harder-to-reach groups (including Black and Minority Ethnic (BAME) and older people) and establish a network of Energy Champions as individuals and organisations to let people know about the project and also engage them in wider discussions about energy use and climate change.

6.8 Recruitment and Energy Champions

Community Engagement group meetings

The meetings started in January 2018 during stage1 of the REPLICATE energy programme to engage community partners to discuss engagement approaches and get the support of these organisations throughout the project. Key partners were:

- Up Our Street who put up posters in all their noticeboards in the Easton and Lawrence Hill areas; published information about REPLICATE throughout the duration of the project in their monthly e-bulletin and hosted one of the legacy workshops
- Bristol Black Carers who provided influential early adopters and were key advocates of the programme as Energy Champions
- Dhek Bhal (supporting the South Asian Community) who allowed us to access a variety of BME older people's groups in the area and helped developed the Energy MOTS (check ups)
- The APE project (a children's play, recreation and activity provider) who hosted solar panel workshops and developed a bike and solar powered float for St Pauls Carnival

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extending the reach of the programme to young people and playful activity.

- Bristol Community fm radio (BCfm) who hosted REPLICATE on the popular Breakfast Show to discuss the offer and to debate energy saving in the home and at work

At this stage in the Project, it had been expected that both the Smart Homes and the Retrofit projects would be deliverd together and that citizens would be offered both at the same time.

6.9 General engagement

BEN also engaged a wider audience of people in the REPLICATE retrofit project through:

- Social media, with total reach on Facebook of 871 and 72 engagements (Likes and Shares) and 41 re-Tweets, 61 Likes and 4 Comments
- Radio presentations on Ujima and the One Love Breakfast Show with an estimated audience reach of 10,000 people each across Bristol
- The BEN website which had over 3000 viewers over the project duration and 99 of these sessions involved people looking at articles about REPLICATE
- BEN presentations and talks at our quarterly Open Meetings (2) for members, individuals and groups interested in community energy, a Spotlight on Solar meeting for members in May 2019

6.10 Energy Champions

Energy Champions were selected in order to engage with different communities. The Champions are representative of the communities that they come from, can communicate in some of the community languages of the area and are passionate about saving energy and helping local people.

"I was excited to help with the retrofit challenge……it was really inspiring to be part of this team" Laura, Energy Champion

Building on the successful series of meetings and training sessions held with the Energy Champions in stage 1 of the project, a team of 10 regular Champions helped to organise and support BEN at over 37 events, giving out 400 flyers and referring 59 people for retrofit measures. Of the 622 people engaged, 41.5% came from black and minority ethnic (BAME) backgrounds and 27% older people which exceeds the target of 17% and 16% respectively, based on the 2019 Statistical Ward Profiles.

By working with Champions, the project was able to reach a much wider, more diverse group of residents. Many of the Champions are part of or have strong links with community organisations

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such as Dhek Bhal and Bristol Black Carers and have benefitted from the Smart Homes phase of the project.

The Champions attended 7 training sessions over the course of the retrofit stage of the project, starting from the basics of REPLICATE and including solar panel workshops and how to engage people in discussions about energy and climate change. As part of these sessions, Champions helped to co-design the engagement programme, agreeing what events and activities to engage in and developing resources, like the EnergyMOT and the EnergyPledge. The Energy Champions were also offered the living wage for attending certain events and a £15 "Thank You" for every referral they signed up that proceeds to take up a retrofit measure.

6.11 Case Studies

Below are two experiences showcased to better describe the figures and the importance of the recruitment process.

Energy Champion- Grand Iftar celebration

Following the first Energy Champions training session, Raj, one of the Champions organised a meeting between BEN and Cllr Abdul Malik who was one of the organisers of the Grand Iftar. The Grand Iftar is a celebration of unity in the community organised by Muslims for Bristol including the leaders of Jamia Masjid mosque in Easton and Muslim businesses. Over 3,000 people attend this event where residents are invited to share food with the Muslim community as they break their fast during Ramadan. The Councillor had worked with BEN before and on seeing the mobile Future Home (see Annex 1), readily agreed for the Champions to attend and allocated a prime location adjacent to the mosque. Five Energy Champions attended and engaged 65 people, giving out around 50 flyers. They booked 3 people onto the solar panel workshop and referred 12 people to the project. A fantastic start!

Energy Champion - Mark Peti

Mark is Hungarian, currently living in Bristol and studying part-time for a degree in Environmental Management and Technology with the Open University. He joined the Energy Champions at the start of the retrofit programme in May. This was after seeing the information about it on the BEN website and wanted to get more practical experience of working in the environmental sector and particularly the energy sector. Mark has enthusiastically engaged with the programme, making positive contributions to the training and co-design sessions and providing invaluable support at the events. Especially the doorknocking element, generating a total of 15 referrals for retrofit measures. Mark has been inspired by being an Energy Champion to attend our BEN Open Meetings. He has recently been elected as the Coordinator of the Greater Fishponds Energy Group with aspirations to develop a community-led urban solar farm with other local residents.

Annex 1: Smart Homes

This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 691735

Definitely a Champion with energy!

6.12 Strengths

The embedding of this project in the local community through the early engagement of community groups and organisations gave the programme traction within the local area. This was demonstrated with the high take up of the offer from residents in Easton, reflecting Up Our Street's good understanding of the offer and consistent promotion. This contrasts to parts of Ashley where take-up could be expected to be equivalent to Easton, but wasn't. It reflected the lack of a trusted local organisation that could regularly and consistently publicise the programme.

Those organisations who had members that had benefitted from previous Bristol City Council or REPLICATE initiatives were great Champions for the project and helped facilitate access to hard-to-reach groups. This peer-to-peer approach also worked well with the Champions group as residents were more likely to trust those from their community, especially with the negative experience that many people have had with solar panel sales.

Energy Champions benefitted from training, as many came without any prior knowledge of energy sustainability or renewables. They enjoyed being able to help shape the programme so that it was sufficiently varied and flexible to suit everyone. They also reported that they enjoyed getting together and working as a team with shared values of environment, saving money and helping others.

Most of the team have said that they would like to continue as Energy Champions and BEN will continue to support and develop them to deliver other projects in the area. BEN will also adapt and use the resources that the Champions helped develop including the Energy Champions packs, the training sessions, the planning and monitoring spreadsheets and using the methodology to expand the Energy Champions programme to other areas of the city.

The St Werburgh's Spring Fair, Grand Iftar and school pick-up were very productive events for engagement with the right demographic (ie homeowners able to invest in measures) that could benefit from the project.

The mobile Future Home, designed in stage 1 of REPLICATE was a very useful tool to draw people into conversations and showcase the project.

The Living Wage contributions and £15 "Thank Yous" were a great incentive for recruiting and maintaining the involvement of Energy Champions. Most of them would not have been able to participate without this financial incentive.

Regular meetings between BEN and Bristol City Council led to good relationships being developed, ensuring problems were resolved quickly and opportunities seized for example the co-design and delivery of the Smart Homes Celebration meal, supported by the Energy Champions.

Annex 1: Smart Homes

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Much of what we have learnt during this project has been incorporated into the "Good Practice toolkit of partnerships between policy and community" – a document BEN have created with contributions from Bristol City Council's Energy Service and will be launched later this year.

6.13 Lessons Learnt

Feedback from the Champions asked for more structured training with more detailed information to take away to reinforce the learning and that they would like training to be given by those delivering the product, in this case the installers. They felt this would enhance their understanding and enable them to answer questions rather than having to refer them on to someone else.

Some of the events attended were not as useful as others, for example the St Judes and Dings Summer Fair – possibly due to the weather conditions, but also because they were in areas with low home ownership.

The mobile Future Home was difficult to move around due to its weight and had some minor lighting problems that proved difficult to get fixed. BEN is working with MuftiGames to make it more accessible and usable so that we can take it to future events.

The management of the payments to Energy Champions was not straight forward, as individuals had to be legally employed by Bristol Energy Network in order to pay them anything beyond expenses, this is time-consuming and not accessible to those on benefits.

Ideally the project would have run alongside SmartHomes project because an offer of a free appliance is easier to engage people with and deliver, but timescales didn't allow for this.

This Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 691735

7. Technical Delivery

7.1 Technical Information

This section of the report will include detail about the product specifications that have been installed.

Solar PV

There was a range of three different modules of solar PV which were of different output size. These were known as standard, superior and premium which gave the participant the opportunity of having less modules for the same output.

Standard Solar Module

The standard solar module is the lowest output producer and was offered as the most cost effective system to the customer and was the first system scoped using PV Sol Software. This was the most popular module installed in the project.

The modules used were **JAP60S01-275/SC** which are manufactured by JA Solar Holdings – see data sheet below for specifications Fig 4-6 below.

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SPECIFICATIONS

Cell	Poly 156.75×156.75mm
Weight	18.2kg±3%
Dimensions	1650×991×35mm
Cable Cross Section Size	4mm²
No. of Cells	60 (6×10)
Junction Box	IP67, 3 diodes
Connector	MC4 Compatible
Packaging Configuration	30 Per Pallet

OPERATING CONDITIONS

Maximum System Voltage	1000V DC (IEC)
Operating Temperature	-40℃~+85℃
Maximum Series Fuse	20A
Maximum Static Load, Front Maximum Static Load, Back	5400Pa 2400Pa
NOCT	45±2℃
Application Class	Class A

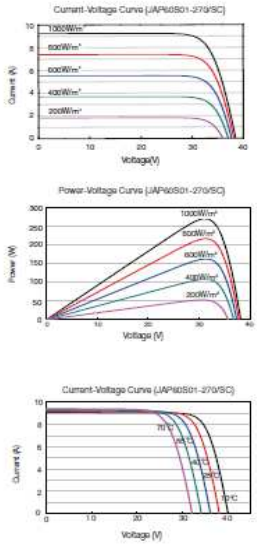
ELECTRICAL PARAMETERS AT STC

TYPE	JAP60S01 -260/SC	JAP60S01 -265/SC	JAP60S01 -270/SC	JAP60S01 -275/SC	JAP60S01 -280/SC
Rated Maximum Power (Pmax) [W]	260	265	270	275	280
Open Circuit Voltage (Voc) [V]	37.74	37.95	38.17	38.38	38.65
Maximum Power Voltage (Vmp) [V]	30.71	30.92	31.13	31.34	31.61
Short Circuit Current (Isc) [A]	9.04	9.11	9.18	9.29	9.37
Maximum Power Current (Imp) [A]	8.47	8.57	8.67	8.77	8.86
Module Efficiency [%]	15.90	16.21	16.51	16.82	17.12
Power Tolerance	-0~+5W				
Temperature Coefficient of Isc (α_Isc)	+0.058%/℃				
Temperature Coefficient of Voc (β_Voc)	-0.330%/℃				
Temperature Coefficient of Pmax (γ_Pmp)	-0.410%/℃				
STC	Irradiance 1000W/m², cell temperature 25℃, AM 1.5G				

ELECTRICAL PARAMETERS AT NOCT

TYPE	JAP60S01 -260/SC	JAP60S01 -265/SC	JAP60S01 -270/SC	JAP60S01 -275/SC	JAP60S01 -280/SC
Rated Max Power (Pmax) [W]	192	196	200	204	207
Open Circuit Voltage (Voc) [V]	35.70	35.94	36.25	36.56	36.85
Max Power Voltage (Vmp) [V]	28.87	29.09	29.29	29.48	29.69
Short Circuit Current (Isc) [A]	7.20	7.23	7.27	7.33	7.40
Max Power Current (Imp) [A]	6.66	6.74	6.82	6.90	6.98
NOCT	Irradiance 800W/m², ambient temperature 20℃, wind speed 1m/s, AM 1.5G				

CHARACTERISTICS



Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

Global_EN_20170905A

Fig 4. Data Specification sheet for the 'standard' solar module JAP60S01-275/SC

Superior

The superior PV Module produced an output of 325 watts and are produced by JA Solar Holdings. The specific module available was **JAM60S03-325/PR**. See Fig. 5 below

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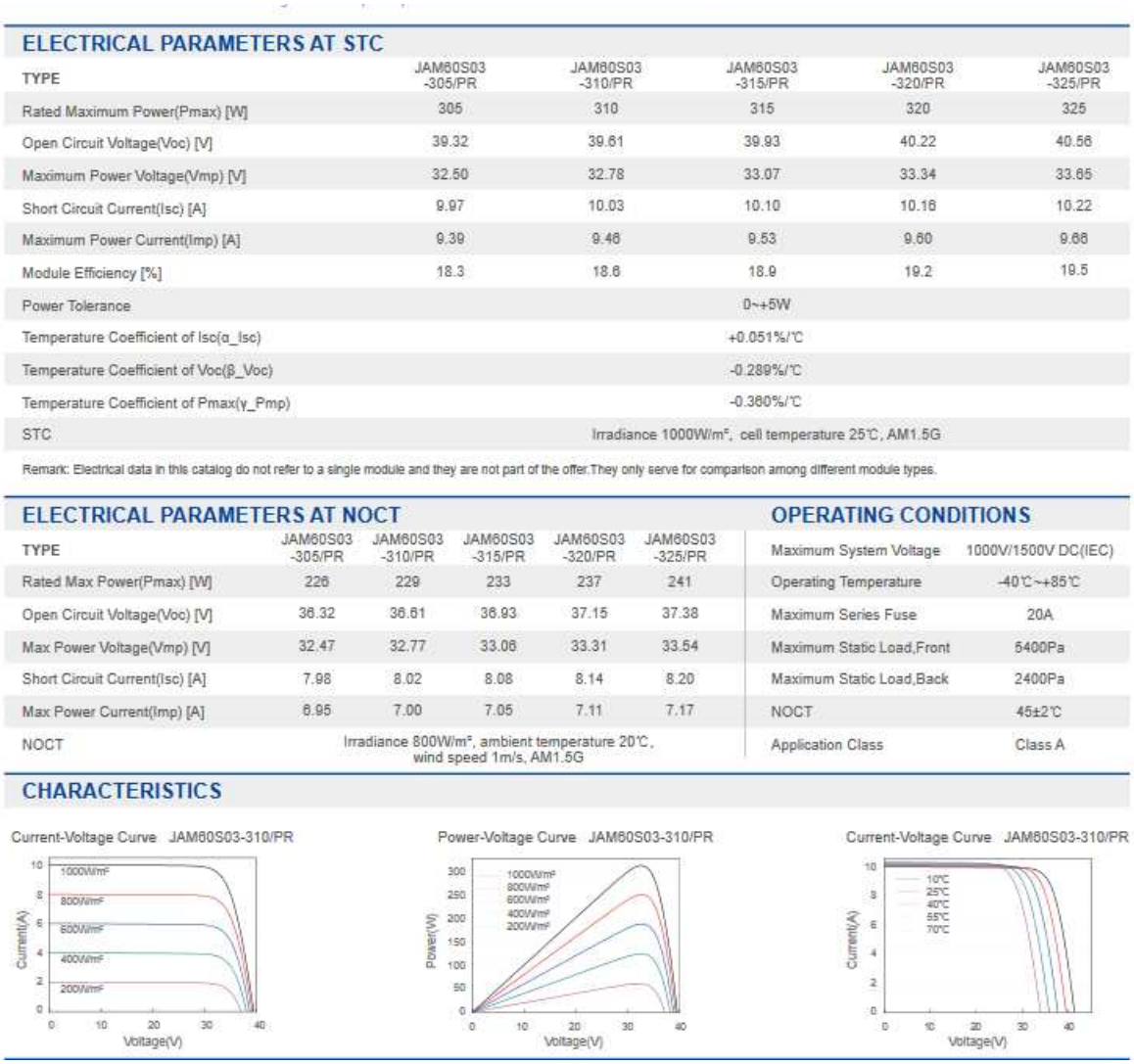

ELECTRICAL PARAMETERS AT STC

TYPE	JAM60S03 -305/PR	JAM60S03 -310/PR	JAM60S03 -315/PR	JAM60S03 -320/PR	JAM60S03 -325/PR
Rated Maximum Power(Pmax) [W]	305	310	315	320	325
Open Circuit Voltage(Voc) [V]	39.32	39.61	39.93	40.22	40.56
Maximum Power Voltage(Vmp) [V]	32.50	32.78	33.07	33.34	33.65
Short Circuit Current(Isc) [A]	9.97	10.03	10.10	10.16	10.22
Maximum Power Current(Imp) [A]	9.39	9.46	9.53	9.60	9.66
Module Efficiency [%]	18.3	18.6	18.9	19.2	19.5
Power Tolerance	0~+5W				
Temperature Coefficient of Isc(α_Isc)	+0.051%/℃				
Temperature Coefficient of Voc(β_Voc)	-0.289%/℃				
Temperature Coefficient of Pmax(γ_Pmp)	-0.380%/℃				
STC	Irradiance 1000W/m², cell temperature 25℃, AM1.5G				

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer.They only serve for comparison among different module types.

ELECTRICAL PARAMETERS AT NOCT

TYPE	JAM60S03 -305/PR	JAM60S03 -310/PR	JAM60S03 -315/PR	JAM60S03 -320/PR	JAM60S03 -325/PR
Rated Max Power(Pmax) [W]	226	229	233	237	241
Open Circuit Voltage(Voc) [V]	36.32	36.61	36.93	37.15	37.38
Max Power Voltage(Vmp) [V]	32.47	32.77	33.06	33.31	33.54
Short Circuit Current(Isc) [A]	7.98	8.02	8.08	8.14	8.20
Max Power Current(Imp) [A]	6.95	7.00	7.05	7.11	7.17
NOCT	Irradiance 800W/m², ambient temperature 20℃, wind speed 1m/s, AM1.5G				

OPERATING CONDITIONS

Maximum System Voltage	1000V/1500V DC(IEC)
Operating Temperature	-40℃~+85℃
Maximum Series Fuse	20A
Maximum Static Load,Front	5400Pa
Maximum Static Load,Back	2400Pa
NOCT	45±2℃
Application Class	Class A

CHARACTERISTICS

Current-Voltage Curve JAM60S03-310/PR

Power-Voltage Curve JAM60S03-310/PR

Current-Voltage Curve JAM60S03-310/PR

Fig 5. Data Specification sheet for the 'superior' solar module JAM60S03-325/PR

Premium

The premium module was the best performing, producing an output per module of 365 watts and would achieve a greater expected annual yield, however these are much more expensive for the customer and would take much longer to payback without a feed-in-tariff.

The module selected as the premium option was **LG370Q1C-A5**

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Mechanical Properties

Cells	6 x 10
Cell Vendor	LG
Cell Type	Monocrystalline / N-type
Cell Dimensions	161.7 x 161.7 mm
# of Busbar	30 (Multi Ribbon Busbar)
Dimensions (L x W x H)	1,700 x 1,016 x 40 mm
Front Load	6,000Pa
Rear Load	5,400Pa
Weight	18.5kg
Connector Type	MC4, 05-8
Junction Box	IP68 with 3 Bypass Diodes
Cables	1,000 mm x 2 ea
Glass	High Transmission Tempered Glass
Frame	Anodized Aluminium

Electrical Properties (STC[3])

Model		LGXXXQ1C-A5		
Maximum Power (Pmax)	[W]	370	365	360
MPP Voltage (Vmpp)	[V]	37.0	36.7	36.5
MPP Current (Impp)	[A]	10.01	9.95	9.87
Open Circuit Voltage (Voc)	[V]	42.8	42.8	42.7
Short Circuit Current (Isc)	[A]	10.82	10.8	10.79
Module Efficiency	[%]	21.4	21.1	20.8
Operating Temperature	[°C]	-40 ~ +90		
Maximum System Voltage	[V]	1,000		
Maximum Series Fuse Rating	[A]	20		
Power Tolerance	[%]	0 ~ +3		

1) STC (Standard Test Condition): Irradiance 1,000 W/m², module temperature 25 °C, AM 1.5.
2) The typical change in module efficiency at 200 W/m² in relation to 1,000 W/m2 is -4.5%.
3) Application Class: A, Safety Class: II.
4) The nameplate power output is measured and determined by LG Electronics at its sole and absolute discretion.

Certifications and Warranty

Certifications	IEC 61215, IEC 61730-1/-2
	IEC TS 62804-1 (PID)
	IEC 61701 (Salt mist corrosion test)
	IEC 62716 (Ammonia corrosion test)
	ISO 9001
Module Fire Performance	Class C, Fire Class 1 (Italy)[1]
Product Warranty	25 Years
Output Warranty of Pmax	25 years linear warranty[2]

Electrical Properties (NOCT[4])

Model		LGXXXQ1C-A5		
Maximum Power (Pmax)	[W]	279	275	271
MPP Voltage (Vmpp)	[V]	36.9	36.6	36.4
MPP Current (Impp)	[A]	7.55	7.51	7.45
Open Circuit Voltage (Voc)	[V]	40.3	40.2	40.2
Short Circuit Current (Isc)	[A]	8.71	8.7	8.69

* NOCT (Nominal Operating Cell Temperature): Irradiance 800 W/m², ambient temperature 20 °C, wind speed 1 m/s

Fig 6. Data Specification sheet for the 'premium,' solar module LG370Q1C-A5

Inverter

Solar PV modules produce Direct Current (DC) which needs to be converted into Alternating Current (AC) before the power can be used in a domestic or commercial property. To do this, the Solar PV System requires an adequate sized Inverter. These differ in size depending on the total expected output of the system – for example, if you have a 10 x **JAP60S01-275/SC** (standard module) system, the Kilowatt Peak (kWp) would be 2.75kWp and an inverter capable of handling 3kWp.

