WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

FREEDOM

WPD_NIA_023

NIA MAJOR PROJECT PROGRESS REPORT

REPORTING PERIOD:

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	Name	Date
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Contents

Glossary

Term	Definition
BAU	Business as usual
BEIS	Department for Business Energy and Industrial Strategy
CEP	Customer Engagement Plan
DG	Distributed Generation
DNO	Distribution Network Operator
FREEDOM	Flexible, Residential, Energy, Efficiency, Demand, Optimisation & Management
GATC	Gas Assessment and Training Ltd
GB	Great Britain
HCI	Human Computer Interaction
HV	High Voltage
IPR	Intellectual Property Register
ITT	Invitation to Tender
kV	Kilo Volts
LCT	Low Carbon Technologies
LV	Low Voltage
NIA	Network Innovation Allowance
Ofgem	Office for Gas and Electricity Markets
PEA	Project Eligibility Assessment
RFI	Request for Information
TWh	Terra Watt hour
WPD	Western Power Distribution
WWHA	Wales and West Housing Association
WWU	Wales & West Utilities

1 Executive Summary

Project FREEDOM is funded through Ofgem's Network Innovation Allowance (NIA). FREEDOM was registered on the 27th September and will be completed by the 31st May 2018.

FREEDOM aims to investigate the feasibility of the use of heat pumps on both WPD's & WWU's network in order to:

- Demonstrate the ability of the hybrid heating system to switch between gas and electric load to provide fuel arbitrage and highly flexible demand response services;
- Demonstrate the consumer, network, carbon and energy system benefits of deployment of hybrid heating systems with an aggregated demand response control system; and
- Gain insights into the means of balancing the interests of the consumer, supplier, distribution and transmission network when seeking to derive value from the demand flexibility.

The project will deliver a hybrid heating system that is able to support the electricity and gas network in the discovery of sustainable alternatives to help deliver the UK's energy requirements. The project will consider whether the technology can defer network investments, remove network constraints and provide a fully flexible domestic heating load management service. The principal benefit is that hybrid systems can unlock the value of flexibility that will help consumers access lowest cost heat. Up to a maximum of 75 participants will be involved in the trial.

This report details progress of the project, focusing on the last reporting period, April 2017 to September 2017.

1.1 Business Case

Initial modelling suggests that customer heating bills could be reduced by c.40%. Energy system savings result from reducing peak capacity requirements, deferral of network reinforcement due to demand response flexibility for which BEIS forecasts that £100Bn of UK network investment is required by 2020. In their report to the Committee on Climate Change (Oct 15), Imperial College forecast annual value of flexibility to the UK at between £2bn and £8bn depending on the level of decarbonisation. Heat pumps are forecast to deliver 175TWh of domestic heating load per year by 2030 and can be a major contributing factor. The market currently lacks a competitive solution to a gas boiler. A hybrid system of heat pumps used alongside existing gas boilers presents the first real future of heat response to all three challenges of the energy trilemma i.e. Energy Sustainability, Energy Affordability and Energy Security. Installing more clusters of Low Carbon Technologies (LCTs) such as heat pumps would lead to the reinforcement of an LV feeder depending on volumes of deployment.

A hybrid heating system is designed for the future and is expected to lower the number of peak periods on the electricity distribution system and reduce the constraint levels in the long term. If we estimated the consumption to be in the region of 3.5 - 4kW per hybrid

heating system then we see huge savings in overall cost compared to an all-electric air source heat pump estimated to consume in the region of 7kW. It is therefore understood that an all-electric heat pump installation would not be cost effective compared to the hybrid heating system due to inability to switch between electricity and gas and adding to more constraints on the distribution system.

1.2 Project Progress

This is the second progress report. It covers progress since from April to the end of October 2017.

The summary of the progress is explained below.