The inverters used were from the **Solis Mini 4G Series Inverter** manufactured by **Ginlong.** These range from 700w – 3600w and were selected depending on the needs of the system.

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Model	Solis-mini-700-4G	Solis-mini-1000-4G	Solis-mini-1500-4G	Solis-mini-2000-4G	Solis-mini-2500-4G	Solis-mini-3000-4G	Solis-mini-3600-4G
Energy Source	PV						
Input Side(DC)							
Max. DC input power(kW)	0.9	1.2	1.8	2.3	3	3.5	4
Max. DC input voltage(V)	600						
Start-up voltage(V)	60			90			
MPPT voltage range(V)	50–500			80–500			
Max. input current(A)	11A						20A
MPPT number/Max input strings number	1/1						1/2
Output Side (AC)							
Rated output power(kW)	0.7	1	1.5	2	2.5	3	3.6
Max. apparent output power(kVA)	0.8	1.1	1.7	2.2	2.8	3.3	3.6
Max. output power(kW)	0.8	1.1	1.7	2.2	2.8	3.3	3.6
Rated grid voltage(V)	230						
Grid voltage range(V)	160-285						
Rated grid frequency(Hz)	50/60						
Operation phase	Single						
Rated grid output current(A)	3.0	4.3	6.5	8.7	10.9	13	16
Max. output current(A)	4.4	5.2	8.1	10.5	13.3	15.7	16
Power Factor (at rated output power)	0.8...1...0.8						
THDi (at rated output power)	<1.5%						
DC injection current(mA)	<20						
Grid frequency range(Hz)	47–52 or 57–62						

General Data	
Dimensins(mm)	310W*373H*160D (mm)
Weight(kg)	7.4 / 7.7
Topology	Transformerless
Self consumption (night)	<1W(Night)
Operating ambient temperature range	-25~60℃
Ingress protection	IP65
Noise emission{typical}	<20 dBA
Cooling concept	Natural convection
Max.operation altitude	4000m
Designed lifetime	>20years
Grid connection standard	EN50438, G83/2, AS4777.2:2015, VDE0126-1-1, IEC61727, VDE N4105
Relative humidity	0~100%
Safty/EMC standard	IEC62109-1/-2, NB/T 32004,EN61000-6-1, EN61000-6-3
Features	
DC connection	MC-4mateable
AC connection	IP67rated plug
Display	LCD,2×20 Z.
Communication connections	4 pins RS485 connector
Warranty	5 years standard (extend to 20 years)

Fig 7. Table of inverert capability Solis Mini 4G Series Inverter manufactured by Ginlong

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Mounting Rail

A module mounting rail is needed to ensure the modules can be affixed to the roof securely and compliantly to domestic properties. The mounting rails used on this project were manufactured by K2 Systems.

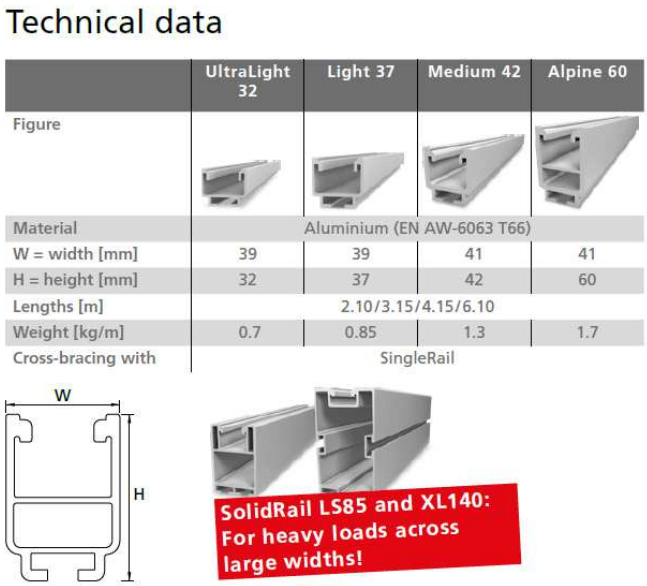

Fig 8. Fastening rails of solar PV

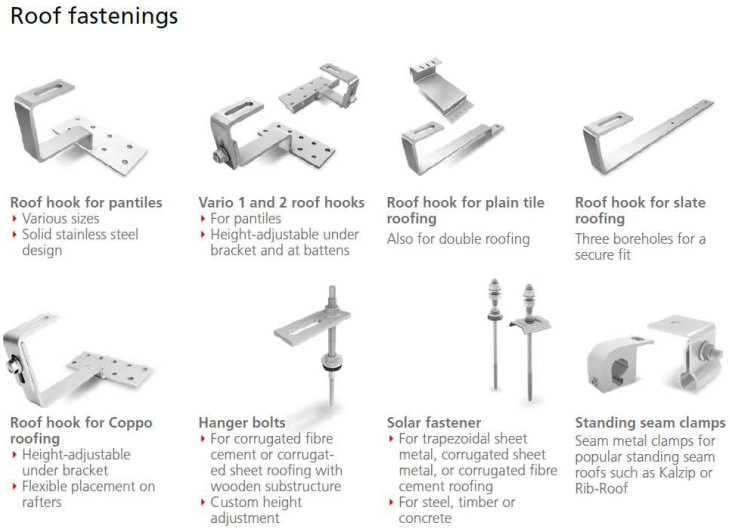

Fig 9. Roof fastenings for solar PV to roof

Annex 1: Smart Homes

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Boiler

Participants interested in a boiler upgrade through the project had a choice of two boiler manufacturers – Worcester Bosch and Alpha.

Worcester Bosch is a renowned manufacturer of boilers. The combination boiler available on the REPLICATE project was the A-rated **Worcester Bosch Greenstar 30i**

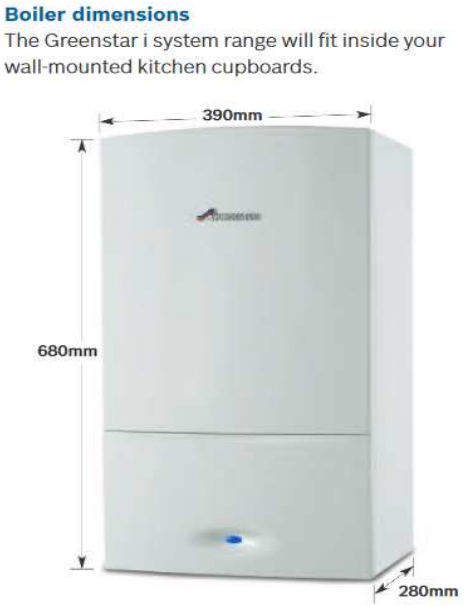

Fig 10. Image of Worcester Bosch Greenstar 30i
www.worcester-bosch.co.uk/img/one_page_overviews_oct18/27i__30i_System_Dual_Brand_WEB.pdf

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Technical data

MODEL		27i SYSTEM	30i SYSTEM
Clearances	Above flue	30mm	30mm
	Sides	5mm	5mm
	Below	200mm	200mm
	Front	20mm*	20mm*
Output kW to central heating (CH)		7.03kW - 27kW	7.03kW - 30kW
ErP Seasonal space heating energy efficiency class		A / 92%	A / 92%
SAP efficiency - natural gas		89.0%	89.0%
Diverter valve kit		✓ (optional)	✓ (optional)
Plug-in timers		✓ (optional)	✓ (optional)
Intelligent controls		✓ (optional)	✓ (optional)

*20mm from a removable cupboard door, 600mm from a fixed surface for servicing.
Same clearances for ventilated and unventilated compartments.

Fig 11. Technical data for the Worcester Bosch Greenstar 30i boiler

The other option available to participants on the REPLICATE project was the A-rated **Alpha EVOKE E-Tech 33** combination boiler:

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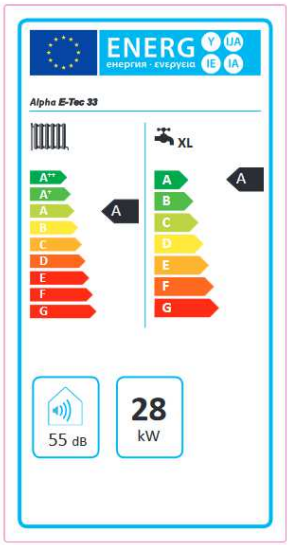
E-Tec 33



Parameter	value
Yearly energy consumption for the heating function (QHE)	1.5 GJ
Yearly electricity consumption for the domestic hot water function (AEC)	29 kWh
Yearly fuel consumption for the domestic hot water function (AFC)	17 GJ
Seasonal room heating yield (ηs)	93 %
Domestic hot water production yield (ηwh)	87 %

Model(s):			E-Tec 33				
Condensing boiler:			YES				
Low-temperature boiler:			NO				
B1 boiler:			NO				
Cogeneration space heater:			NO	Equipped with a supplementary heater:			NO
Combination heater:			YES				
Item	Symbol	Value	Unit	Item	Symbol	Value	Unit
Rated heat output	P_n	28	kW	Seasonal space heating energy efficiency	η_s	93	%
For boiler space heaters and boiler combination heaters: useful heat output				For boiler space heaters and boiler combination heaters: Useful efficiency			
At rated heat output and high temperature regime (*)	P_4	28.0	kW	At rated heat output and high temperature regime (*)	η_4	87.9	%
At 30% of rated heat output and low temperature regime (**)	P_1	9.3	kW	At 30% of rated heat output and low temperature regime (**)	η_1	97.6	%
Auxiliary electricity consumption				Other items			
At full load	el_{max}	0.012	kW	Standby heat loss	P_{stby}	0.057	kW
At part load	el_{min}	0.006	kW	Ignition burner power consumption	P_{ign}	0.000	kW
In standby mode	P_{SB}	0.002	kW	Emissions of nitrogen oxides	NO_x	30	mg / kWh
For combination heaters:							
Declared load profile		XL		Water heating energy efficiency	η_{WH}	87	%
Daily electricity consumption	Q_{elec}	0.131	kWh	Daily fuel consumption	Q_{fuel}	22.362	kWh
Contact details	Alpha Therm Ltd., Nepicar House, Wrotham Heath, Kent. TN15 7RS						
(*) High temperature regime means 60°C return temperature at heater inlet and 80°C feed temperature at heater outlet. (**) Low temperature means for condensing boilers 30°C, for low-temperature boilers 37°C and for other heaters 50°C return temperature.							

50 Alpha E-Tec 28 and 33 - Energy Classification

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(Fig 12. https://www.alpha-innovation.co.uk/custom/upload/pdf/ERP/E-TecERP.pdf)

Loft Insulation

One of the most popular measures on the retrofit project was loft insulation as this is one of the easiest and most cost effective ways to improve your homes efficiency.

The current regulation for loft insulation is 300mm in depth and the product used to achieve this in homes was **KNAUF Earthwool 44:**

(Fig 13. https://pim.knaufinsulation.com/files/download/kine1508dat-earthwool-loft-roll-44-datasheet_5cf68e1e3c899.pdf)

LED lighting voucher

As well as providing funding for the above energy saving measures, all homes participating in the Smart Appliance or Retrofit project received an LED Voucher for 4 LEDs upon paying the final invoice.

LED lighting is a cost effective way of further reducing your home's energy consumption with up to 80% higher efficiency than incandescent lightbulbs.

Due to differering light fixtures and needs for the homeowner, it was decided an LED Voucher was the most effective way of providing even further energy savings measures. As this gave the participant the freedom to choose the bulb most suitable for the homeowner.

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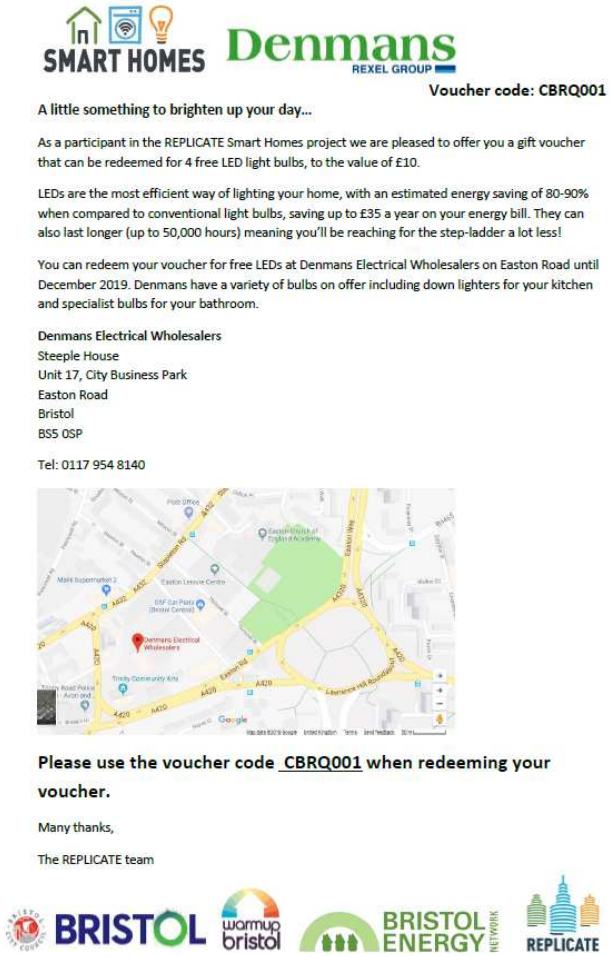

SMART HOMES Denmans REXEL GROUP

Voucher code: CBRQ001

A little something to brighten up your day...

As a participant in the REPLICATE Smart Homes project we are pleased to offer you a gift voucher that can be redeemed for 4 free LED light bulbs, to the value of £10.

LEDs are the most efficient way of lighting your home, with an estimated energy saving of 80-90% when compared to conventional light bulbs, saving up to £35 a year on your energy bill. They can also last longer (up to 50,000 hours) meaning you'll be reaching for the step-ladder a lot less!

You can redeem your voucher for free LEDs at Denmans Electrical Wholesalers on Easton Road until December 2019. Denmans have a variety of bulbs on offer including down lighters for your kitchen and specialist bulbs for your bathroom.

Denmans Electrical Wholesalers
Steeple House
Unit 17, City Business Park
Easton Road
Bristol
BS5 0SP

Tel: 0117 954 8140

Please use the voucher code CBRQ001 when redeeming your voucher.

Many thanks,

The REPLICATE team

BRISTOL warmup bristol BRISTOL ENERGY NETWORK REPLICATE

Fig 14. An example of the LED Voucher provided to particpants after paying their final invoice.

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8. Procurement

The delivery of energy efficiency under REPLICATE required three different contracts to deliver, each one covering a different measure. These were the delivery of boilers, insulation (loft and initially cavity) and solar PV. Additional to this, there was the supply of LED bulbs which was delivered through a partnership approach with Dennmans, a local LED supply company.

Bristol City Council (BCC) has a long history of delivering energy efficiency measures into the private domestic sector. BCC runs its own in-house delivery team to recruit customers and coordinate the delivery of contracts, installations and quality assurance. As such, there were existing contracts for boiler installations and insulation. These were fixed term measured contracts.

Domestic Solar PV was a new measure for the team to install and a procurement exercise took place to find a contractor to deliver this. This procurement was more complicated and had an impact on the delivery of the project and the delay in starting installations. The details of this are outlined below.

8.1 Boilers and Insulation

The delivery of boilers and insulation was carried out using existing contracts. These were fixed term measured contracts procured to support the council's entire program of domestic energy efficiency works.

The procurement route for these was decided given the predicted volume of work that Bristol City Council deliver into domestic properties and the need to ensure a dedicated contractor to deliver these works. The benefit of fixed term measured contract is that:

- Contractor is obliged to deliver the volume given
- There are strict Key Performance Indicators (KPIs) to ensure timely delivery and quality
- Procurement process ensures level of stability and quality from contractor

The risk in a fixed term contract, as opposed to a Framework, is that if the contractor does not perform there are no alternative contractors that can be used. The process for enforcing penalties on the contract would need to be followed to manage an underperforming contractor and whilst this was happening customers would not be getting the level of service required.

The specification and rate card for the contracts were set at tender stage. These were based on industry standards and companies who bid for the tender were allowed to vary from the rate card. This meant we could tender for the best priced contract as well as quality.

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8.2 Solar PV

A domestic Solar PV installer had to be procured for the delivery of REPLICATE. The value of the contract meant we could employ a 3 Quotation tender approach. The technical specification was written in house using existing expertise in the solar industry. The tender included 3 options for quality for panels, basic, superior and premium. This enabled consumers to have a choice which was a key part of the REPLICATE retrofit project.

The time allowed for procurement within the delivery timeframe was always going to be challenging. There were further delays due to procurement and legal support over the Christmas period followed by contractor negotiations. This meant that a contractor was in place later than anticipated delaying the start of the solar PV program.

9. MARKETING

9.1 Business objectives

- Coordinate the REPLICATE project with partner organisations – a European funded research and development project that aims to deploy integrated energy, mobility and ICT solutions such as electric vehicles and sensors to monitor air quality and traffic.

- Make council-owned and private sector homes more energy efficient in order to reduce fuel costs and deliver energy efficiency measures to those most in need. For the private sector this includes the insulation/external cladding through Warm Up Bristol and piloting smart appliances as part of the REPLICATE project.

9.2 Communication objectives

- Between November 2018 and August 2019, generate 2,000 enquiries about the grant funding available for residents in Ashley, Easton and Lawrence to install energy efficient measures to their homes.

- Convert 12% of enquiries to 240 homeowners in Ashley, Easton and Lawrence Hill who have utilised the grant funding available to install an energy efficient measures to their home by October 2019.

9.3 Audiences

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- Homeowners in Ashley, Easton and Lawrence Hill
- People visiting or working in Ashley, Easton or Lawrence Hill
- Local builders and contractors
- Local community centres and groups
- Local media
- Local businesses
- Estate agents (specifically targeting first time buyers and/or those purchasing properties that need renovating)
- Bristol citizens (outside of Ashley, Easton and Lawrence Hill)
- Political members (such as councillors, MPs and the Mayor)
- Council staff.

9.4 Inputs (preparation – insight, budget, creative approach, content)

- Used insight and feedback from Smart Connected Homes project and their Energy Champions to inform communications approach
- Worked in partnership with Bristol Energy Network for targeted community engagement
- Cross-promotion with key partners and local businesses, such as Bristol Credit Union
- Artwork reflected previous Smart Connected Homes project 'look and feel' for consistency
- Directed audiences to a dedicated webpage on the Connecting Bristol website for more information and/or an online questionnaire to start an enquiry
- Tested different messaging via letters and Facebook advertising
- Household data analysis for specific targeting
- Continually monitored enquires and installations to focus and revise communications.
- £4,500 budget
- 1 x introductory letter to Ashley, Easton and Lawrence Hill homeowners – £1,558
- 1 x reminder letter to Ashley and Lawrence Hill homeowners – £1,082
- Facebook adverts x 3 – £300
- A5 flyers – £615
- A4 posters – £190
- Infographic design – £110
- Stock imagery – £67.50
- Up Our Street comms subscription – £60.

9.5 Outputs

Delivered

- Dedicated webpage on the Connecting Bristol website (November 2018) *Unique views 2,797*

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- 1 x introductory letter to Ashley, Easton and Lawrence Hill homeowners (November 2018)
- General Assembly blog post on the Connecting Bristol website (November 2018) *101 views*
- Celebration of Success article on Bristol City Council's internal intranet (November 2018)
- 3 x Facebook adverts targeted towards Ashely, Easton and Lawrence Hill residents (November 2018, February and May 2019)
- 200 x A4 posters and 5,000 x A5 flyers distributed to local shops and businesses (December 2018 to August 2019), including:
  - Bristol Credit Union
  - Post offices
  - Estate agents
  - Builders
  - Sustainable home delivery food providers (e.g. vegetable boxes)
- Prepared briefings and a campaign toolkit for key partners and stakeholders such as councillors, local MPs and Bristol Green Capital Partnership (February to May 2019)
- Up Our Street social media, e-bulletin and noticeboards (February to June 2019)
- Organic Facebook, Twitter and Nextdoor posts (February to July 2019)
- Homepage promotion on the council website (April and May 2019)
- Article within Bristol City Council's Our City newsletter (May 2019)
- 1 x reminder letter (including infographic) to Ashley and Lawrence Hill homeowners (June 2019)
- Targeted door knocking via Bristol Energy Network (July 2019).

<u>Audience responses</u>

- <u>Website</u>
  - 846 x clicks to the REPLICATE Expression of Interest form from general REPLICATE communication (Bit.ly)
  - 283 x clicks to the Smart Appliance and Energy Efficient Measures Questionnaire from general REPLICATE communication (Bit.ly)
  - 57 x clicks to the Energy Efficient Homes webpage from general REPLICATE communication (Bit.ly)
  - 46 x clicks to the Energy Efficient Homes webpage from the council's homepage promotion
  - 3 x clicks to the Energy Efficient Homes webpage from campaign toolkit (Bit.ly)
  - 266 x views to the Bristol Credit Union solar webpage.

- <u>Print</u>
  - 321 x clicks to the Energy Efficient Homes webpage from introductory letter (Bit.ly)

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- 305 x clicks to the Smart Appliance and Energy Efficient Measures Questionnaire from reminder letter (Bit.ly)
- 62 x clicks to the Energy Efficient Homes webpage from A5 flyer (Bit.ly)
- 3 x clicks to the Energy Efficient Homes webpage from A4 posters (Bit.ly).

- Organic social media
  - 583 x clicks to the Energy Efficient Homes webpage (Bit.ly)
  - 13 x Facebook posts (14,382 x reach and 2% engagement rate)
  - 10 x Twitter posts (34,253 x impressions and 0.88% engagement rate)
  - 4 x Nextdoor posts (2,507 impressions)
  - 87 x clicks to the Energy Efficient Homes webpage via Up Our Street
  - 2 x Twitter posts via Bristol Credit Union (1,787 impressions and 11 engagements).

- Facebook adverts (redirecting to the Energy Efficient Homes webpage)
  - November: 422 x clicks, 22,283 impressions, 14,539 reach and £0.24 cost per click
  - February: 249 x clicks, 26,289 impressions, 16,055 reach and £0.40 cost per click
  - May: 548 x clicks, 24,339 impressions, 16,688 reach and £0.17 cost per click.

- Newsletter articles
  - Our City – 1,404 subscribers, 891 opens, 13 unique clicks
  - Up Our Street – 1,884 subscribers, 76 clicks
  - Bristol City Council Celebration of Success – 388 unique page views.

9.6 Outcomes

- 770 x Smart Appliance and Energy Efficient Measures Questionnaire (enquires) completed
- 413 x energy efficient measure quotations raised
- 160 x energy efficient measure quotations/installations accepted in 151 homes
  - 65 x Loft Insulation
  - 65 x new Boilers
  - 30 x Solar PV Systems

- €247,007.26 funding committed
  - 60.55% of total funding available

- 14,766 m2 energy efficient measures committed
  - 68.36% of m2 total target (21,600 m2).

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10. Issues

This section of the report explains the issues that arose during the delivery of the project and how these were overcome by the project team.

10.1 VAT

In the proposal of the project, the delivery team was to calculate funding based on multiple measures from the Best table as this would give a clearer understanding of the total estimated savings and funding for all measures selected. This approach was developed during the initial proposals of the project and in theory was the best way to produce a whole house funding figure. During the first calculations of this approach, it became clear that due to differing VAT levels for boiler installations (20%) and loft insulation (5%), this wasn't possible as quotations became overcomplicated for the customer and to produce. The decision was taken at this point to produce a Best table per measure for the property as this was the most efficient method for the delivery team and meant more quotations could be produced. This new approach meant the delivery team was able to produce more quotations in a shorter time period, meaning we were able to include more people. This also gave us more flexibility for existing participants who were interested in a solar PV system when it became available.

10.2 Solar Delay / end of feed-in-tariff (FiTs)

Warm Up Bristol were not in position to start delivering solar PV systems to participants due to delays in procurement and contract negotiations until May 2019. However, solar PV was included as available on the initial letter drop in November 2018. We stored all interested homes until we were in a position to transfer them over for a desktop survey and PV Sol if viable. Unfortunately, this delay until May affected the number of homes who accepted a solar PV system significantly, as the majority of acceptances were much newer enquiries.

One of the key incentives in the past for solar PV installations was the UK Feed-in-Tariff which bought solar produced energy at a cost per unit when fed back into the grid. This enabled solar PV systems to pay for themselves much quicker and also accelerated the number of homes installing solar PV. This ended in April 2019 without a replacement coming into force until January 2020, and as a lot of homes were aware of this incentive, it did prove to be a stumbling block for certain homes who decided to not proceed to installation.

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10.3 Project Pause / Best Table issues

Regular analysis of the funding amounts provided to participants occurred during the first two months of the project, the delivery team noticed anomalies which needed investigating. The main issue was how the Best table was calculating funding, as we expected to see differing amounts depending on existing house fabric. For example, different funding amounts for the size of the house. This wasn't the case in reality and at this point of the delivery we decided to pause the project until further work on the Best table could be done to ensure accuracy in funding amounts. With more clarity on the Best table and how funding should be calculated, the Best table was improved to reflect a more accurate funding figure based on the property size and estimated kWh/m2 saved.

10.4 Cavity Wall Insulation

Cavity Wall Insulation was originally available as an energy saving measure on the retrofitting tradional buildings projects. This is a type of insulation which is blown into wall cavities to reduce the amount of heat lost through walls. This measure is only suitable for homes built with cavity walls – in the UK that means most homes built after 1930 – and with the clarification we received from the Commission regarding the house type that was expected, the decision was made to exclude this all together. The house type expected for this project was pre-war mid-terrace properties and these were built with solid walls. External wall insulation (EWI) or Internal Wall Insulation (IWI) is a viable measure for this house type, however this was not offered under the REPLICATE project.

11. Lessons learnt/reflections

There have been multiple lessons learnt from the delivery of this project by the Warm Up Bristol team which should be considered for any future domestic energy efficiency projects.

Firstly, full clarification of the expected house type was needed from the beginning as this created confusion within the project team and ultimately lead to the project being placed on hold for a number of weeks. The early momentum achieved with the high volume of interest was greatly affected as there were a number of potential customers who had to wait for the project to begin to proceed on the customer journey. This also affected the recruitment work by the Energy Champions and Bristol Energy Network, as it was unclear whether the project would continue.

Procurement and contract negotiations took much longer than anticiapated and meant the solar PV offer was only available for residents from May 2019 onwards. The nature of public sector procurement means this process can be extremely time consuming and delays often occur. This

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could have been planned more efficiently and more resources provided to the procurement team to reduce the risk of delays.

Direct mailing residents in the partnership area was an effective way of generating initial interest in the project, however, when the first letter produced in November 2018 it stated solar PV was available as an energy saving measure. In retrospect, this should have been marketed separately once the contract negotiations were close to being finalised as the project team found the number of acceptances to be lower from homes waiting for several months.

Resource within the core project team was at times overstrectched due to the number of enquiries. The project manager requested more resource internally which took longer than anticipated to be in post. This could have been avoided if the resource needs were carefully considered early on in the project.

Requesting energy consumption information in the format of monthly bills, rather than using an innovative technological solution to monitoring (such as smart meters), proved to be extremely time consuming for the delivery team. Resource needed to be allocated to checking the monthly bills, requesting any missing information from participants and multiple follow up calls which could potentially have been avoided with monitoring technology. This also means the University of the West of England will need to request further bill information from participants post installation of energy saving measures.

Smart meters are not mandatory in the UK but it was anticipated during the writing of the project that they would be readily available. When beginning the retrofit project, only SMETS 1 meters were available on the market and the data was tied to the energy provider. Individual homes choose their energy providers in the UK and gaining access to the data for each home would have been impossible. Therefore the monitoring process has had to be done manually to ensure energy data can be collected. Bill data was collected for two years prior to installation of measures and will be provided in Dec 2019 and Dec 2020. This is a time consuming and labour intensive process which will take the involvement of several partners, but will ensure data is available.

Working collaboratively with Energy Champion volunteers and Bristol Energy Network was of great benefit to the project delivery. This relationship helped to promote the project within communities where BCC has found difficult to reach historically. This has improved the reputation of the delivery team's work and is a relationship Warm up Bristol is keen to continue to develop to the benefit of future energy efficiency projects within Bristol.

Engagement with homes in highly diverse and deprived areas as targeted through this project has taken considerable time. To fully engage with people in the project area, it has taken a multifaceted approach through mailouts, social media, events and calls, community organisations and champions. The management of this work and subsequent follow up customer enquires was extensive and at times was hard to quantify when chasing people throughout the process. For example, the approach used to generate initial interest in the project through direct

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mailing, in some the areas proved to be effective; with roughly 75% of homes stating they heard about REPLICATE through a 'letter from the council'. This is something that will be considered for future domestic energy efficiency projects.

Even though measures were subsidised, when engaging with fuel poor homes, this is still a significant cost to the customer. This should not be confused with the home not wanting or needing measures. It became evident that some measures were still more than the homes could afford. Additional funding or subsidies would ensure those most affected could still benefit from the outputs.

Delays in procurement and contract negotiations meant Warm UP Bristol were unable to begin the solar offer until approximately 6 months after the approval of the project was granted. While the waiting list of interested homes was a good idea, the delays did affect the number of acceptances, especially from those who contacted us early in the project. In retrospect, a decision to exclude this from the first letter and raise awareness of this separately once available could have produced a higher number of installations of this measure.

12. INNOVATIONS, IMPACTS AND SCALABILITY

The full and exact impacts of the project will be known after the two year research period, especially in regards to the energy savings results, however in this section of the report the expected environmental impacts that this project will deliver will be explained as well as the social benefits to the neighbourhood partnerhip area.

12.1 innovative solution

Working collaboratively with community engagement organisations was an innovative approach to retrofitting traditional buildings in the City of Bristol. This method was created and developed by Bristol City Council and Bristol Energy Network to help recruit participants.

The Energy Champion Volunteers were volunteers from varied backgrounds who are conscious of the effects of climate change and the climate emergency. Through their own networks, they helped to reach homeowners who otherwise wouldn't take advantage of the funding availability.

This also resulted in much stronger links being developed between Bristol City Council and community energy action groups like Bristol Energy Network for this project and will help shape how we, the Energy Service, provide our services to domestic properties in future projects.

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12.2 Social impacts

One important impact energy saving measures bring to the homeowner is a cost saving when regularly heating your home during the winter months. A key concern for Bristol City Council is Fuel poverty reduction through energy efficiency and this project, with funding available, will result in 151 homes seeing a reduction in their heating costs.

The 'Energy Champions' who volunteered to support the project in recuriting has had a lasting impact and legacy as this is in place to continue to generate more discussions about the climate emergency and raise further awareness within Bristol.

12.3 Environmental impacts

Over the next two years, the Unviersity of the West of England will be researching the energy bill information for those homes who had an energy saving measure installed. The exact extent of the environmental impact this project has had will be better understood at the end of this period, however, with the information we had through the Best Table calculator, we estimate the impact to be:

- A carbon reduction of 69,014.93 kg/year
- A kWh/m2/yr saving of 2,929.00

12.4 Replication and scalability potential

Reducing monthly costs is a top priorty for a lot of households within the UK and one of the best ways to do this is through energy saving measures making your home more energy efficient. These measures can be expensive to homeowners and can often be pushed back as a priority due to costs. For a project like this to achieve it's goals, putting energy efficiency back on peoples minds was key. We achieved this through marketing techniques and tools discussed earlier in the report to great effect in terms of number of enquiries.

The funding available within the partnership area was essential to achieving these results as it enabled the homeowner to receive financial support towards the installation to ease the burden of making your home more energy efficient. To achieve large scale energy interventions within the domestic market, incentives or funding towards the installation cost is essential to make it cost effective to those homes with poor existing efficiency.

Working collaboratively with community engagement groups to help tie the marketing and funding offer to residents has been invaluable when aiming to reach those living in fuel poverty. This approach and support helped make the project understandable to the community and enabled customers to feel supported by an independent group. This is an effective way of

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communicating the benefits of energy saving measures with residents through the 'Community Champions'.

12.5 Economic feasibility

The total cost of 160 installations was €390,041.21 with the REPLICATE project committing €247,007.26 worth of funding to residents.

This equated to 63.3% of the installation cost being funded due to the expected savings produced after intervention.

For the majority of the participants, a contribution was needed to make up the shortfall after funding has been applied and the installation cost was usually the deciding factor for the homeowner. Without funding for residents, it would have been much more difficult to achieve these results and support with the cost is essential when looking to replicate this project elsewhere.

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13. CONCLUSIONS

As part of the REPLICATE project, Warm Up Bristol has delivered energy saving measures within a diverse community within three areas of Bristol. It has contributed to increasing the energy efficiency of homes by implementing loft insulation, boilers, solar panels and LED lighting.

The retrofit project worked closely with community organisations to help maximise the number of participants taking part in the research and this approach helped reduce barriers for residents interested in the project, as well as providing the project team with key feedback from residents which helped improve delivery. This approach to deliver domestic projects proved effective with valuable lessons learnt and will be continually developed by the adoption of Warm up Bristol delivering future projects.

Carbon reduction savings have been realised at an early stage of the project and will continued to be monitored throughout the remainder of the project. Warm Up Bristol estimates benefits of 69,014.93kg of carbon to be saved each year. This should provide significant reduction of fuel costs and increased comfort levels for participants and environmental benefits to the City of Bristol. There are also social and economic benefits being realised also through warmer homes, however, the true impact will be known once the research has been completed over the next 18 months.

Despite the challenges faced, the project continued and lessons learnt will be integrated into the planning and roll out. Given more time, Warm Up Bristol felt they would have been able to recruit the remaining homes as the demand was high. It was evident during the delivery of this project that energy efficiency measures are important to homeowners; however, funding towards the installation costs is critical for its adoption. Feedback from customers suggested that they were more likely to be involved in the research with subsidised works. This was particularly important given the project targeted those most vulnerable to fuel poverty issues and not just homes that were already 'energy efficient minded' who could afford the improvements.

The customer journey has been a key part of the project delivery. Communication was vital to update homes throughout the process, especially when delays were experienced to ensure those customer who were interested were informed. Unfortunately the contacts rate did fall when the project was delayed, however there was still a high rate of involvement.

Warm Up Bristol will use the experiences and lessons learnt through the delivery of this project to improve the planning of projects to avoid delays as much as possible which will benefit the delivery of energy saving measures to residents of Bristol and South West England.

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14. Appendices

Annex 1 Smart Homes (attached)

Annex 2 Community PV installation report: Lawrence Hill Bus Depot (attached)

Annex 3 Technical Survey (attached)

Annex 1: Smart Homes

Project no. 691735

REPLICATE PROJECT

Renaissance of Places with Innovative Citizenship And Technology

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Smart Homes (Smart Appliances) Recruitment Strategy 42

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1 EXECUTIVE SUMMARY

The Smart Homes project successfully installed smart appliances and monitoring equipment in to 151 homes. Samsung washing machines, dishwashers and dryers were deployed alongside Loxone Smart Home hub and Raspberry Pi providing secure data transfer to the Smart City Platform via a VPN.

The project involved two main elements, community engagement and ICT systems integration. The community engagement activities were highly successful and resulted in a diverse participation in the project area. The foundation of this work programme was building close relationships and subsequently commissioned a local community organisation, Bristol Energy Network to support recruitment and be a key sounding board for decision making on the project. Other community engagement activities included the co-design of a Demand Side Response trial and co-design process of a mobile engagement tool, the 'Mobile Future Home'. This element was led by Knowle West Media Centre and involved the commissioning of local designer makers to create this engagement tool.

The ICT integration of Smart Homes for the energy management use cases has been a significant challenge. This involved integrating smart appliances with the Smart City Platform and Energy Demand Management System. Changing API's from providers and reliability issues around this have led to a shift to an alternative deployment approach. This has caused delays and additional resources within the project partners to be required. At the time of writing (October, 2019) the final testing of the alternative option is underway and it is planned that a small trial will be held before the end of 2019 to test the end to end ICT architecture around DSR and user interaction with this. Evaluation of this element of the project will be undertaken by University of Bristol.

Overall key impacts of Smart Homes to date include:

- Over 700 attendees at 23 events and engagement activities
- Electricity energy savings in households estimated at up to £150 per year
- 29% of participating households living in social landlord properties
- 31% of households were from Black, Asian, Minority Ethnic backgrounds

The DSR trial is still in development but has potential to be unique within the UK in its co-design nature and deployment method. Learnings from the community engagement approach and DSR design are already being scaled within wider city council initiatives.

2 INTRODUCTION

The Smart Homes project included installation of smart appliances in 151 homes in the project area. These included washing machines, dryers and dishwashers. The purpose of the installations was to reduce energy consumption in households whilst enabling a trial use case for the Energy

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Demand Management System. In addition to the smart appliances, homes received smart home monitoring equipment to capture data from both the smart appliances and the whole house electric energy usage. A VPN was deployed through a Raspberry Pi to securely provide data to the Smart City Platform.

Smart Homes consists of two elements. 'Smart Connected Homes' involving installation of Smart Appliances in 150 homes, and the Retrofit involving energy saving measures in up to 240 homes. Smart Connected Homes are one use case within the Energy Demand Management System (EDMS) developed by NEC. This document relates to D5.1 Retrofitting in the neighbourhood partnership of Ashley, Easton and Lawrence Hill.

3 PROCUREMENT AND INSTALLATION OF HOME AUTOMATION UNITS

3.1 Research: Smart Home technologies

The first sub task (5.1.3.1) within this deliverable was to more closely define the scope of home automation units. Extensive desk based research was undertaken to assess the current market for home automation units more commonly described as 'smart home' equipment. Specific attention was paid to smart appliances which were referenced in the grant agreement. The project team analysed the literature and products available to assess which appliances would be most suitable for their intended purpose. There were two intended purposes for the smart appliances, firstly to have an excellent energy efficiency rating so that they would save energy compared with the machines they were to replace. Secondly, the machines should be 'smart' meaning they would have wifi connectivity and be able to link with the NEC EDMS to run a trial around residential Demand Side Response (DSR). At this point, it was decided that fridges and freezers would not be included in project offer to households as they would not offer enough energy use to shift for DSR given the energy efficiency rating of the machines. It was also viewed as potentially laden with risk if errors occurred and household fridges and freezers were to malfunction potentially losing valuable food. Comparatively it was decided that the project would deploy smart washing machines, dishwashers and tumble dryers based on their load shifting capability and comparatively high energy use.

Through this process the project team gained some insights in to smart appliances and similar project delivery to avoid making the same mistakes. While lessons were learnt from other projects, this is an innovative approach and the ability to make comparisons was limited.

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3.2 Pre procurement Market Engagement

Supplier day

As a result of the background research undertaken it was decided that a formal pre procurement market engagement period would take place due to the lack of in depth information of the smart functionality of certain products available to the public.

From the background research a number of companies were identified who could meet the high level specification for smart home equipment. These were all well-established international white good suppliers, though it was always anticipated that a consortium would be required to deliver the full extent of the project delivery brief including installation and supply of associated smart home hubs and monitoring devices. A supplier day was scheduled to invite potential suppliers to find out more information ahead of the invitation tender being released. They were supplied with a high level specification for the project in advance and invited to listen to presentations from the project team, in particular in relation to the ICT requirements.

It was notable that some of the main potential suppliers at this stage did not choose to proceed to tender as they were not able to meet the requirements of the brief. These shortcomings were either in relation to being able to offer a full installation of their products and support package and/or having an open API that would enable the EDMS to communicate with the smart appliances.

Test bed

Concurrently to this activity a smart home test bed was established at Bristol City Council owned 'Eco Home' where the project team purchased two different smart appliances to test API and integration with the EDMS and Smart City Platform, one was from Samsung and one from Bosch. This was intended to shorten the learning curve around integrating smart appliances with the smart city platform independent of what brand of machine was to be eventually supplied.

As a by-product of using the space, the Eco Home was renovated and then utilised as a demonstration space for the General Assembly visit in Bristol. Over £15,000 worth of sponsorship and in kind support was provided by technology companies and other suppliers. The ambition is that the renovations continue to make this a fully updated showcase facility for smart energy.

3.3 Community Engagement

Alongside the procurement of smart appliances and installation, it was recognised that there would also be a substantial work package required around marketing and recruitment of participants for the trial to ensure a true representation from the project area.

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There had been issues surrounding Bristol City Council (BCC) previously delivering energy efficiency projects in the same area as REPLICATE, which were not entirely to the satisfaction of those involved. Smart Homes therefore set off on a challenging foothold to engage audiences to participate in the trial. It was recognised that a different approach was required to which BCC would normally take in recruiting participants for this type of project. Rather than traditional approaches involving advertisements and door knocking by potentially unknown parties, it was decided at the Communication Sub Group, to take an Asset Based Community Development Approach to engaging local residents. This approach is one which seeks to exploit the existing strengths, skills and expertise within a community rather than relying on outside agencies. Meetings were held early in the process with community organisations who we could potentially work alongside to deliver engagement activities.

Bristol Energy Network was identified as a body that fitted with the requirements of having a track record of delivering community engagement around energy projects in the REPLICATE area. Other community organisations were identified as potential supporting bodies that had more general expertise in engaging local residents across a variety of topics. The initial scope of works was to include both supporting Smart Connected Home recruitment and Retrofit.

It was identified that to provide resources to a local community organisation (to support the delivery of smart homes) a separate procurement process would be required in addition to the home automation kit.

3.4 Procurement

Smart Home automation procurement

Following the supplier day, information and feedback from potential suppliers was gathered and fed in to updating the tender documentation. A procurement panel was convened including a representative from the ICT Sub Group (Zeetta Networks) and from the Energy Sub Group (Bristol City Council Energy Service) alongside the Smart Homes project manager. A specification for the procurement was drafted and agreed by all partners.