- The FREEDOM Project is currently delivering the main trial deployment of hybrid heating systems. We are deploying three hybrid heating systems (Samsung, Daikin and MasterTherm). By the 26th of September the FREEDOM Project had completed 50 installations (37 MasterTherm, 7 Daikin and 6 Samsung). 21 more installations are scheduled for installation by the end of October: 3 MasterTherm, 9 Daikin and 9 Samsung. We shall have a total of 71 by the end of October. All completed installations have the Passiv hybrid heat pump controls installed.
- All installations are adhering to the Construction Design Management process. To date we have 0 - health and safety issues, 0 - incidents/accidents and 0 - complaints.
- Recruitment: PassivSystems has successfully secured 71 homes to take part in the Freedom Project. There is also a pool of homeowners who have registered that are on the backup list in case there are dropouts with participants already signed up.
- Customer Engagement: Passiv has focused on customer engagement and ensuring that all tenants and homeowners are educated about the FREEDOM Project, including the scheduled hybrid heat pump experiments that are during the 2017/18 heating season.
- Pre-trial surveys are being completed and the data is being gathered. The survey can be viewed here: https://www.surveymonkey.co.uk/r/MPS2ZCL
- FREEDOM Project Branding: The project branding has been carried out by Synergy.
- City University has been developing the wireframes or graphical explanations on energy consumption, demand response and budgeting
- Delta-ee has been conducting surveys with homeowners following the pilot trial. Delta-ee has been analysing the pre-pilot trial survey data. Delta-ee conducted tele-depths with pilot trial participants in the post-installation phase of the pilot trial, to understand and learn from the installation process to help the main trial run more smoothly.
- Imperial College has continued to assess the Bridgend electrical distribution network based on information obtained from WPD. This will allow them to model the network for the trial.
- Meetings between WPD, WWU and PassivSystems continue on a monthly basis.

1.3 Project Delivery Structure

1.3.1 Project Review Group

The FREEDOM Project Review Group meets on a bi-annual basis. The role of the Project Review Group is to:

- Ensure the project is aligned with organisational strategy;
- Ensure the project makes good use of assets;
- Assist with resolving strategic level issues and risks;
- Approve or reject changes to the project with a high impact on timelines and budget;
- Assess project progress and report on project to senior management and higher authorities;
- Provide advice and guidance on business issues facing the project;
- Use influence and authority to assist the project in achieving its outcomes;
- Review and approve final project deliverables; and
- Perform reviews at agreed stage boundaries.

1.3.2 Project Resource

Project Partner	Resource	Detail
Western Power Distribution	Faithful Chanda	Project Manager, WPD
Wales & West Utilities	Oliver Lancaster	Project Manager, WWU
	Lucy Mason	Innovation Manager , WWU
PassivSystems	Ian Rose	Professional Services Director, Project Lead
	Tom Veli	Professional Services Manager, Project manager
Delta - EE	Andrew Turton	Principal Analyst: Customer proposition and development of engagement framework
	Phillipa Hardy	Senior Analyst: Customer proposition and development of engagement framework
City University	Simone Stumpf	HCI Design Lead
Imperial College	Goran Strbac, Dimitrios Papadaskalopoulos, Meysam Qadrdan, Predrag Djapic, Marko Aunedi	Network Modelling Team led by Prof Goran Strbac

Table 1: Project resource

1.4 Procurement

The following table details the current status of procurement for this project.

Provider	Services/goods	Area of project applicable to	Anticipated Delivery Dates
Samsung	Samsung heat pump system	Main FREEDOM installations in Bridgend , South Wales	Upfront purchase (15 Samsung heat pumps)
ThermalEarth	MasterTherm heat Pump system	Main FREEDOM installations in Bridgend , South Wales	Upfront purchase (40 MasterTherm heat pumps)
Daikin	Daikin heat pump system	Main FREEDOM installations in Bridgend , South Wales	Upfront purchase (16 Daikin heat pumps)

Table 2: Procurement Details

1.5 Project Risks

A proactive role in ensuring effective risk management for FREEDOM is taken. This ensures that processes have been put in place to review whether risks still exist, whether new risks have arisen, whether the likelihood and impact of risks have changed, reporting of significant changes that will affect risk priorities and deliver assurance of the effectiveness of control.

Contained within Section 7.1 of this report are the current top risks associated with successfully delivering FREEDOM as captured in our Risk Register. Section 7.2 provides an update on the most prominent risks identified at the project bid phase.