The tender was publicised but a low number of responses were received. However it was viewed that Narec Distributed Energy were appointable based on their experience of delivering energy technology projects in to homes. The technology that Narec specified to use was Loxone smart home automation and energy monitoring which utilised smart plugs to automate 'non-smart' appliances. It was requested and subsequently agreed that Narec change their approach from smart plugs to appliances with a built in wifi/API to enable the use cases intended through the EDMS that smart plugs would not have allowed delivery of. Samsung had submitted a tender and

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the machines were successfully tested at the Eco Home so were chosen as the supplier of white goods for Narec to use.

Figure 1: Samsung 'smart appliances'

Community Engagement Group procurement

An internal process was undertaken to procure support from Bristol Energy Network to support the Smart Homes recruitment activity. The scope of the brief was to include:

1. Set up and co-ordination of a consortium partnership representative of the project area and agree approaches and targets for different areas and housing types
2. Set up Community Engagement Group (10-15 participants) to reflect on project activities and to act as a sounding board to the project team
3. Develop engagement materials in collaboration with KWMC and community partners – including the creation a mobile show home or testing facility
4. Manage and deliver roadshow events across the target areas in collaboration with consortium and community partners
5. Support engagement activities at a street level, including supporting local organisations at events
6. Support local energy champions working with partners to participate in the scheme – including training and project resources

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7. Provide newsletters and other media updates to interested stakeholders, working with KWMC / REPLICATE communications team to develop content
8. Work with BCC communications team; create/manage private online and offline social networks for participants to share experiences
9. Feed into monitoring and evaluation working with university partners and use learning to develop approaches during the project
10. Share widely the lessons learned from the project so that knowledge can be transferred across the city and beyond.

The specification for works was co-designed with Bristol Energy Network to ensure it was deliverable and relevant to the local context. This was then agreed and passed through BCC's internal procurement processes. The specification also included the desire for other community organisations to be brought in to the project on a sub contracted basis which resulted in a number of bodies becoming involved such as Bristol Black Carers and children's charity, The Ape Project.

3.5 Participant recruitment

A Community Engagement Group (CEG) was formed, led by Bristol Energy Network and project partners Knowle West Media Centre, who had overall lead for citizen engagement for the Bristol Pilot. The group also included Bristol Energy Service and Warm Up Bristol to involve the Retrofit programme simultaneously. Bristol City Council's volunteering lead was also a group participant to support the Energy Champions element member. The remit of the group was to make decisions around delivery of the Smart Homes project and provide a general peer sounding board.

The CEG worked together to design the Terms and Conditions for households to participate and also the criteria for selection. It was decided that households must have older, less energy efficient appliances to be included so as not to replace newer machines that were already energy efficient. Households were required to agree to the monitoring and evaluation requirements of the project and for rented properties to gain the permission from their landlord.

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Figure 2: Community engagement event using the Mobile Future Home

It was anticipated that there would be direct crossover between the recruitment of Smart Connected Homes participants and the retrofit interventions. Due to the delays around the process for Retrofit, Smart Homes proceeded separately until later in the programme delivery period. At this time, existing Smart Home participants were approached to engage in the retrofit programme. This was based on information already collated as part of the initial marketing questionnaire including their suitability for other energy saving measures and therefor avoiding duplication of information requests. In total, only 21 households had a crossover between having smart appliances and retrofit measures.

A recruitment strategy (Appendices page 38) was developed amongst the CEG. Although there was no set targets set as part of EU deliverables for Smart Homes in terms of home demographics, it was decided to set goals around these to ensure a diverse reach of participants. In particular, the CEG were keen to understand the barriers for a range of household demographics to engage in a smart technology project and to ensure that participants were not just from groups with high levels of digital skills and energy usage awareness. In order to strike this balance the on the ground, recruitment activities targeted those who were defined as traditionally less likely to engage in this type of project.

A range of recruitment activities were undertaken including:

- Local Event/ Community meeting attendance (23 events, over 700 attendees)
- Utilising mailing lists of community organisations

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- Word of mouth through champions (14 early adopter referrals, 62 main cohort referrals)
- Door knocking
- Social media targeted campaigns (over 35,000 reaches)
- Articles in local press/ newsletters / dissemination events (19 instances)

From all these sources potential participants were referred to the Warm Up Bristol customer care team who provided further information, gathered additional data and then liaised with contractors to book installation dates, if all the criteria was met.

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Figure 3: Smart Homes Recruitment Flyer

Bristol Energy Network (BEN) also recruited and trained Energy Champions to support recruitment activities. A session was held in the Eco Home to demonstrate the Smart Home equipment and Bristol Energy Network incentivised the champions to recruit other members of the community to participate. Some of the champions were current participants whilst others just had a general interest in home energy. BEN did not accurately record how many referrals were generated by the Champions. Only three instances occurred where Champions were rewarded by referral vouchers. 14 early adopter referrals were made through BEN and 62 subsequent referrals up to August 2018.

A co-design process took place led by KWMC, to create of a 'Mobile Future Home' which is an innovative engagement tool that travels around the community to engage communities in a fun way. Workshops were held on the design of a mobile vehicle and how it would engage the public, involving local community organisations and individuals. KWMC managed the advertisement and

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subsequent appointment of a contractor to undertake the design and build. This process resulted in local designer maker organisation Mufti Games and InBristol studio being commissioned. The final design included an energy game, solar panel powered an on-board battery for speakers/ tablet display use and smart home equipment on display. The pop up smart home will be a community asset going forward that can be used to engage the community around smart energy topics. It enables a broad reach by getting out to community events and spaces that have not been previously possible.

Figure 4: Development of Mobile Future Home

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Figure 5: Co-design workshop

Fig 6: Mobile Future Home event

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Figure 7: Community Engagement event

All these activities led to the recruitment of 151 homes with an additional home above target being installed due a late enquiry that the budget allowed us to meet the installation costs.

14.1 Installation

The installation of the smart home equipment was managed by Narec who in turn sub contracted to electrical installers North East Electrical to install the smart home equipment and the Pacifica Group to install the appliances. Appointments were booked with households on a cluster basis for efficiency.

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Figure 8: Smart Appliance installation

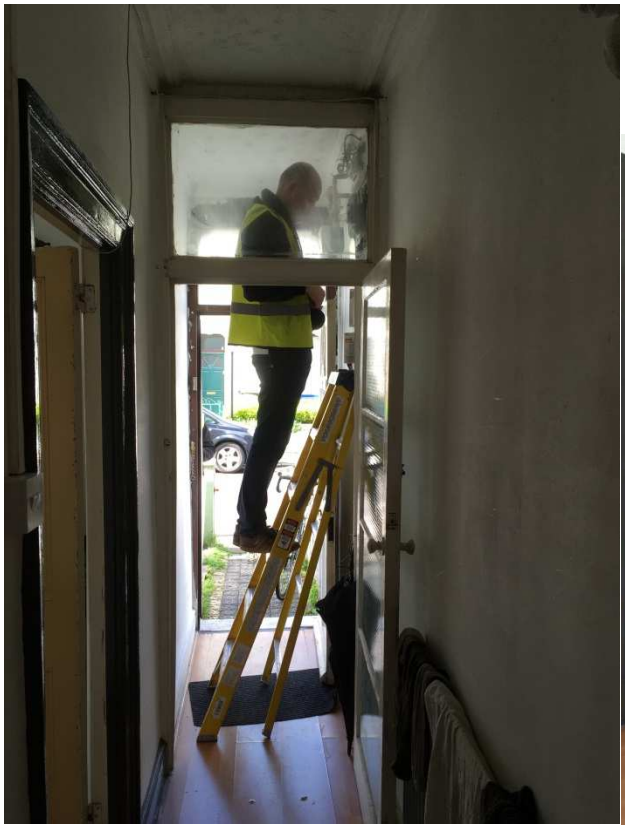

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Figure 9: Smart Home installations

A training day was coordinated for all the subcontractors to brief them on the project. This was done at the Eco Home where the machines were demonstrated. Narec had worked closely with North East Electrical previously around Loxone installations. The training day was to ensure that anyone from the project team entering a home had a good level of knowledge about the wider project and was able to answer general queries or at least be able to refer to the relevant party. In reality, as the project progressed, there were reports of misinformation coming through participants provided by the installers. It may have therefore been preferable that a project team member was on site during installation.

Installations were completed in two parts between the appliances and the smart home equipment whilst Narec ensured that the communication systems were up and running remotely. Due to ongoing difficulties with home users interfering with equipment e.g. unplugging monitoring devices and VPN reliability issues, the contracting arrangements with Narec were elongated. Many of the issues were unforeseeable but issues arose when negotiating the roles and responsibilities around fixing these as they emerged. A significant volume of time was taken for partners to revisit homes to fix snagging issues following the initial deployment. In future, a larger contingency both in terms of time and finance would be beneficial to aid resolutions.

Households received guidance on in-home setup and a demonstration around the devices. Unfortunately at the time of installation, the Samsung 'Smart Home' app was frequently unable

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to connect to machines due to software issues. Therefore, homes were encouraged to just use the machines without the smart capability until the Energy Management Trial. This created a negative opinion of the smart technologies for some households from the beginning. Households have subsequently been advised to upgrade to the Smart Things app. It is not possible within the project to accurately track how many households have installed the new device due to the time consuming nature of contacting every household.

A local appliance recycling charity in the project area 'The Sofa Project' was approached to work with the project to receive the outgoing appliances. These would then be recycled and provided at free or low cost to low income families in Bristol. The Pacifica Group delivered the used appliances to the Sofa Project. Narec also contracted to The Sofa Project (a social enterprise) to provide a depot for storage of Smart Appliances delivered direct from Samsung.
It was estimated that approximately 30% of the machines were re-used whilst the remaining were recycled. The Sofa Project experienced several issues with the supply of Samsung machines which were often delayed and occasionally damaged. Samsung were also not able to meet the requirements in terms of delivery timescales causing delays to installation dates at a times cancelled installations. Furthermore, Samsung took a significant amount of time to re-collect damaged machines causing inconvenience and storage expense. The poor customer service experienced by the sub-contractor Narec led to the making a complaint to resolve an issue.

3.6 Demand Side Response Trial

The smart appliances in Smart Homes were a listed use case for the EDMS. To deliver this, it required input from a range of ICT partners and subcontractors. The aim,was to enable an ICT architecture that would enable the control of appliances in line with the parameters set by the EDMS i.e. to work at times that are beneficial for the environment and energy grid and in turn potentially cheaper for households. Households would remain entirely in control through setting their preferences on a calendar via the Loxone app. The EDMS would only then work in line with the times that households are happy for their machines to run. In addition, any time the household wanted to override the control they could do so by switching the smart mode off on their machines turning off the method of external communication.

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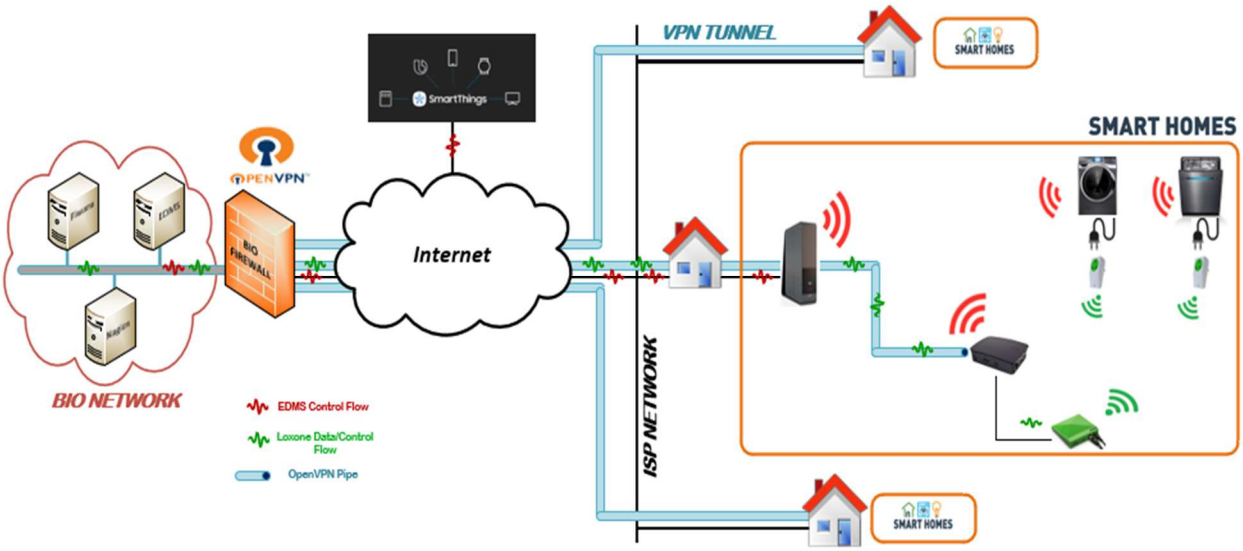

Figure 10: Smart Homes ICT architecture

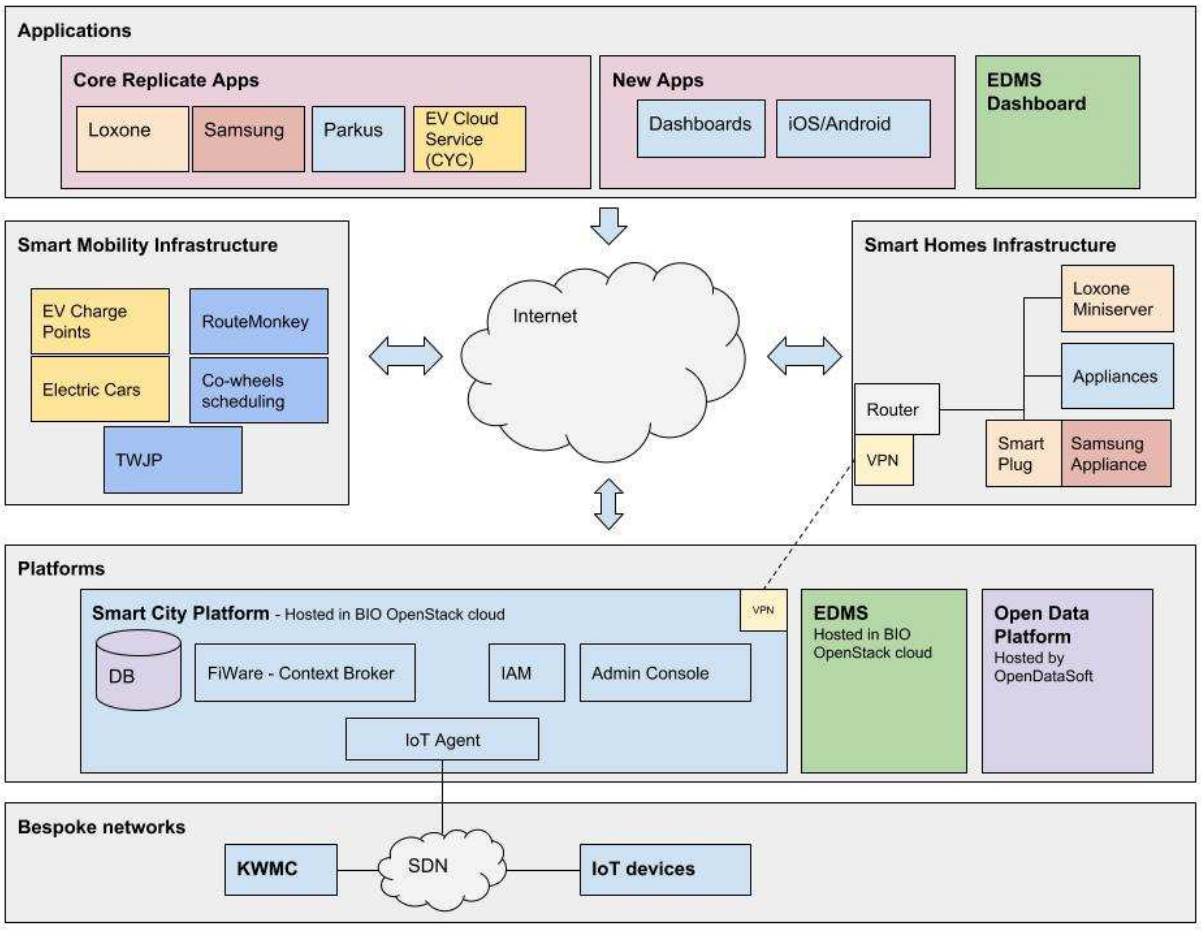

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Figure 11: Smart Homes within wider REPLICATE architecture

The DSR trial could not commence at the point of installation due to the ICT requirements not being in place. This was largely due to the untimely and limited interaction possible with Samsung and also the lack of coordination within the ICT sub group to manage the required tasks through to completion. Samsung were unwilling to adapt their app to enable users to have just one app for the DSR trial therefore modifications were required in the Loxone app to enable the interactions required, such as push notifications, preference setting and reward tracking. The trial has not yet started.

At the time of writing the ICT elements of the DSR trial are yet to be completed and BCC are pursuing Samsung by means of complaint regarding the unreliability of the API and issues relating to the 'SmartThings' app which are delayed the start of the trial. The delivery team have subsequently moved to an 'option b' deployment.

Significant issues were encountered with the originally modelled deployment architecture. After initially successfully testing the Samsung API for the smart appliances, during a further testing phase, Samsung changed their API, back and front end systems entirely without prior notice to the delivery team. This resulted in challenges for all ICT partners having to adapt to the new architecture. Furthermore each household had (to varying degrees of success) a redundant app installed to control their machines. A requirement to move from the Samsung 'Smart Home' app to the 'SmartThings' app required contacting all households to make the change. This caused annoyance and further frustration for households. Many of which had not been able to successfully use the original app due to bugs and incapability issues that emerged upon deployment e.g.: some models of smart phones proved to be incompatible. Due to a lack of effective and timely support from Samsung and ongoing bug issues, this caused significant reliability concerns. It was decided to entirely change the deployment architecture away from using the Samsung API to instead using the Loxone smart plug to control the appliances. This came with the downside of time required to re-design the architecture and integrations and also that we could not include dryers or dishwashers in this part of the trial. This was due to restrictions on their functionality. Specifically, these machines would not restart themselves like a washing machine would do automatically when using a smart plug.
A positive outcome from the process to date has been the numbers of homes who have volunteered to partake in this element of the trial. Marketing materials were provided to households to explain the DSR trial and a positive response was received. In total 55 households agreed to participate if required. Anecdotal feedback showed that participants understood the purpose the DSR trial which was a significant concern at the outset of the project. This demonstrated that the marketing materials, terms and conditions and follow up conversations

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had sufficiently outlined the process that would be involved to enable people to feel confident enough to participate.

Figure 12: Smart Homes Energy Management Information Booklet for homes

3.7 Monitoring

Questionnaire data gathered for retrofit measures from participants captured information around their household type and demographics. The monitoring programme for Smart Homes also consisted of data collection from homes from their smart appliances via Smart Plugs and from whole home through a clip on smart energy meter. Both units were supplied by Loxone. Where the design of the household did not allow for a power source to be supplied to the smart whole home meter a manual download meter was installed. There was a delay in revisiting home to install meters due to contractual issues with Narec which resulted in a 6 month delay in getting whole home monitoring data from these households from January 2019 onwards. Manual downloads of the data will be required on request.

Although there was no expected impact on whole home electricity use other than that created through the switch to a more energy efficient appliance, it was felt that this would be useful

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contextual information to gather. No pre monitoring data around the household electricity use was captured from the outset but this was to be collated through past energy bills gathered by UWE (as outlined in D5.1 section 5.6).

Information was collected on the energy efficiency of outgoing appliances and an Energy Saving Calculator was created to estimate the likely savings that would be achieved from their old versus new appliance, assuming usage patterns remained the same.

Qualitative data from events including attendance and audience was captured within the project wide project wide WP11 Communications Log and includes analytics from Facebook marketing campaigns.

Connectivity monitoring in households is undertaken by an online system implemented by Bristol Is Open using Nagios and hosted within the Smart City Platform. We are able to see an overview of the status of the VPN connection in to homes and also look in depth at the history of this connectivity (Figures 13 and 14 below).

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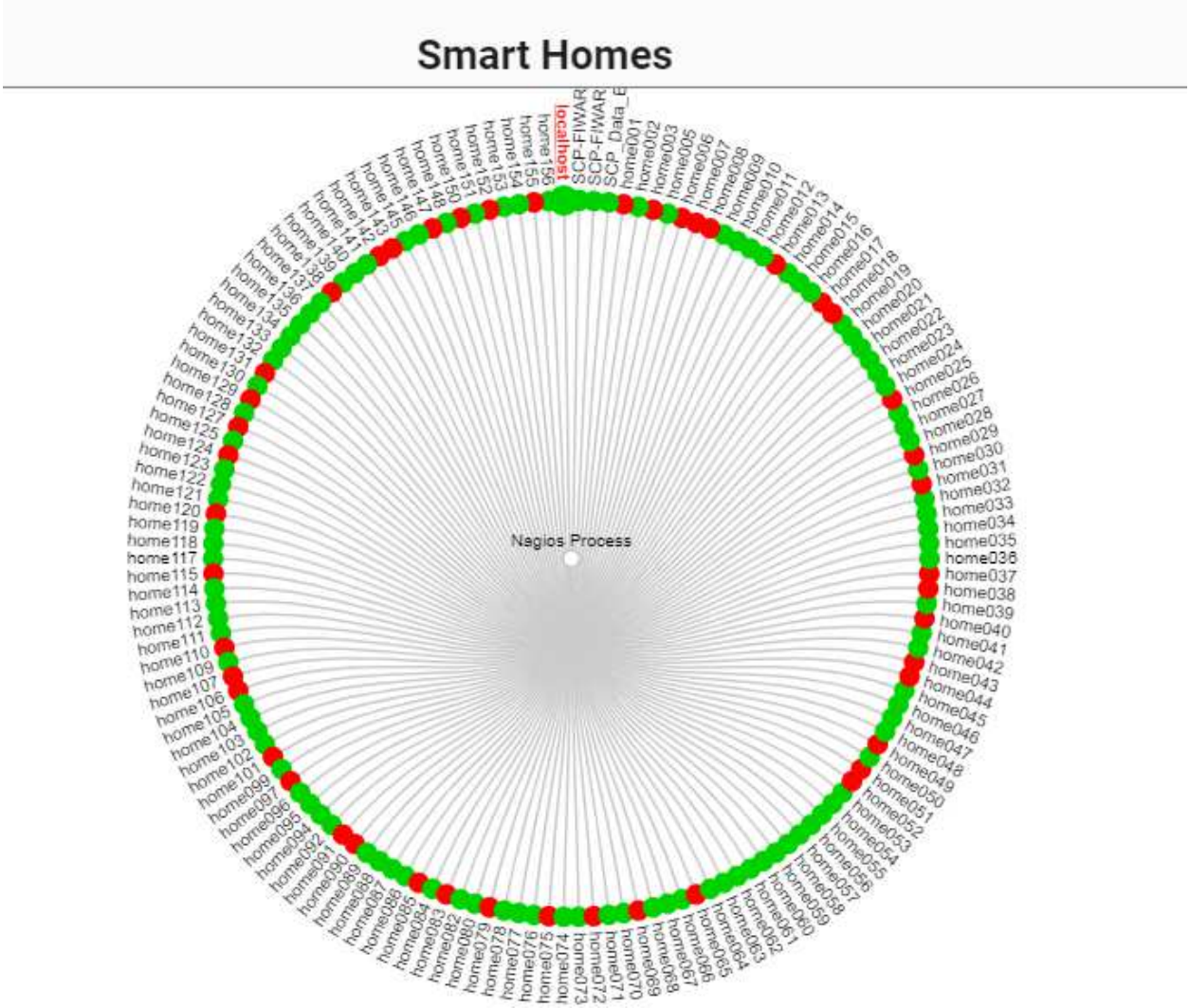

Figure 13: VPN monitoring status of Smart Homes

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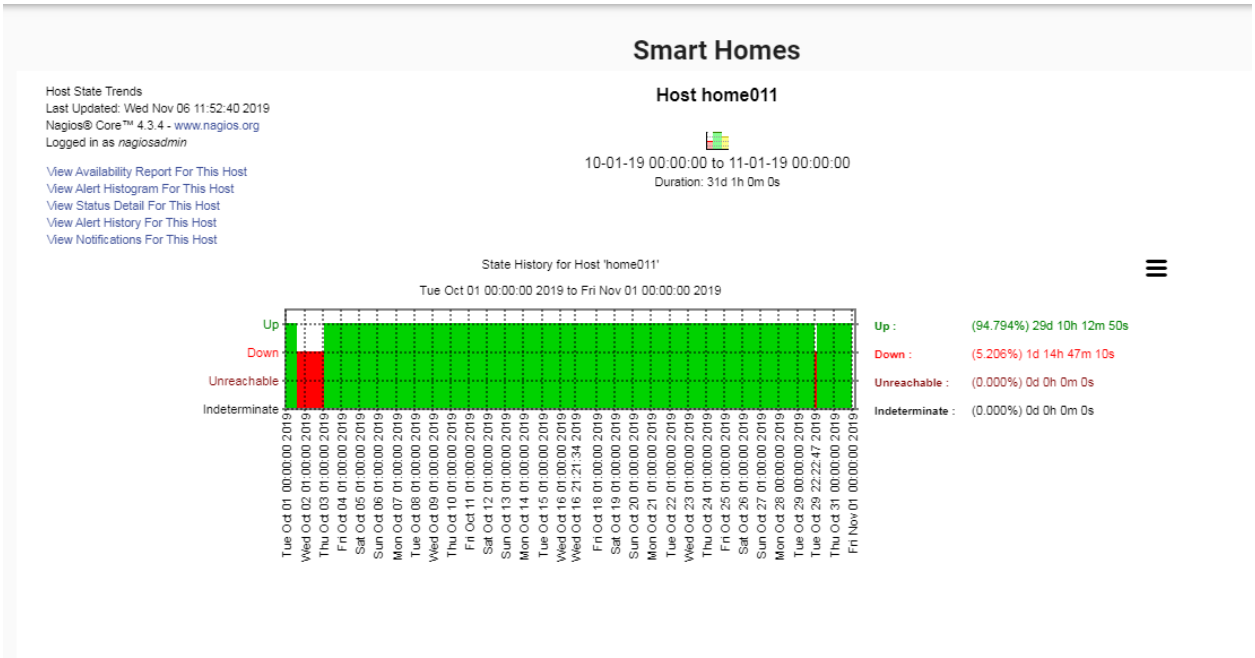

Figure 14: Individual smart home VPN monitoring log

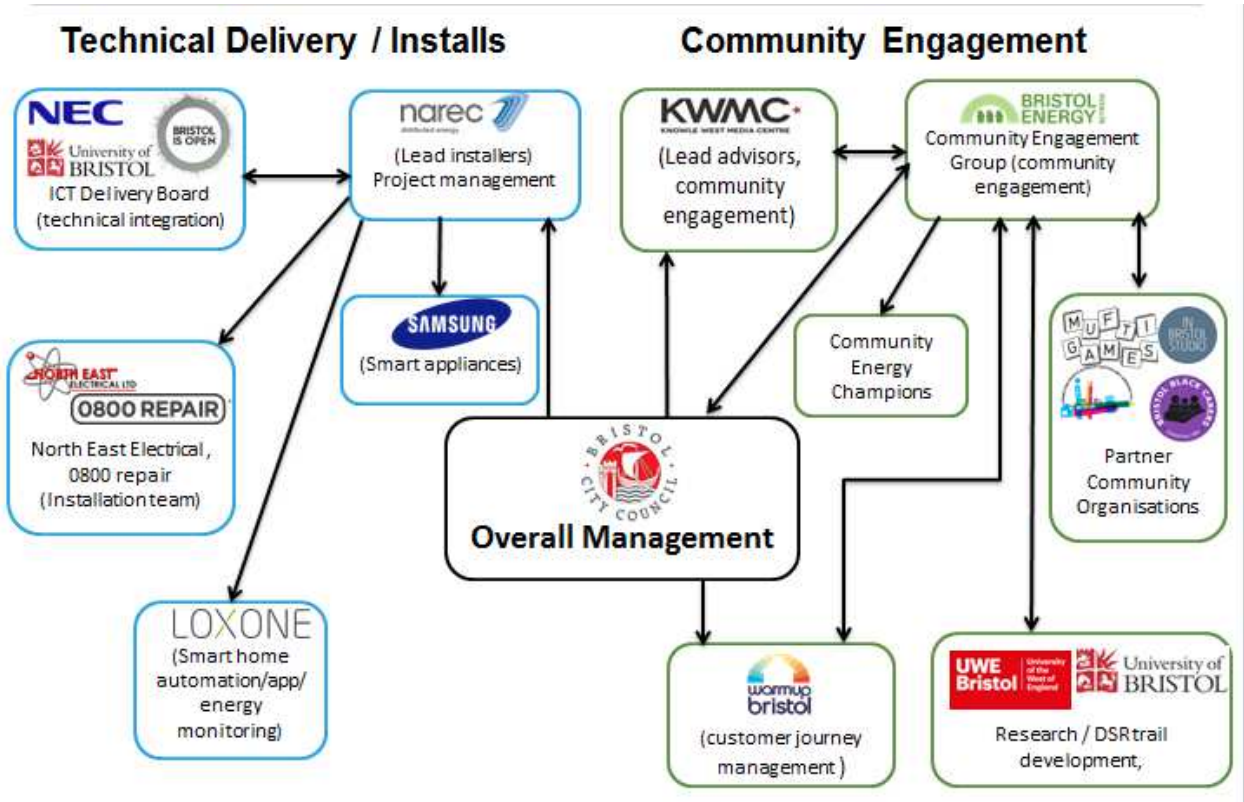

Figure 15: Project delivery team

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4 LESSONS LEARNT

Due to the innovative nature of the project, Bristol was the first city to use the appliances from Samsung and Smart Home kit from Loxone in the UK in this way and has raised significant challenges and many lessons have be learnt.

14.2 Procurement

The procurement of the home automation equipment was challenging due to the nature of the requirements for DSR to be trialled, namely having a usable open API. This limited the number of equipment providers that could meet this criteria. It would have been beneficial for a supplier to be a partner on the project to aid a closer development relationship. This would have enabled a stronger issue resolution process to take place.

The specification within the procurement tender was not sufficiently examined by the ICT partners, despite having a representative on the procurement panel. This was due to misunderstandings of the reviewed of the documentation and is being taken as a lesson learnt for future projects. This led to a gap in security being identified post contractor commissioning and led to significant increase in time and expense to rectify. As a result, a VPN was added via a Raspberry Pi which was not within the original specification. In future, it would be prudent to put in place liability clauses for partners to cover costs of previously unflagged issues in procurement documents if raised at a later date.

The pre-market engagement exercise, Eco Home testing and supplier day did not yield the depth of information from potential suppliers as intended. This was later exposed when more live tests were undertaken on equipment, which revealed significant bugs in the equipment purchased. It was only when full end-to-end testing took place that some of these issues were revealed. Furthermore, within the procurement process, suppliers did not alert us to any future changes in their systems which might occur during the lifetime of the project. In the case of Samsung, this involved changing their smart appliance application from 'smart home' to 'SmartThings', which was an entirely new app and infrastructure from a company that Samsung had acquired. This had a knock on effect on the API which was also modified; meaning the initial testing that took place in the Eco Home became invalid between the point of testing and the installation of the homes. In hindsight, an agreement should have been put in place to cover costs and development required from any significant app and API changes during the life of the project. A formal complaint process is currently underway with Samsung regarding the issues, this and other ICT changes have caused as resource reallocation has been significant.

At the supplier day hosted by BCC there were very few questions asked about the project. It was felt that this might be because of competitors being in the same room. A lesson learnt from the process was if one to one conversations had have taken place, this might have been more

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productive. However, this would have created additional administrative burden having to share the questions and answers with other potential bidders.

14.3 Installation

The structure of the installation delivery team made for a challenging coordinated approach from subcontractors. This often resulted in homes having to make themselves available for multiple visits, rather than just the one. However, it would be unlikely that a company who installs white goods could also install smart home equipment and undertake tasks, such as provisioning. Having the lead contractor on site during the installations might have been beneficial, but as they were based remotely, this was not possible and not costed for. Furthermore, the Smart Home equipment installers, North East Electrical were also not locally based, meaning that any snagging issues could not be quickly resolved locally.

There were delays that occurred throughout the installation period due to the varying nature and suitability of homes for installations, particularly in relation to the electricity monitoring devices. Where homes had an electricity meter too far away from a power source for the monitoring equipment, a more basic clip of meter was required alongside a manual download process rather than being automatic. Although all the white good hardware was installed by January 2019, there were a number of homes that required revisits due to installers not being able to fit standard equipment. There was a long time lag before all these issues were resolved, meaning the loss of some 'whole home' data during this time. In future, it would be appropriate to do pre-installation visits to check each home's suitability; however, this would come at a significant extra cost and resource. Also for some homes the cost of the electrical alterations required was more than anticipated or could be covered by the householder in future particularly where most of the changes were as a result of poor existing electrical safety.

The equipment itself also revealed to be relatively fragile to the day to day operations of a household. Several items were damaged and wires lost, some homes had removed the equipment altogether when moving furniture around and not replaced it. Many households had simply switched off the equipment and without the project team having an automated system in place to identify these 'switch offs', then data loss resulted. There was not enough staff time in the project team to manually check the data for errors in the frequency that would be required. If it was just the Raspberry Pi that was unplugged, then data was backed up locally on the Loxone hub but unplugging the hub would result in data loss.

On commissioning, the project team were assured by contractors that the remote location of the contractors would not cause any issues but in reality this did occur and caused delays to snagging issues being resolved. Staffing issues within the contractor also meant that snagging issues did not get resolved until August 2019. In future a local contractor would be better placed to deliver

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the project, however on this occasion, no local contractors responded to the tender brief/were able to deliver.

14.4 Mobile Future Home

The co-design process around the Mobile Future Home highlighted the importance of this process. The project team initially thought a mobile electric large display vehicle would be the best marketing option. However on consultation this was rejected by the community, due to not wanting another vehicle on their congested streets. The idea for a smaller pop up display vehicle was put forward by the community demonstrating the importance of co-design and being open to change plans accordingly.

The location for storage of the Mobile Future Home was an additional cost that was not accounted for and would benefit from being agreed at the outset. The custom build nature of the item also required many fixes to keep it up and running that were not originally budgeted for.

14.5 ICT integration

Throughout the project speaking and engaging with suppliers has provided challenging regarding the actual viability of some elements of smart technologies versus the reality of on the ground deployment. Integration with the Smart City Platform and EDMS has been significantly more resource intensive due to the difficulties of utilising the API of Samsung and its reliability. The suitability of the Loxone smart home equipment was also questioned by the ICT partners following completion of procurement, meaning a VPN solution had to be added at a time and expense cost. A review of data flow security within the procurement stage did not flag this as an issue so a more in depth review should have been undertaken with more suitably qualified advisors.

Ideally, the Samsung app for appliances could have been utilised by users to set their preferences for the DSR trial, however Samsung were unwilling to make any modifications to their app, due to lack of any partner relationship or seeing the value to their company in doing so. The Loxone app had to be used instead. This involved development time for Loxone that was not anticipated causing delays. Narec needed to sub contract to Loxone for this time, as they did not have the in house capability to make all the modifications required. In future, a one app solution would provide a much more seamless solution for households.

Communications with the in ICT group were an ongoing challenge though weekly technical catch ups around the energy management use cases did aid the progress. The chair was unable to regularly attend these meetings and other ICT partners stepped up as chair at times to take forward delivery. However, this created inconsistencies and attendance was irregular or entirely missing on many occasions. However lessons have been learnt from this for future management and delivery. Using the online tool 'Slack' was helpful in improving dialogues between the ICT

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group and Samsung, however it did not lead to timely resolution of issues but at least raised them more efficiently.

At the point of installation, households had the Samsung 'Smart Home' app installed on their personal smart phones to control the appliance.. They also allowed the project team to be a member on their account to enable remote communication with the machines. This integration was tested, however Samsung later revealed that the Smart Home app was to become obsolete and a changeover to the 'SmartThings' app was required. In future, an agreement would be beneficial to try and compensate for any changes, such as this out with the project teams control resulting to significant impacts to the project.

14.6 Community engagement

The community engagement around the recruitment of participants was a success with a highly diverse cohort engaged and capacity built within local organisations. Having local community organisations leading the public facing element of the project built trust in BCC. Bringing community organisations in to the inner decision making processes around the project, helped to foster strong relationships that aided the delivery of the project. For example, when delays or issues occurred BCC could communicate these in a shared setting, building empathy and understanding that had not occurred in past similar projects. This led to community organisations being able to pass on reasons for changes in the project or delays in a more sympathetic manner creating transparency of process and greater trust.

It is clear that projects should move in line with trust gained when concerning community engagement. It took some rebuilding of past relationships with community organisations with whom the project wanted to partner with. This time was well invested, however as it resulted in community organisations who were initially sceptical of involvement eventually coming on board as partners/ promoters.

A key learning point from Smart Homes was expectations around capacity of community organisations. It was thought that community organisations would welcome the additional resource that was being offered by the project to work with the team, however it was often found that although organisations were keen to work with us, that they were already at full capacity working on existing project commitments. This hindered the ability of community organisations to support events where they would have added value. More time was also required from Bristol Energy Network to build relationships with other community organisations. This was often simply a case of those organisations being very busy and not prioritising the Smart Homes project. Engagement was most successful where meetings were more informal on a drop in basis with these organisations and also by attending events where stakeholders could be engaged which could then lead to joint activities going forward.

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The recruitment period prioritised those groups who were agreed by the CEG to be less likely to engage in the Smart Homes project. Potential participants who fell in to this group had more time to become involved in the project and it was agreed that CEG would earmark an allocation of the 150 homes for that group. Therefore, 50 homes were allocated to those recruited directly through the CEG. In addition, engagement with registered social landlords allocated 20 homes to one particular provider who expressed a strong interest in the project. The allocation of these potential homes would be reserved until later in the project delivery period. The learning from this was that there was a very balanced mix of demographics and housing types as a result of this approach however a wider ranging promotional campaign should have been started earlier so that the final installations were not as close to the deadline as intended.

The social landlord properties did not see much take up however engagement with BCC's own social properties team although presenting some initial sign off hurdles yielded far more participants. This was also aided by a local organisation 'Centre for Sustainable Energy' who referred potential participants as part of another energy efficiency savings conversation. This demonstrated the strengths of utilising referral organisations already engaged in energy saving conversations with households.

Social media engagement became an asset within the recruitment phase towards the end of the delivery period and generated a significant reach for the project. Initial concerns that this would attract a certain 'usual suspects' cohort turned out to be (at cost) broadly unfounded as there was not a substantial shift in the demographics of participants in the later stages of project recruitment. Social media generated significantly more referrals for Warm Up Bristol to follow up compared to traditional approaches so this would be utilised again in future and targeted to certain groups particularly. The social media reach was most effective when organisations and individuals posted about the project directly rather than others posting to their pages.

The asset based community development (ABCD) and co-design approaches have been particularly good practice within the project and have already been replicated on other projects. In particular the process to design the Mobile Future Home resulted in a truly community led design and outcome which was an excellent engagement tool. There were elements of the Mobile Future Home process that could have been improved for example not having an agreed storage location has been an ongoing issue and the handing over of the asset to the community took a longer time to arrange and required a contract to be drawn up.

14.7 Monitoring and Evaluation

One of the primary lessons learnt from the monitoring and evaluation programme included the need to avoid changes to questionnaire format mid project. This caused backend analysis issues and additional resources to clean and sort the data once outputted.

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Although Smart Homes and Retrofit recruitment did not take place concurrently as initially planned, the questionnaire for Smart Homes included relevant questions for Retrofit that could then be followed up later. Although this created some efficiency, the decoupling of the primary recruitment phases for each project resulted in substantial loss of planned efficiencies for the monitoring programme.

Throughout the project it had become evident that the nature of the equipment in households was particularly vulnerable. The Loxone home hub and Raspberry Pi required cable connections and individual power sources that we found were regularly unplugged or damaged in people's homes. This meant that in some instances there were either gaps in data that had to be retrieved from the home hub manually via the local backup or if power had been removed that total loss of data occurred for that period.

At the time of writing, a monitoring alert system for any unplugged devices is being investigated, however in hindsight this should have been implemented from the outset by the ICT partners. This has resulted in the creation of a system which requires manual checking of data flows which is inefficient. Furthermore, the software only allows for distinguishing whether or not the VPN connection to homes is up or down rather than any assessment of data quality, this has to be checked manually. Ensuring effective data monitoring protocols were in place from the outset would have substantially improved data quality.

The timing of the UWE led evaluation activities at present are scheduled to take place before the full implementation of the DSR trial has taken place. This will result in interim findings and should have taken place in the final year of the project to allow for a longer term impact to be captured from participants. The timing of the evaluation was linked to deliverables but did not take in to account DSR trial and any delays around the project in general that might occur. In future, there should be greater flexibility for evaluation activities to take place at an appropriate time after the project impacts have been realised.

The questionnaire data that was gathered was reviewed at fortnightly CEG meetings to provide a snapshot of current enquiries and demographics around these so the group could target either different areas, groups or otherwise as appropriate. This was a useful practice as it resulted in a wide demographic and geographic spread as intended.

In hindsight, a richer evaluation would have been possible with pre-monitoring data recorded in households prior to the installation of new equipment. Although the details of the old appliances were gathered which could infer the likely change in energy use, it would have been useful to have the actual figures from pre monitoring homes.

Within the grant agreement, there were no clearly defined outcomes from the Smart Connected Homes project therefore these had to be shaped throughout the project. In particular, the lack of clarity around the DSR use case resulted in partners being unclear as to their individual roles and

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remits and time allocation regarding this work package but furthermore were often reluctant to adapt resources to accommodate the changing nature of the research and development project due to budget constraints/time available.

14.8 Delivery team resourcing

Project Management

At project initiation in 2016 it was considered that a subcontractor would deliver the entire element of Smart Homes. A large multidisciplinary consultancy was engaged and conversations advanced to a late stage, however, contractual discussions and funding limitations proved to be barriers for delivery of Smart Connected Homes. The expertise and past experience of delivering similar projects could have been extremely valuable in progressing certain elements of delivery in a more timely manner. To avoid longer learning curves in future it may be beneficial to bring in specialist delivery support within a team. However, this would come at the loss of capacity building within the council and community.