1.6 Project Learning and Dissemination

Project lessons learned and what worked well are captured throughout the project lifecycle. These are captured through a series of on-going reviews with stakeholders and project team members, and will be shared in lessons learned workshops at the end of the project. These are reported in Section 5 of this report.

Event	Date	Attended by/ To be attended by	Location
Future of Gas, IGEM South West	09/11/16	WPD, WWU & PassivSystems	Bristol
Carbon Connect	08/02/17	WWU	Westminster, London

Low-carbon Heating Technical Innovation Workshop	14/02/17	PassivSystems	BEIS
Wales Energy Conference	16/05/17	WPD	Cardiff
IEA Heat Pump Conference	15/05/17 – 18/05/17	WWU & PassivSystems	Rotterdam, The Netherlands
IEA Heat Pump Conference	26/09/2017	WPD, WWU & PassivSystems	BEIS, London
IEA Annex 45	05/10/2017	WWU & PassivSystems	Utrecht, The Netherlands
WPD Balancing Act	05/10/2017	WPD, WWU & PassivSystems	Westminster, London

Table 3: Dissemination Details

2 Project Manager's Report

2.1 Project Background

WPD and WWU put together a proposal to deliver an innovation project to realise the benefits of using the hybrid heating system (heat pump and gas boiler) for the electricity and gas networks and their customers. PassivSystems were engaged to deliver the project. The trial is being conducted in domestic housing units in the Bridgend area.

The proposed project runs for 27 months and has been broken down into two phases, defined in 14 work packages. The phasing reflects the contractual break clause prior to installations commencing. Phase 1 covers all work required to produce the models, hypotheses, plans and recruitment actions required for the heat pump procurement and installation activity to commence. Phase 1 also includes a 4 home pilot installation which assess the hardware and installation risk and collect the baseline data required for the advanced control development. Phase 2 covers the work of installation, commissioning, aggregated control development, field experiments, data capture and analysis, reporting and knowledge dissemination.

2.2 Project Progress

2.2.1 Main installation

This reporting period has mainly been focussed on the delivery of Phase 2 of the project.

We are also focused on customer engagement and ensuring that all tenants and homeowners are educated about the FREEDOM Project, including the scheduled hybrid heat pump experiments that are due to commence in the 2017/2018 heating season.

Below is a typical configuration of a hybrid heating system:

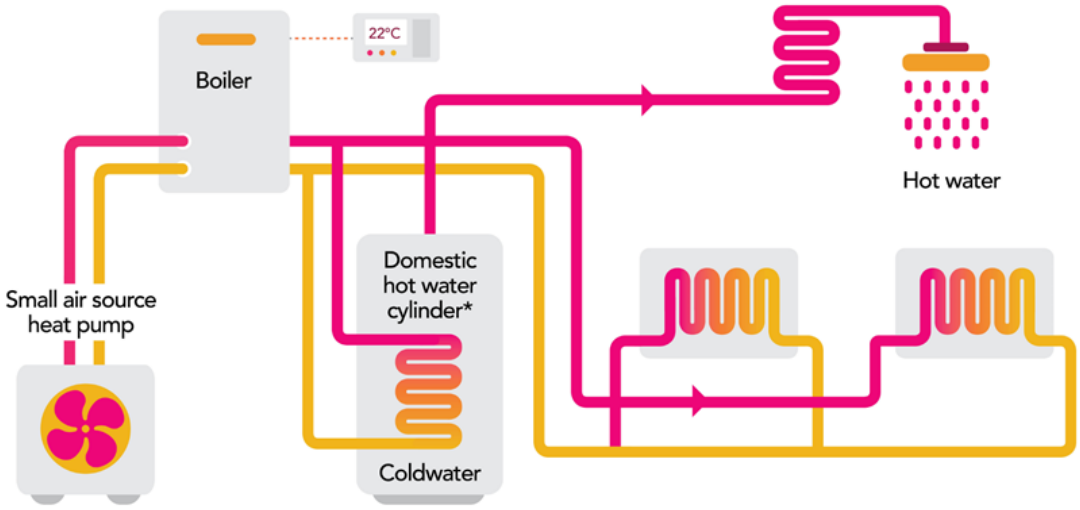

Figure 1: Configuration of a hybrid heating system

The FREEDOM Project is currently delivering the main trial deployment of hybrid heating systems. We are currently deploying all three hybrid heating systems (Samsung, Daikin and MasterTherm). By the 26th of September the FREEDOM Project had completed 50 installations: 37 MasterTherm, 7 Daikin, and 6 Samsung. 21 more installations are scheduled for installation by the end of October: 3 MasterTherm, 9 Daikin and 9 Samsung. We shall have a total of 71 by the end of October. All completed installations have the Passiv hybrid heat pump controls installed. We procured all hybrid heat pumps upfront (40 MasterTherm, 16 Daikin, and 15 Samsung). The 40 MasterTherm heat pumps were allocated to Wales and West Housing Association. The other 35 heat pumps consisting of Daikin and Samsung have been allocated to private homes.

Below are some of the installations from the main trial:

- Daikin - 5kW

Figure 2: Daikin units installation

The Daikin Combined unit is being installed by WDS Green Energy.

- MasterTherm Heat pumps - 8kW

The MasterTherm and the Vaillant boiler are being installed by Thermal Earth.

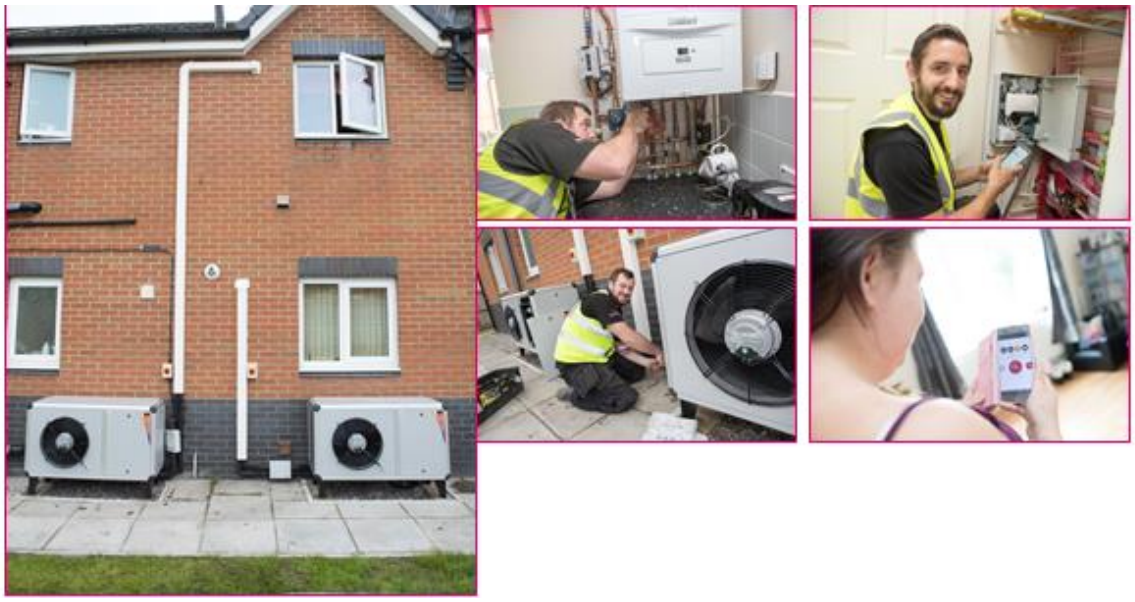

Figure 3: MasterTherm installation

- Samsung Heat Pump – 5kW

The Samsung heat pumps and the associated Worcester Bosch boiler are being installed by Spire Renewables.

Figure 4: Samsung installation

2.2.2 Branding

The branding logo for the project is shown below.

Figure 5: FREEDOM logo

In order to solicit support and promote awareness of the project, various organisations and sectors of community have been engaged across Bridgend including:

- Madeleine Moon, Bridgend MP – supporter of energy innovation and the local community.
- Bridgend County Council – supporter of energy innovation and the local community.
- Welsh Assembly - supporter of the local community.
- Catapult - supporter of energy innovation.
- Wales and West Housing Association, social landlord – supporter of the local community.
- Hafod Housing, social landlord - supporter of the local community.

2.2.1 Next steps

- Effective customer engagement
- Regularly supplying information and conducting surveys
- Passiv controls installations
- Site visits (Bridgend) with BEIS end of October

3 Progress against Budget

Spend Area	Budget (£k)	Expected Spend to Date (£k)	Actual Spend to Date (£k)	Variance to expected (£k)	Variance to expected %
WPD Project Management	70	34.887	34.887	195.334	-13

Project Partner Project Costs	1,562.447	1,367.113	1,367.113	35.113	-50
BRANDING FEES	4	3.495	3.495	0.506	-13
TOTAL	**1,636.447**	**1,405.495**	**1,405.495**	**230.952**	**-14**

Table 5: Progress against budget

3.1 Explanation in variance

Spend is below the expected value as the project is delivering in accordance to the project plan - on time and on budget. We have had to spend less on branding fees, project partner costs are paid in line with the agreed schedule, and so are the project management fees.

4 Progress towards Success Criteria

Expected success	How this is being achieved
Present a comprehensive review of the technology	With support from Delta-ee and through a thorough procurement process which includes a Request For Information, an assessment, Invitation To Tender and a pilot trial review we were able to assess the heat pump performance of our chosen three heat pump technologies. The aim was to have more than one hybrid supplier which will mean that the project will have a second or third supplier available if the hybrid systems are not performing well.
Produce a case study of how the technology contributes to the reduction of carbon emissions and compares with previous energy bills for domestic consumers through increased heating system efficiencies and a reduced unit cost	This is yet to be determined as we move into the 2017/18 heating season. A series of hybrid heat pump experiments are scheduled for the coming heating season.
Identify if the solution can bring benefits to WPD's & WWU's networks	This is yet to be determined
Deploy trials subscribed to by up to 75 participants	By the 26th of September the FREEDOM Project had completed 50 installations: 37 MasterTherm, 7 Daikin and 6 Samsung. 21 installations (3 MasterTherm, 9 Daikin and 9 Samsung) are scheduled to be completed by the end of October. There is also a pool of homeowners who are registered on the backup list in case there are dropouts from the current sign ups.

Produce a proven architecture for the hybrid heating system; and	Based on the successful pilot installations, it is appropriate to say some measure of success has been recorded. To date, all completed installations have the Passiv hybrid heat pump controls installed and working correctly.
Develop a business process (polices, standard techniques etc.) for the use of hybrid heating system.	This is yet to be determined.

Table 6: Progress towards success criteria

5 Learning Outcomes

- Coordination between installation teams is always vital to prevent making multiple visits to the property: Once the hybrid system installation and the meter and monitoring equipment had been installed, PassivSystems would enter the home and connect these items to the Passiv hub. Between the homeowner, the installation contractor and PassivSystems we had to arrange availability to do this and it took more effort/coordination than expected. In future, the installation contractor will connect the hybrid system, meters and monitoring equipment straight after the hybrid system has been installed – this will provide a fluid process and minimal visits to the home.
- Customer engagement – During the pilot trial we learnt that landowners needed to know about the project to a comfortable level of detail. We ensured that sufficient information was provided in the main installations.
- Incompatibility with equipment during installation: Sontex heat meter used was not compatible with the Daikin unit. The installation contractor attempted to fit the Sontex heat meter to the Daikin unit, however, could not fit the final temperature sensor probe as it was too big to integrate with the unit. A Danfoss heat meter was eventually used and this required a second visit for the installer to fit the unit and a second visit for PassivSystems to connect to the hub, which was an inconvenience for the homeowner.
- Post installation work: Following the pilot trial installations, through PassivSystems we were able to review each supplier and contractor and ensured that lessons learnt were implemented in the main installations.
- We also experienced situations where the homeowner suddenly withdrew from the project impacting on recruitment and set targets. To get around this problem, we have now ensured that there is sufficient cover or alternatives to call upon by accepting more participants through recruitment.

6 Intellectual Property Rights

A complete list of all background IPR from all project partners has been compiled. The IP register is reviewed on a quarterly basis.

The Freedom Project has generated IPR in a variety of areas.

Wireframes from City University and code from PassivSystems have been produced to develop specific hybrid heat pump controls.

A number of modelling scenarios based on early project results have been produced by Imperial College.

7 Risk Management

Our risk management objectives are to:

- Ensure that risk management is clearly and consistently integrated into the project management activities and evidenced through the project documentation;
- Comply with WPDs risk management processes and any governance requirements as specified by Ofgem; and
- Anticipate and respond to changing project requirements.

These objectives will be achieved by:

- ✓ Defining the roles, responsibilities and reporting lines within the Project Delivery Team for risk management;
- ✓ Including risk management issues when writing reports and considering decisions;
- ✓ Maintaining a risk register;
- ✓ Communicating risks and ensuring suitable training and supervision is provided;
- ✓ Preparing mitigation action plans;
- ✓ Preparing contingency action plans; and
- ✓ Monitoring and updating of risks and the risk controls.

7.1 Current Risks

The FREEDOM risk register is a live document and is updated regularly. There are currently 18 live project related risks. Mitigation action plans are identified when raising a risk and the appropriate steps then taken to ensure risks do not become issues wherever possible. In Table 7-1, we give details of our top five current risks by category. For each of these risks, a mitigation action plan has been identified and the progress of these are tracked and reported.

Details of the Risk	Risk Rating	Mitigation Action Plan	Progress
Ability to recruit sufficient homes	Minor	Passiv and Delta-ee will create a thorough recruitment strategy and engagement strategy which we will plan to. Invest significant time and resource in customer engagement.	In progress/On track
Poor hybrid heat	Minor	PassivSystems (with	We procured all hybrid

pump technology used		support from Delta-ee) will deliver a thorough procurement process which will include an RFI, an assessment, ITT and a pilot trial review. Based on these activities we will be able asses the heat pump performance. The aim is to have more than one hybrid supplier which will mean that the project will have a second or third supplier available if the chosen hybrid systems are not performing well.	heat pumps upfront (40 MasterTherm, 16 Daikin, and 15 Samsung).
Field trial results fall short of model expectations	Minor	Robust System Design specification and Development plan to be implemented.	In progress
Poor consumer understanding of project aims and interventions	Minor	PassivSystems, Delta-ee and City University are designing and implementing a customer engagement plan which will incorporate learnings from previous projects, learnings and the pilot trial. This should provide substantial education. In the event that this does not work, the project partners will visit Bridgend and conduct workshops.	Stakeholder engagements planned to understand the level of interest
Increase in consumer heating bills	Minor	PassivSystems to hold meetings with all triallists to ensure they are clear on project aims and the planned customer journey.	In progress

Table 7-1: Top five current risks (by rating)

Error! Reference source not found. provides a snapshot of the risk register, detailed raphically, to provide an on-going understanding of the projects' risks.

Likelihood = Probability x Proximity	Certain/Imminent (21-25)	0	0	0	0	0
	More likely to occur than not/Likely to be near future (16-20)	0	0	0	0	0
	50/50 chance of occuring/ Mid to short term (11-15)	0	0	0	0	0
	Less likely to occur/Mid to long term (6-10)	0	0	0	0	0
	Very unlikely to occur/Far in the future (1-5)	4	7	7	0	0
		1. Insignificant changes, re-planning may be required	2. Small Delay, small increased cost but absorbable	3. Delay, increased cost in excess of tolerance	4. Substantial Delay, key deliverables not met, significant increase in time/cost	5. Inability to deliver, business case/objective not viable
		Impact				
	Minor	Moderate	Major	Severe		
Legend	18	0	0	0	**No of instances**	
Total	**18**				No of live risks	

Table 7-2: Graphical view of Risk Register

Table 7-3 provides an overview of the risks by category, minor, moderate, major and severe.This information is used to understand the complete risk level of the project.