14.9 ICT Coordination

The resourcing of the Smart Connected Homes project was not sufficient to effectively deliver the project in its entirety. Compared to other Smart Home projects that the team have researched, the budget was extremely limited and in particular there were knowledge gaps in the resources available to deliver the ICT requirements. Furthermore, time to deal with the plethora of in-home issues that occurred due to human interference which was very limited. A full time project officer with strong ICT skills would be necessary to circulate amongst homes to ensure data quality, engagement and issue management. This would have also allowed for more regular communications to take place with households to keep them abreast of the latest project news.

Within the original project budget and following changes to the person months, BCC did not sufficiently resource an ICT lead to help coordinate this piece of work. This emerged as something that was required due to the lack of coordination effort from the wider ICT project leads and insufficient knowledge of IoT integration in this area. It would have been substantially more efficient and effective to have the ICT coordination being led by a suitably skilled individual within BCC. A lack of technical expertise and experience around IOT within BCC delivery team caused challenges in terms of delivering these elements within smart homes. Reliance was placed on project partners to learn, advise and deliver the ICT elements of the project use cases but this lacked coordination and resulted in ongoing delays and uncertainties amongst partners around roles and responsibilities. This lack of coordination was most keenly felt when working with Smart Connected Homes contractors who required timely and accurate feedback on systems. Issues with this progress led to duplication of effort and some in-efficiencies around deliverables. For

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example, it was only highlighted retrospectively that a VPN would need to be installed in homes in addition to the smart home kit despite the ICT sub group being consulted on this.

5 INNOVATIONS, IMPACTS AND SCALABILITY

5.1 Innovation solution

Community Engagement

In the case of Smart Connected Homes a large part of the innovative activities stemmed from the community engagement activities and approaches to those.

The commissioning of a local community organisation to both lead engagement activities whilst also being closely involved in day to day project decision making was innovative for BCC. This resulted in joint decisions and greater levels of acceptance and ownership of the project by the community organisations involved. An example of one joint decision was the recruitment strategy which was co-designed and included agreeing eligibility criteria.

The Mobile Future Home development process produced an engagement tool which was innovative in its design and development process through to its actual usage. Co-design workshops helped shape the project and the end product is unique in nature. The engagement tool helped the team to break down perceptions of smart technologies that do not always have a favourable reputation in the UK particularly related to energy due to the association with the unsuccessful Smart Meter programme rollout.

DSR Trial

The DSR trial as part of the Energy Demand Management use case has been highly innovative and the first of its kind in the UK in the way the ICT infrastructure is being delivered. The use of FiWare, Smart City Platform and Energy Demand Management System linked to homes in a way which home owner's consent to and the technology allows for has been innovative. For example, the utilisation of the Samsung control API for the smart appliances has not been utilised anywhere else in the world.

The project team researched other DSR trials and utilised learning from elsewhere to inform the design of this element of the project to ensure it was innovative. For example, the full automation of the appliance control was something that had not been delivered elsewhere in the UK previously, possibly even the world.

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The co-design process through workshops led by University of Bristol around the DSR trial has led to an approach that is user centric rather than top down. This included discussions around the user interface design and rewards. This means that users can set their own preferences for control to take place and are rewarded for behaviour that aligns with what is positive for the energy grid. The project has captured a design for how communities might receive such a similar future project that could be utilised elsewhere.

The project as also engaged with colleagues from Greenwich Borough Council who had been developing a trial similar in nature. Key documents were shared between both council's which was highly beneficial in terms of shaping the trial and communication materials. The results of the workshops were written in to a specification for the ICT group to deliver, of which not all were possible within the limitations of the existing Loxone app but nevertheless modifications were made.

Monitoring

The team developed a smart appliance Energy Saving Calculator which is the first of its kind in the extent of its flexibility to incorporate a range of different appliance energy ratings. Background research was undertaken to gather data relating to known energy ratings and savings across washing machines, dishwashers and dryers. Where gaps existed these were filled by via extrapolation. The tool was then reviewed by project partners UWE to validate the methodology. This tool was then published online on the project website where potential participants could put in their existing appliance rating and see what savings could result.

5.2 Social impacts

One of the primary aims of the smart homes project was to save energy used by appliances in people's homes. The smart appliances which were procured had the highest possible energy rating (A+++). The agreed recruitment strategy set a series of criteria for eligible households, the main one being that households could only participate if their appliance to be replaced was rating 'A' or lower. This decision was taken to positively target households that may have lower income therefore greater potential to be in fuel poverty. Although this was not measured as a pre-requisite, the project area has a high level of fuel poverty, so it was likely that some households engaging in the project would come from this cohort. The CEG activities and events were also focused on lower income households to ensure a wide range of beneficiaries.

The recruitment strategy was highly successful in its aims. This is evidenced by the difference between the cohort of the applicants to smart homes compared with the actual installed cohort. There was a skew towards those households that met the recruitment strategy target group from

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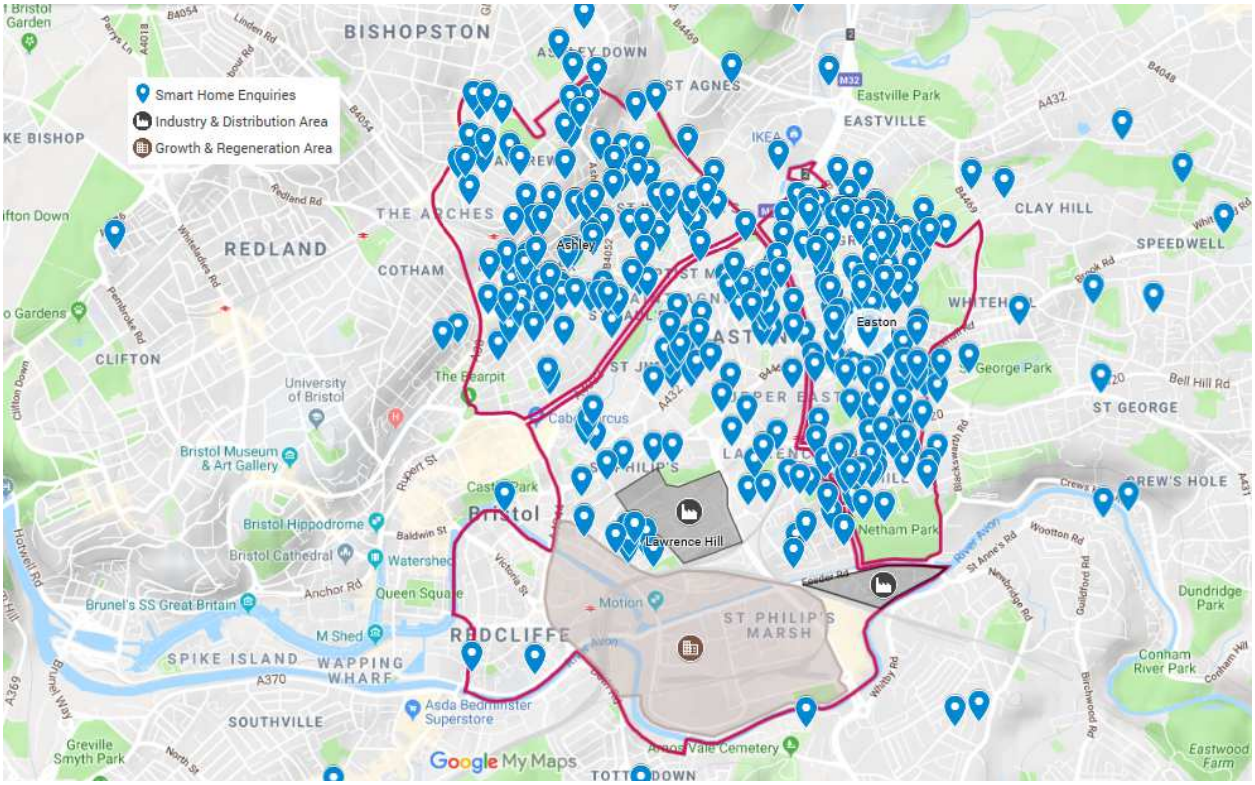
those who had expressed and interest and those who went on to receive an install. For example within the whole response cohort only 19% were from social housing whereas 29% of the installed cohort were from this group. This suggests the project has successfully targeted homes more likely to be in fuel poverty.



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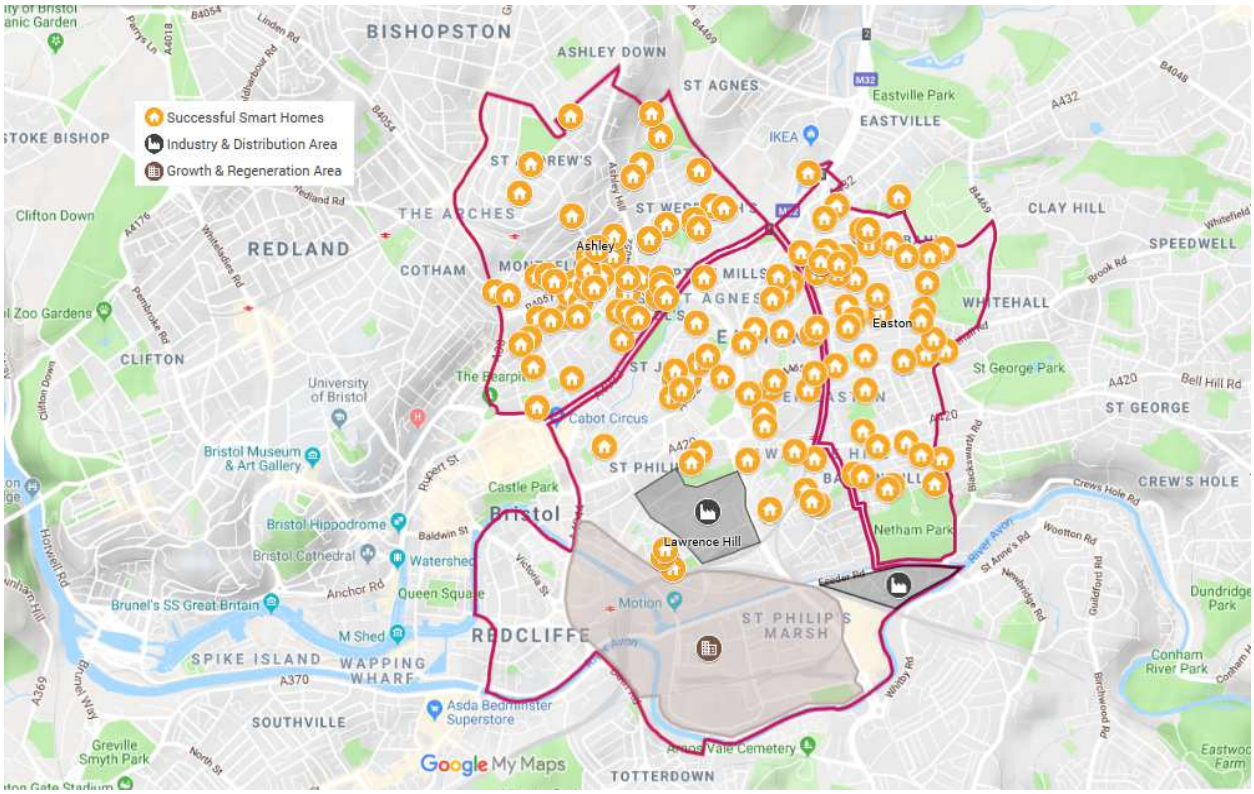

Figure 16: Map of Smart Homes enquires versus installations

The project focused on all housing tenure types to enable learning from a broad perspective. There were significant challenges and additional resources required to engage social housing tenants, and private rented homes as compared with owner occupied properties. The benefit of negotiating this process and the relevant permissions was that it enabled households who would not necessarily be able to participate in projects of this nature to do so. Technology and innovation projects tend to target those who are immediately interested and knowledgeable about the project area rather than those who stand to benefit most but have amongst the lowest awareness of the benefits that could arise.

This approach resulted in 29% of participating households living in social landlord properties (14% Bristol City Council Housing, 15% registered social landlords)

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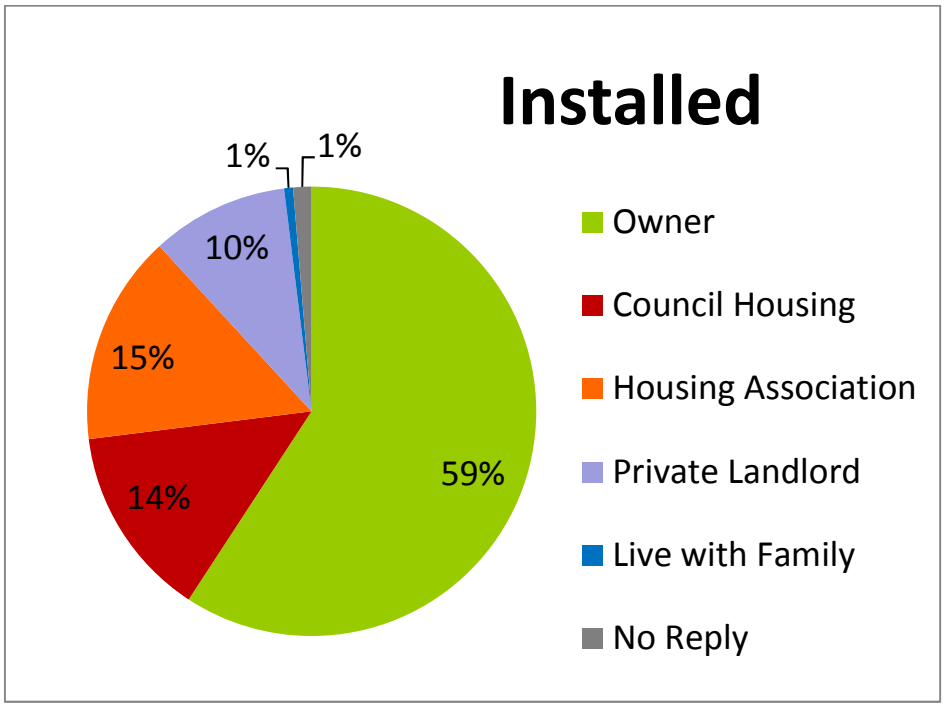

Fig 17: Demographics of house type

Although there was no pre monitoring data available to gather data relating to the money spent by households running their old appliances the Energy Saving Calculator created by the team estimated the likely savings based on their outing appliance energy rating. UWE then verified the methodology which showed that households could save up to £150 per year (if they had two appliances). Further analysis based variables specific to the homes e.g. occupant numbers, would enhance the accuracy of the evaluation.

Further social impacts in future could be realised through applying the learning about understanding the barriers to a range of household types and demographics engaging in this type of project.

5.3 Environmental impacts

A desktop analysis from the Energy Savings Calculator it is estimated that individual households could save up to 260.8kgCO2. Further, in depth work, is required to evaluate these figures that will be undertaken by UWE.

Through the procurement of Smart Homes where possible, local contractors were used. There was a weighting in the criteria to favour local contractors and to ask them to travel sustainably where possible to reduce the environmental impacts associated through delivery.

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The new smart appliances use less water on average compared with the appliances they replaced. No in depth analysis has been undertaken on this but it is an area that could be further explored. However, as electricity savings were the main focus for smart homes, this has been where the evaluation effort has taken place.

LED lights were given away as an incentive for participants of Smart Homes to further reduce energy in homes. Although no monitoring took place as to whether or not they have been implemented or what additional savings have been made from a household's energy. Modelling could be undertaken to estimate this figure but has not as yet been undertaken. This could form part of the final evaluation of the project.

Whilst the main aim of recruitment activity has been around sign up to Smart Homes simultaneously Bristol Energy Network (partners and champions), were engaging people in energy saving behaviour change conversations. It is not possible to estimate any of the wider energy savings as a result of these engagements, but it can be assumed that some level of behaviour change resulted.

5.4 Replication and scalability potential

Funding

The community engagement approach taken through Smart Homes has already been replicated in a successful Innovate UK design study bid for a future energy system project Bristol Energy Smart System Transformation (BESST). This involved working closely with community organisations and the Bristol Energy Company to develop the design and engage communities. A close working relationship was again formed which was central to project delivery.

Furthermore, learnings from the delivery approach are being taken in to a smart speaker trial as part of a smart health project. In particular, procurement learning and community engagement approaches are being taken from the smart homes project and adapted to the local context.

Dissemination

Smart Homes learnings have been shared at a range of high profile European events and conferences. Most recently this has included being showcased as part of shortlisting for an innovation award at the annual awards ceremony for Eurocities.

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Figure 18: Eurocities event case study

Both speaking at conferences and participating in a range of European wide workshops has enabled sharing of good practice and lessons learnt. For example, efficiencies have been saved where other municipalities have taken those lessons and applied them to their own context. A Spanish Municipality contacted the project team to ask about data flow between appliances and a decision was made to use data from smart meters and not the machines themselves due to the

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issues we encountered in easily accessing data. Shortening the learning curve for other smart home projects has been possible through examples like this.

Bristol City Council received a national Smart City UK award for the community engagement work around REPLICATE

Figure 19: Community Engagement Group receiving Smart City UK award for community engagement

There have been 19 dissemination and marketing instances regarding Smart Homes including social media campaigns. These include internationally significant Smart City Events through to local press and media. Estimates of reach through these stands at 90,851.

5.5 Economic feasibility

Smart appliances of this nature are relatively new technology and choice is limited at time of commissioning and is only available at a higher price point with additional functionality. The market has put these capabilities to their highest end, feature packed machines when in reality they do not need these features to also be 'smart'. The wifi connected capability of machines is a low cost addition and is likely to be seen in most home appliances going forward as a result. It has been noted that there is a slight shift in the market to more 'smart' appliances being available, however this still seems more of a 'gimmick' rather than required functionality.

The cost of a like for like smart vs non smart machine with the same features is currently perhaps around 20% difference. There is no real economic incentive for households to buy a smart

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machine due to the lack of energy pricing tariffs currently available that make it worthwhile for households to time machines when energy is cheaper for example.

At a scaled wider project delivery level, the market is not yet in a position to create economic incentives linked to the capabilities smart appliances have. For example, the amount of energy that can be shifted from appliances is not necessarily worthwhile when compared to the infrastructure required to enable that to take place. If reliant on a household having a smart meter, home hub and other IOT equipment that are constantly switched on, this is not only a large outlay financially (with a home hub costing upwards of £100 plus any other equipment required i.e. smart plugs) then the returns do not cover this. Currently this is because the price of electricity is not significantly variable enough. However, it is anticipated in future with the electrification of transport and heat that the prices will vary significantly enough to warrant further inclusion of DSR in households.

Households participating in the DSR trail were incentivised to allow their machines to run with the control of the EDMS. This was done through a virtual tariff taken from energy supply company Octopus who have a variable daytime dynamic traffic. Participants would then be provided with a cheque at the end of the project period which provided the difference between what they would have saved being on a dynamic tariff if the appliance cycles and the EDMS had controlled this.

Through renovating the Eco Home as a showcase smart home the project was able to leverage £15,000 worth of sponsorship and in kind support. The Eco Home is now in a position where renovations can continue and it can develop in to a more polished offering for visitors to the city and suppliers to showcase their 'smart and efficient' products.

5.6 Impact on SME´s

The project has supported a number of organisations through its delivery. The primary contractor Narec and in turn their subcontractors are SME's. Local installation teams were used where possible and the ongoing electrical maintenance is being undertaken entirely by a local electrician.

The community engagement work has supported a range of community organisations to grow, in line with the ABCD approach taken. Capacity has been built amongst community organisations around smart energy themes. In particular, Bristol Energy Network have developed a greater presence in the project area as a result and made lots of new connections with other community organisations and champions. The Smart Homes project has enabled conversations to start between organisations that perhaps had not worked together previously therefore encouraging future collaborative working. The Mobile Future Home is now an asset to be used in the community for future events and activities

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6 CONCLUSIONS

The Smart Homes project can be seen as two separate but intertwined elements, community engagement and ICT integration. The community engagement element to the point of installation was highly successful in achieving its goals and has won a UK national award and shortlisting for a European Award. However, the ICT integration has proved to be significantly more challenging and is still unclear whether or not the full extent of the intended delivery will be achieved. Where the two elements most overlap is the DSR trial where the greatest delivery challenges have been faced.

It is clear that smart technologies in the market place are not prepared for DSR and community usage in the way most would use and in reality come across them in their day to day lives.

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7 APPENDICES

Smart Homes (Smart Appliances) Recruitment Strategy

Purpose

The purpose of this document is to outline the recruitment strategy for the 150 trial homes to participate in the Smart Appliance element of Smart Homes within the overall REPLICATE project. The document intends to clearly set out the criteria and approach to ensure there is transparency and equity in the selection of households.

Background

In our project bid, the Bristol REPLICATE partners stated the aim to 'explore how technology could help tackle inequalities, such as how smart homes could help ease fuel poverty'. In this light, there is no defined 'hard' priority around specifically targeting those who are in fuel poverty. However it is the project's intention to try where possible to do so. In addition, due to the research nature of the project, it is important that the participants are diverse so that we can take the away the learning. Again, no hard targets have been set for how this diversity would be structured. A Community Engagement Group (CEG) led by Bristol Energy Network made up of local community organisations has been specifically commissioned to support this process. One of the first actions for this group is to define the priority group then deliver engagement around this.

Initially it was planned that recruitment of the 150 homes would be from those who had already taken part in the retrofit element of the project (240 homes in total). However due to delays in procurement for retrofit, this is now a two phase approach with Smart Appliances being undertaken first. In light of this it is envisaged that there will be a number of homes that participate in Smart Appliances but then do not go on to participate in the retrofit measures. However where possible, Smart Appliance participants will be strongly encouraged and supported to benefit from the retrofit project, so that more aspects of their home can become more energy efficient.

The overall recruitment approach is geared towards resourcing the process to recruit those people defined as being within the priority group.

Priority Group

In order to address the aim of exploring 'how technology could help tackle inequalities, such as how smart homes could help ease fuel poverty', it was agreed that priority households should be defined. The Community Engagement Group met in February 2018 to discuss how it might ensure that all members of the community from the project areas are represented in the project. It was agreed that community outreach rather than printed media or events would be needed to support

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those who may not typically access this offer due to barriers of trust, awareness of printed media, language, lack of time or other resources. This approach has been reinforced by the initial take-up of the project's 'expressions of interest form' promoted via local printed media which has attracted interest from the less deprived areas of the wards and is under-represented in areas which have a higher BME, multiple indices of deprivation & / or child poverty demographics – the latter are indicators of fuel poverty as defined in the recent draft of Bristol's the Joint Strategic Needs Assessment (JSNA).

Understanding Fuel Poverty

The Bristol Joint Strategic Needs Assessment for 2018 has recently been consulting on a chapter on fuel poverty. The text below is extracted from a recent draft of that work.

'Fuel poverty is a complex and hard to define issue, with varying impacts on different groups. Fuel poverty in England is measured using the Low Income High Costs (LIHC) indicator. This considers a household to be fuel poor if they have required fuel costs (based on modelled energy need) higher than the national median and, were they to spend that amount, be left with income below the official poverty line. Using this definition, latest estimates (2015) consider 11% of households in England to be fuel poor (DECC, 2015). Higher levels of fuel poverty are seen amongst private renters [where rents are highest] and households with low energy efficiency ratings.

However this definition excludes households with low modelled fuel costs (often those living in smaller homes), and ignores differences in heating needs of different groups including elderly people and people with health conditions exacerbated by the cold.

For the purposes of the JSNA: *'a household in Bristol is defined as fuel poor if they are on a low income and unable to adequately meet their required fuel costs. Fuel costs here are defined as those needed to reach an adequate standard of warmth (21°C in the living room and 18°C in other occupied rooms for normal households – this may be higher for those with health needs) and meet their other energy needs, e.g. hot water, cooking, lighting, appliances. A household's income should be adjusted for their size and not include their housing costs or any benefits which are specifically linked to health or disability needs.'*

Most people experiencing fuel poverty will not consider themselves to be fuel poor, but will present to services with problems that may be a symptom of fuel poverty. Symptoms include not being able to pay household bills or other necessary costs, debt, excessive damp and mould growth, and health problems (physical and mental) especially cardiovascular and respiratory problems.

Those whose health is at highest risk from the harmful effects of living in a cold home include:

- older adults

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- young children
- households with someone who is disabled or has a long-term limiting illness
- respiratory or circulatory disease
- mental health problems'

Text from Bristol Joint Strategic Needs Assessment Fuel Poverty Chapter draft, CSE 2018

Demographics, diversity and deprivation

The project area includes the three most ethnically diverse wards in the city. They are also areas with high levels of child poverty and include some of the bottom 10% areas of multiple deprivation in the country (see maps). Lawrence Hill has a high child population whilst Easton has more older people.

Facts and figures by ward			
Data set	Lawrence Hill	Easton	Ashley
Population by age, census 2011	5,000 (Children 0-15), 12,600 (Working age 16-64), 1,300 (65 or over)	3,300 (Children 0-15), 10,600 (Working age 16-64), 3,600 (65 or over)	3,400 (Children 0-15), 14,400 (Working age 16-64), 1,100 (65 or over)
BME %, 2011 census data	59.6%	37.9%	33.5%
Child poverty % children under age of 16 in child poverty 2014 statistics *See child poverty map below	Around half of the ward area's children live in low income households	Approx one quarter of the ward area's children live in low income households	Approx one quarter of the ward area 's children live in low income households with the south of the ward experiencing higher levels of income deprivation

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			(up to 50%) and the north being relatively affluent (less than 10%)
Indices of multiple deprivation (2015 statistics)	Over half the ward is within the most deprived 10% in England and the rest within the lowest 10-20%	Around 30% of the ward fall within the lowest 10-20%, and another third within the lowest 20-30%	In the Southern half of the ward, half is within the lowest 10% and half within the lowest 10-20% most deprived

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https://www.bristol.gov.uk/documents/20182/436737/Easton.pdf/a27d08ae-9a03-405f-a96f-a41018364763

https://www.bristol.gov.uk/documents/20182/436737/Ashley+ward+profile+report

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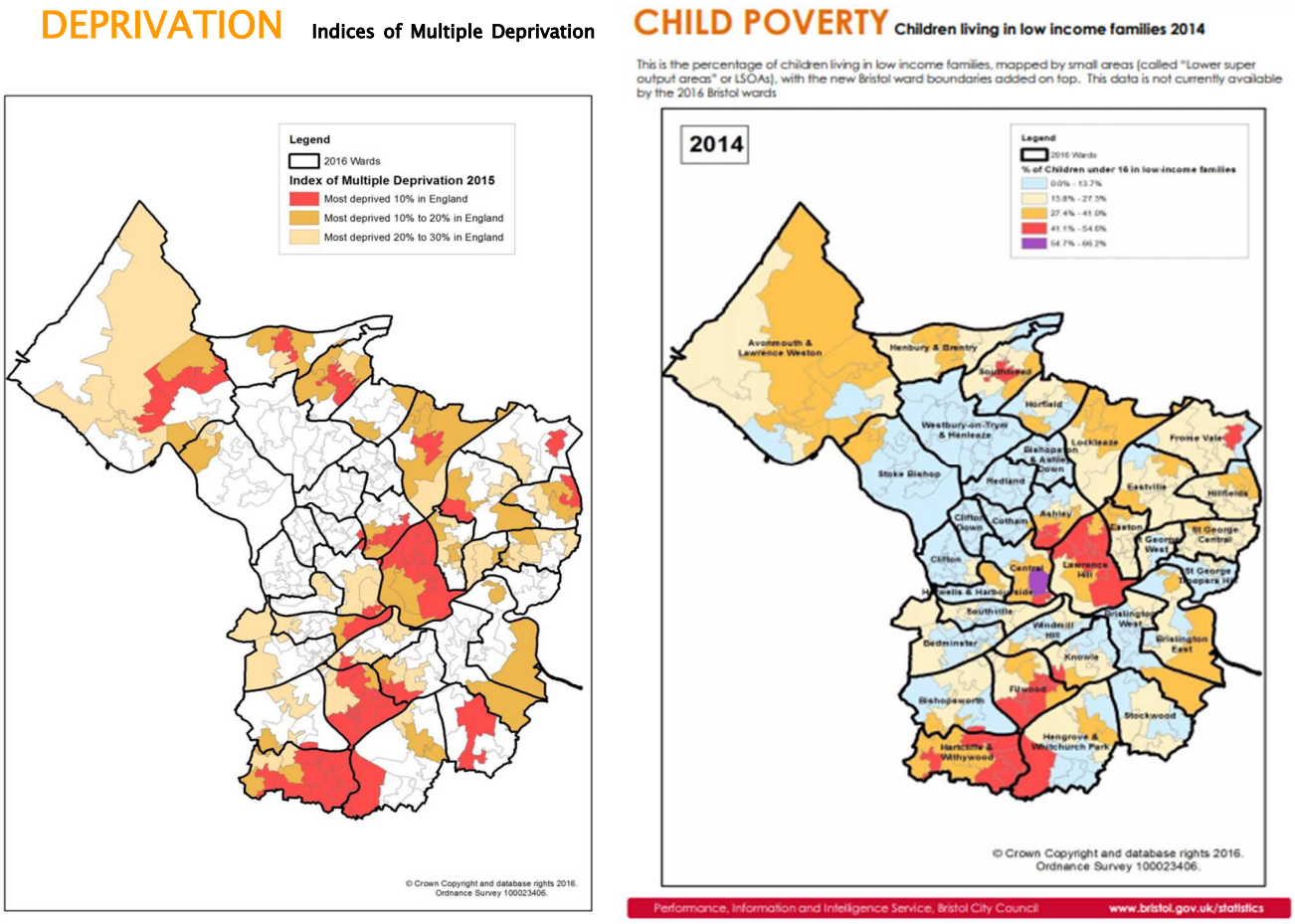

Fig 12.: 2015 indicator maps of multiple deprivation and child poverty rates in Bristol

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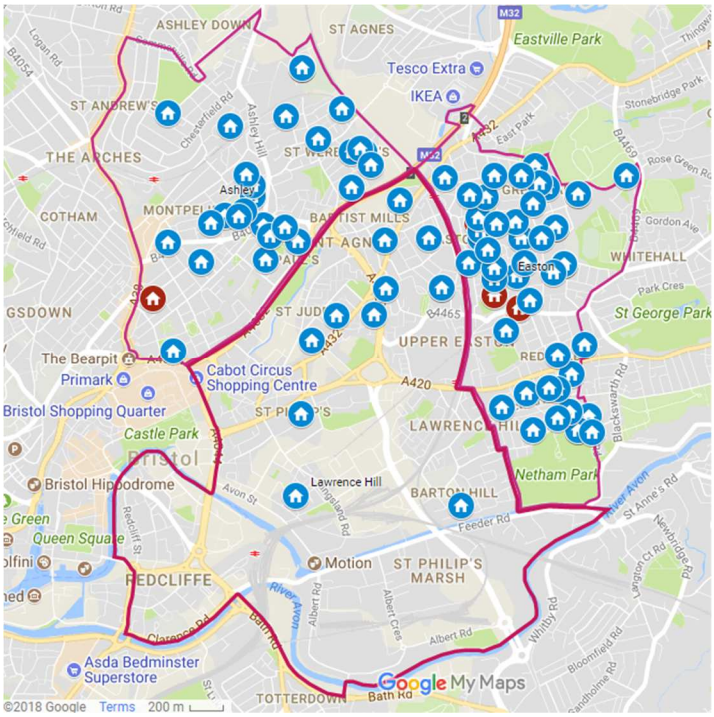

Fig 13 Map: REPLICATE Expressions of Interest in Smart Homes at 25th April 2018

Expressions of Interest in REPLICATE Smart Homes

The REPLICATE Smart Homes project to date has been promoted largely through local printed media and there have now been over 100 expressions of interest. These are mostly from the more affluent areas of the Easton and Ashley Wards – see map.

Priority engagement

Based on the analysis above, additional effort will be made to engage with areas and populations under-represented and most in need, adding additional resources to supporting and encouraging representation from those groups who may not be currently well represented and who might benefit the most – including low income families, BME communities and older people. By targeting geographical areas and segments of the population identified as being more likely to be impacted on by fuel poverty, we will seek to bring them into the project so that they can benefit from the technology on offer.

It is recognised that within the priority group there will be those who may face barriers to accessing the project. These barriers are well documented in Smart Energy GB's report "Smart energy for all: Identifying audience characteristics that may act as additional barriers to realising the benefits of a smart meter July 2015". These groups include:

- People lacking proficiency in English (there are 91 languages spoken in Bristol)
- People lacking basic digital skills
- People with no personal internet access
- Prepay customers
- Private tenants
- Social housing tenants

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- People with a learning disability
- People with low literacy
- People with memory impairment
- People with severe or profound deafness
- Low trust levels in Council led initiatives and utilities companies

In seeking to engage across the identified priority groups, efforts will be made to recognise and overcome some of these barriers.

Approach

Bristol Energy Network is working with local organisations to develop outreach and engagement processes and has also identified local champions that reflect the diversity of the community and who will support recruitment from the priority group. Engagement mechanisms might include working with groups that specifically support populations most at risk of fuel poverty such as older people, low income families, single parents, private tenants etc. The project aims to recruit members of the priority group in Tranche 3 via a variety of approaches once the sign-up process has been tested via Tranches 1 and 2 (early adopters phase and supported applicants from social housing) – so that the process itself does not become a barrier.

Recruitment principles

Tranche 1 – early adopters

As Smart Homes is part of REPLICATE, a European funded innovation research project it is necessary to test the equipment to be installed in a small number of homes prior to full rollout.

It was felt by the project's ICT subgroup technical support team that 10 homes would be sufficient to undertake this testing from a technical perspective. In addition it was felt by the Community Engagement Group that 10 homes would give a good mix of participants to get a sense of any challenges to delivery we might experience relating to customer journeys and user experiences.

The CEG will take the lead on recruiting the early adopters with the following criteria:

- Have to live in the project area
- Cannot be BCC energy service or city innovation team staff
- Must have the time to commit to the install and feedback process
- Must have some level or familiarity with using an app
- Must have broadband connectivity in their home

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- Must be people already known and trusted by CEG members
- Must have immediate permission of home owner

Tranche 2 – social housing

Three local social housing providers were approached to participate in the project. United Housing came forward with most interest in aiding the recruitment process. Social housing providers were approached due to the added benefit of being able to draw on their expertise regarding their tenants status and suitability to participate in the research. They were also assumed to house people who are more likely to be within the Smart Homes preferred priority groups as defined by the Community Engagement Group.

It was agreed that 30 households would be reserved for United Housing to recruit to with the deadline of August 2018. The rationale for these being within the first tranche is that they should provide a diverse mix of people and also have the added benefit of additional support from United Housing community engagement staff to participate.

Participation would be on a first come first served basis providing participation criteria is met.

Tranche 3 – priority group

At least 50 households will be specifically targeted by the Community Engagement Group's outreach staff. These will be those households that fit within the agreed priority groups and reserved for those only. Although a firm aim, no hard target is set for the makeup of the participants.

In recognition that these households will need more time to work through the process and be recruited, wider advertising to the general populous will be limited until these 50 allocations have been taken.

Participation would be on a first come first served basis providing participation criteria is met.

Tranche 4 – interested public

The Community Engagement Group will also lead this tranche in terms of recruiting participants through a range of activities and events. This tranche will also include those who have previously expressed an interest in REPLICATE and any wider public who have seen any advertorials placed up until the end of February 2018 when it was agreed by the CEG that such adverts would be put on hold. A holding email will be sent to those who have expressed an interest already in March 2018.

It is thought that this Tranche would allow the mix of participants to include those who do not fall into the priority groups to bring a different group of people in to the project. Specifically it is

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assumed that people in this group would be more likely to be those who would traditionally engage in an innovative technology project.

Participation would be on a first come first served basis providing participation criteria is met. Expression of interest forms submitted will be worked through in date order.

The recruitment strategy will be flexible to allow for a range of different techniques to be introduced such as increased mass marketing if Community Engagement Group methods prove to be less effective than planned. This will be reviewed at monthly meetings with the CEG as plans adapted accordingly.

Tranche 5 – mass media engagement

If any allocations remain after the first four tranches then the final tranche will involve going out to mass media through magazine, press and social media advertorials. At this point the full questionnaire will be made available so anyone can fill it out. Until that time the expression of interest form will remain the main contact point that can be completed via the project website or telephone.

Marketing and communications activities will be reviewed at once monthly meetings alongside uptake figures. There will be an adaptive approach where possible.

Other

Any contacts made through other means such as word of mouth will be asked to complete the EOI online or by post. If submitting by post their place in the priority list will be held at the point of phone contact so as not to disadvantage their chances or participation compared with those completing online.

In summary 150 homes would be made up as:

- 10 early adopters

- 30 United Housing tenants

- At least 50 referrals from Community Engagement Group's priority group

- Remainder (60 or less) EOI list and/or wider interested parties

Summary of roles

- Bristol City Council City Innovation Team: REPLICATE Smart Homes delivery
- Warm Up Bristol: managing customer journey, inward and outward calls and communications

Annex 1: Smart Homes

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- Community Engagement Group, led by Bristol Energy Network: recruitment and support of households and general advisory role
- United Housing: referral and support agency for Tranche 2
- Knowle West Media Centre: overseeing overall project wide community engagement and coordination support role for Community Engagement Group
- Bristol City Council Corporate Communications: Overseeing marketing and communication activities and facilitating sign off of key communication materials and marketing collateral.

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Annex 2 – Lawrence Hill Bus Depot Solar Installation – REPLICATE

1. How the PV was procured

BCC Energy Service were approached by First Bus with a view to installing pv arrays on two of their depots – previously we had successfully installed at another of their sites at Hengrove in Bristol. The tender for pv array at Lawrence Hill was issued under the Bristol City Council Solar PV Framework, which was in its final year of operation. Initially the tender also included Weston Bus Depot in Bath, but issues with Western Power and First Bus (the owners of the site) meant that in the end only Lawrence Hill Bus Depot went out to tender. The Procurement framework had been set up in 2015 and three pre-qualified solar installation companies were appointed to it after an OJEU compliant tender process. The companies were EVO Energy (trading as Stepnalls), Dulas and Mi-Space.

In the Summer of 2018, following a tender process where only two of the aforementioned companies returned a tender (EVO/Dulas), EVO were appointed as the contractors to install the array at Lawrence Hill.

Their submission included full potential shading analysis of the roof (from obstructions such as chimneys, nearby trees, tall buildings etc), a method statement geared to working in a high occupancy, potentially dangerous bus depot site and solutions on limiting the amount of cabling/drilling for cabling required during installation – the age of the building (some parts are pre-WW1) means asbestos is present in some areas and should not be disturbed.

2. When it was installed & commissioned

The pre-start meeting took place on the 22nd August 2018 with representatives of EVO, First Bus and BCC Energy Service in attendance.

Structural checks on the roof were carried out on the 5th September 2019 and it was confirmed that the roof was strong enough to bare the weight of the array.

Installation took place between October and December 2018. Some delays occurred as a result of inclement weather – ice and low temperatures followed by high winds (roof steeply pitched and slippery in such conditions). Works were completed on

Commissioning forms were sent to Western Power on the 10th January 2019 and an on-site handover meeting 7th March 2019.

Project no. 691735

REPLICATE PROJECT

Renaissance of Places with Innovative Citizenship And Technology

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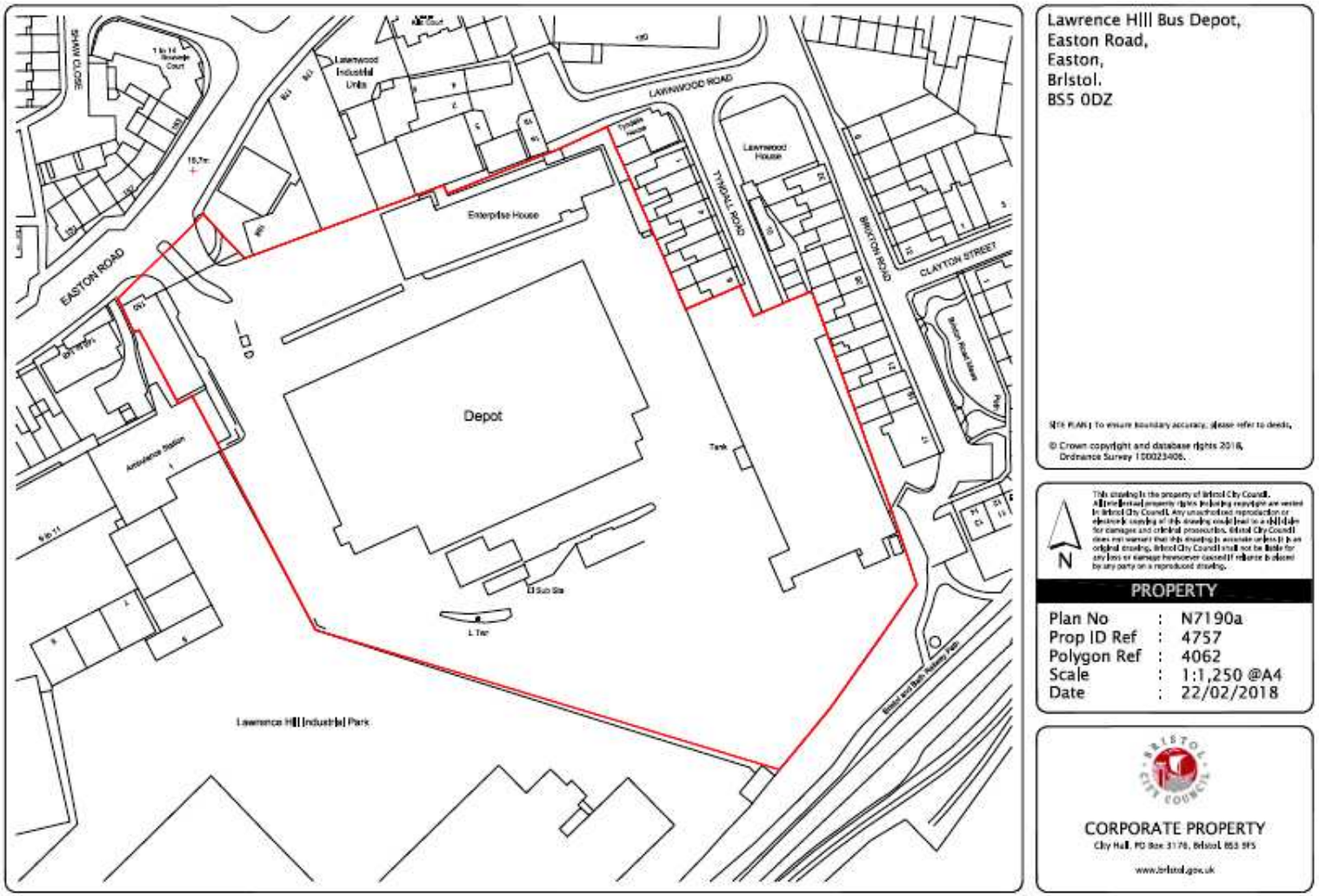
Site plan (site boundary in red). The building marked "depot" was where the PV array was installed.



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3. Technical details of the installation – extracted from PV Sol software

Roof shot showing the intended solar array on the bus station

The 130.68 kWp array on Lawrence Hill Bus depot's main workshop building consists of 484 Trina 270 Wp panels. The layout was designed to enable access via a "mansafe" system installed at the same time and to avoid sky lights and ensure a safe distance from the edge of the roof.

The panels are mounted on an industry standard K2 mini-rail system which is connected directly to the crowns of the roof allowing the panels to be mounted in a landscape orientation.

(Below) The 3 Fronius Eco and 2 Symo invertors required to convert the electricity generated from the array from direct to alternating current are sited on the southeast corner external wall of the workshop building.

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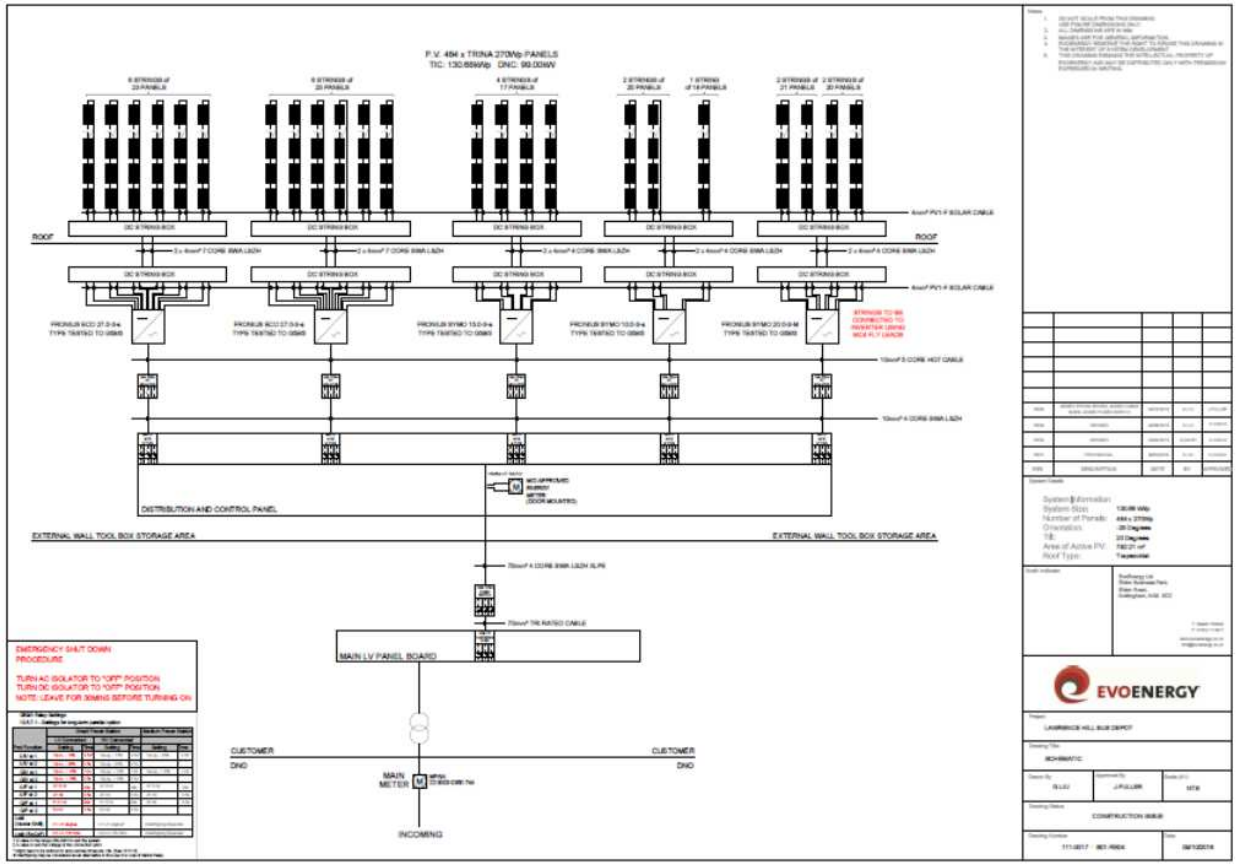
(Right) Standard export/generation meter sited next to invertors. This can be read manually. Estimated on-site usage around 80% (busy Bus Depot operating 24hrs a day).

BCC entered into a PPA – Power Purchase Agreement to sell First Electricity at 12 pence per kilowatt hour.

Schematic showing how the "strings" of panels are connected to the invertors and fuse boxes/export meter



The completed installation:

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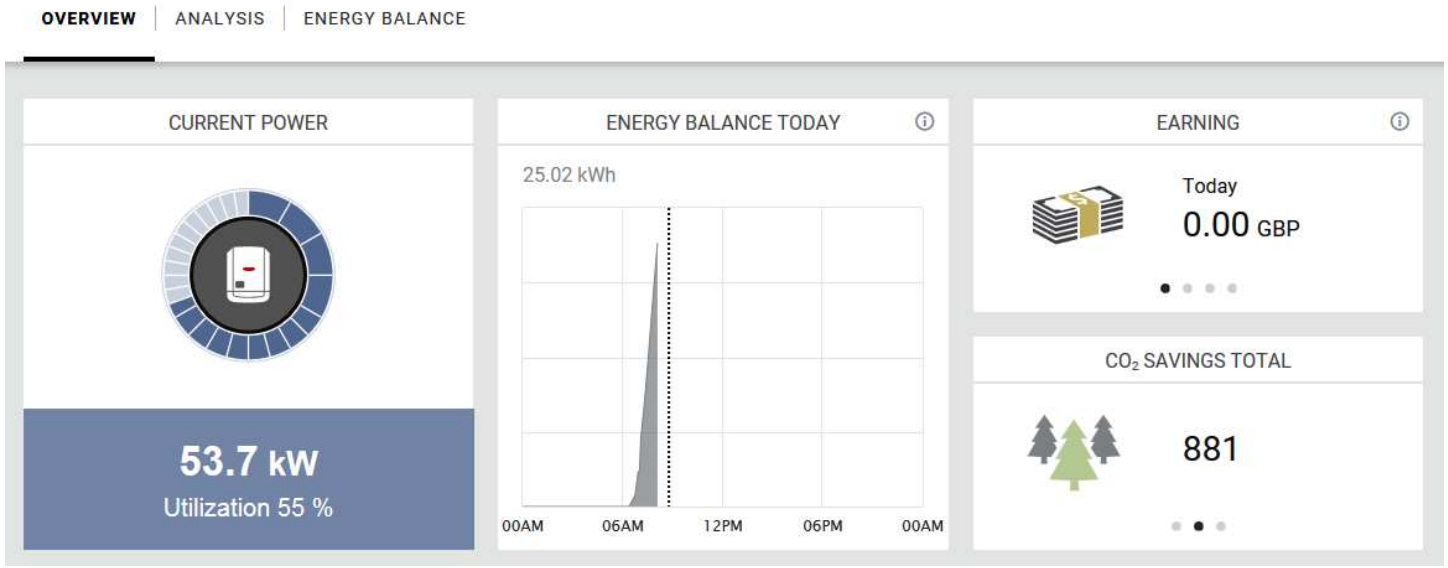
4. How monitoring of the generation/installation is undertaken

When the system was installed, the inverters that EVO specified were equipped with capacity to export data relating to the generation. The data is collated in real-time and is available via a portal on the Fronius website (https://www.solarweb.com/)

The images below show the range of the data available on the web portal (via a link provided to us by EVO).

Excerpt from dashboard, showing real-time data



(Earning and CO2 Savings cells change periodically to show different data – today, month, year, total and tonnes, trees equivalent & car km driven saved)

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Total production of 64.19 MWh (NB. Figs not available for Jan/Feb/March – portal not set up)

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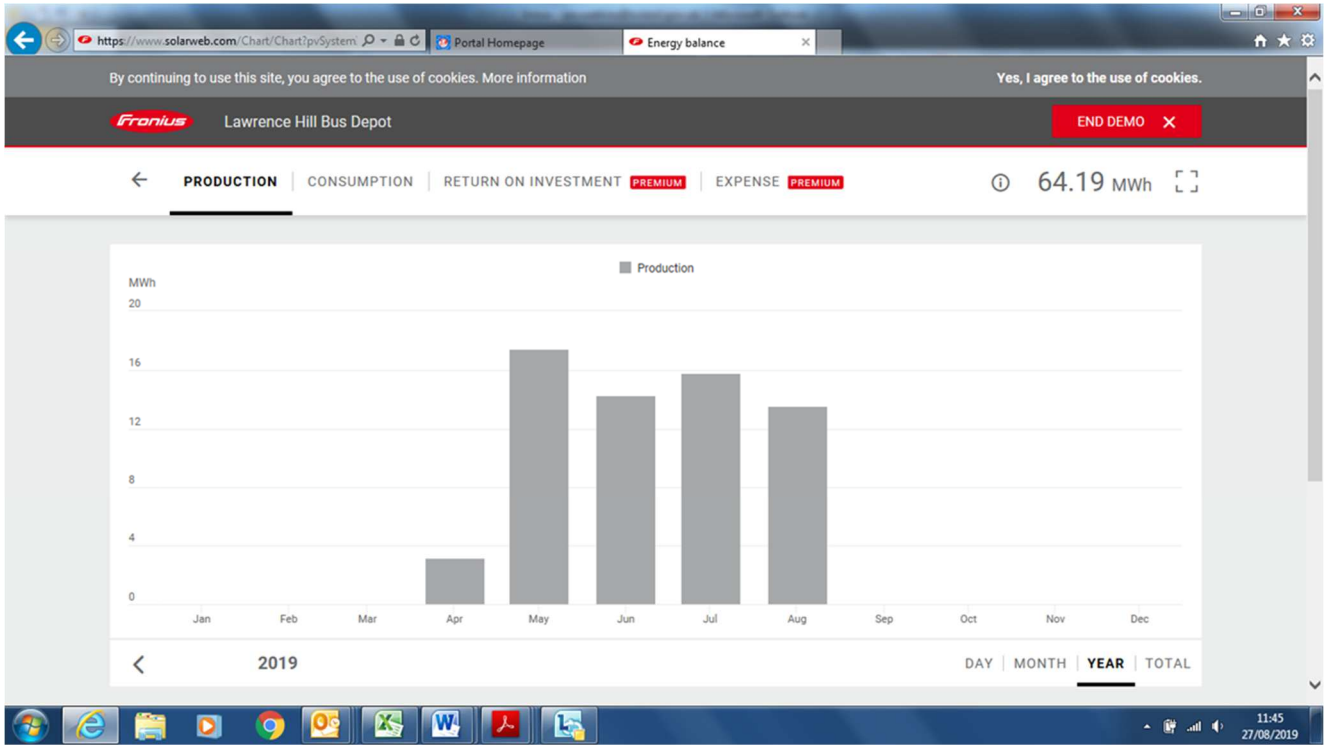

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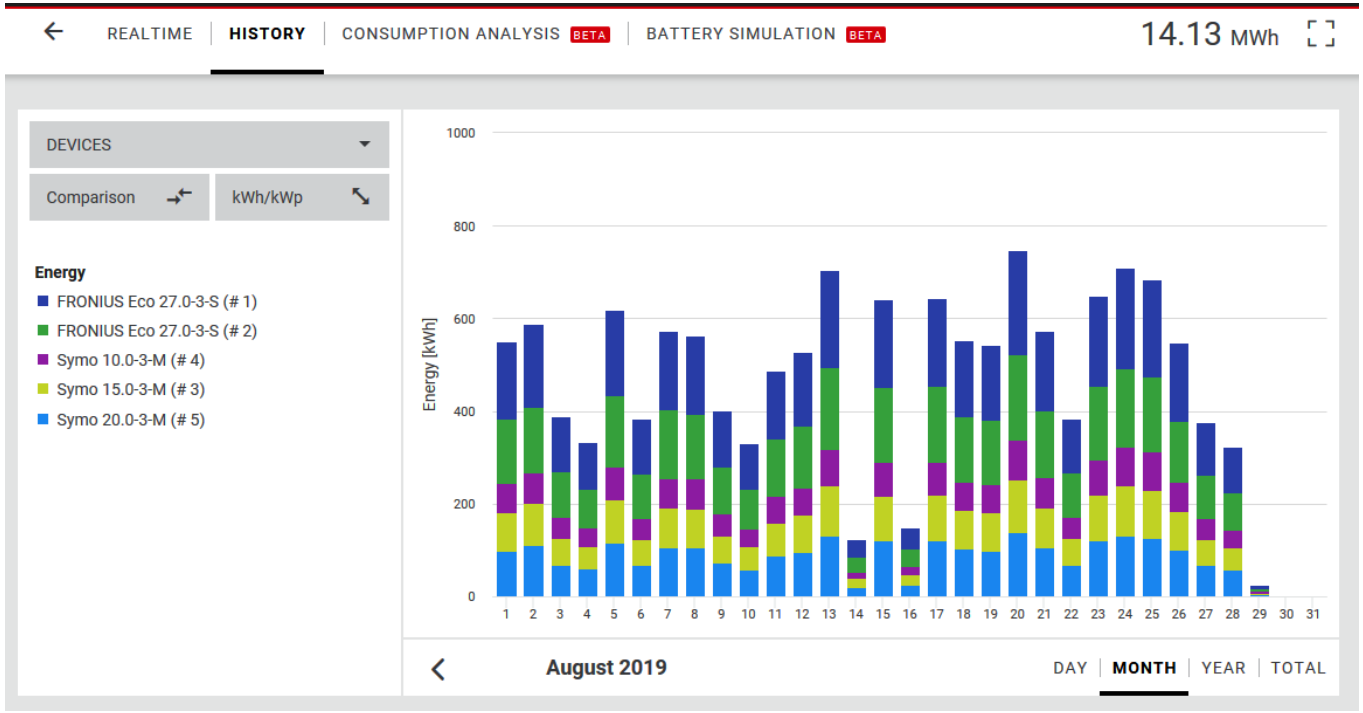
Monthly Breakdown of generation by inverter:



5. Lessons learnt from the procurement/construction process

The importance of buy in from on-site management and staff cannot be underestimated in projects of this nature. Although the initial approach and will to install solar came from the National Office in Scotland the staff at Lawrence Hill we helpful and showed great interest in the project from its inception. This was partly down to good communication as to why the array was being installed – the likely benefits to First Bus financially and environmentally were communicated to staff when they were informed of the project start date and proposed installation schedules.

Having been to site a number of times during the installation and also for the handover meeting I was struck by how many ordinary site staff thought that it was a great idea to use the roof to generate electricity and that pv should be installed wherever possible, both on First's portfolio and in the wider City as a whole.

One thing I was not prepared for was the amount of legal paperwork required to allow the array to be installed on a Bristol City Council owned building that was occupied under licence by First Bus – this, on the face of it should've been a straight forward exercise, but because we were not leasing the roofspace/airspace above a private building as is often the case the solicitors on both sides got rather caught up in the intricacies of the law pertaining to licences rather than leases. This lead to a lot of toing and froing between legal persons and some delays to the project.

Further details relating to the changes in the project from original bid submission are detailed in Periodic Report 3 and amendment documentation.

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D5.1 Annex 3 – Technical Survey Example

Solar PV Survey Form

Project Information					
Project Reference:	**BI-4007**	**Surveyor:**	[redacted]	**Date of survey:**	**27/8/19**
Customer Name:	[redacted]				
Address:	[redacted]				
Site Address (if different to above):	**N/A**				
Postcode of Installation site:	[redacted]				
Contact Details	**Telephone:**	**N/A**	**Mobile:**	[redacted]	
	Email:	[redacted]			

Roof Access	
How is the roof to be accessed?	**Scaffolding required to rear of house. First 2m wide lift at 2.5m high, 2nd lift full width of building and up to the gutter height for installation. Lean to at the back.**
Is the access required for one elevation?	**N/A**
Are there any other access issues to be considered?	**Yes. Very narrow street, limited parking. No access to back garden.**

Solar PV Survey Form

System Design		
Is this survey being carried out "on site" or remotely?	On site	
Building use – domestic or commercial?	Domestic	
Build type – retro fit or new build?	Retro fit	
Size of system desired/proposed (in kW):	2.75 kWp	
Will the proposed system be roof, wall or ground mounted?	Pitched Roof Mounted System	
On or Off Grid?	Connected to the Grid	
Will the proposed orientation and tilt angle of the array achieve optimum collection capacity for the location and building design?	Yes	
Proposed make and model of modules (if known)	JA Solar Holdings – JAP60S01-275/SC	
Monocrystalline/Polycrystalline?	Polycrystalline	
How many strings will the proposed system have?	Single String	
Present electricity cost per kilowatt hour:	N/A	
Is there a valid EPC in place for the property?	N/A	If YES – Energy Rating: N/A

B I ELECTRICAL SERVICES

Solar PV Survey Form

Roof Assessment	
General roof condition:	**Good**
Is the property in an exposed location?	**Yes**
Inclination of roof from horizontal:	**45°**
Roof slope length, ridge to eaves:	**4 m**
Lower width – gable to gable:	**6 m**
Upper width – if different:	**6 m**
Gutter height above ground:	**6 m**
Is the installation likely to result in the loading on the roof structure increasing by 15% or more? Any prior increase in the loading of the structure must be taken into account	**No**
Is the proposed PV array mounting surface of sufficient area, including any required clearances?	**Yes**
Is the condition of the proposed PV array mounting structure and mounting surface satisfactory?	**Yes**
Are there any obstacles that will cause shading issues? (Chimneys, windows etc.).	**No**
Is there a likelihood that significant overshading issues could occur in the future e.g. tree growth?	**No**

Solar PV Survey Form

System Data – Sun path and shading assessment is required from the base of each array facing SOUTH	
String 1 – Proposed number of modules:	10 modules
Proposed installed total capacity:	2.75 kWp
Orientation (Variation from South):	245°
Inclination (Variation from Horizontal):	45°
Is any shading present within 10 m of the proposed array?	No
String 2 – Proposed number of modules:	N/A
Proposed installed total capacity:	N/A
Orientation (Variation from South):	N/A
Inclination (Variation from Horizontal):	N/A
Is any shading present within 10m of the proposed array?	N/A
String 3 – Proposed number of modules:	N/A
Proposed installed total capacity:	N/A
Orientation (Variation from South):	N/A
Inclination (Variation from Horizontal):	N/A
Is any shading present within 10m of the proposed array?	N/A

Solar PV Survey Form

Electrical Assessment	
Distribution Network Operator (DNO) for this region?	**Western Power Distribution**
Which Engineering Recommendation will apply to this installation? (e.g. G83/2)	**G98**
Will permission from the DNO be required prior to installation?	**No**
Customer's electrical supplier?	**N/A**
Proposed method of connection to the Consumer Unit?	**Connection to new CU**
Is the existing electrical installation in good condition?	**Yes**
What is the distance from the Consumer Unit to the proposed location of the inverter and what is the estimated voltage drop?	**15 m**
Have regulatory periodic inspection and testing requirements been met?	**N/A**
Is main earthing and bonding in place?	**Yes**

Solar PV Survey Form

Proposed Location of Key Components	
Proposed location of Inverter:	**In the loft space - loft hatch small (45cmx40cm)**
Proposed location of Generation Meter:	**Cupboard behind supply meter**
Proposed location of the DC Disconnect and AC isolator:	**Cupboard behind supply meter**
Do the proposed locations of the above meet with both the regulatory requirements and the customer's expectations?	**Yes**

General	
Will the installation work result in non-compliance with the Building Regulations in relation to workmanship; materials; structural stability; fire safety; resistance to moisture; conservation of fuel and power and electrical safety?	**No**
Will the proposed installation result in non-compliance with the IET wiring regulations?	**No**
Will the proposed installation be compliant with any requirements stated by the Solar PV system component products manufacturers?	**Yes**
Will any form of protected species be disturbed during the installation process?	**No**

Solar PV Survey Form

Additional observations: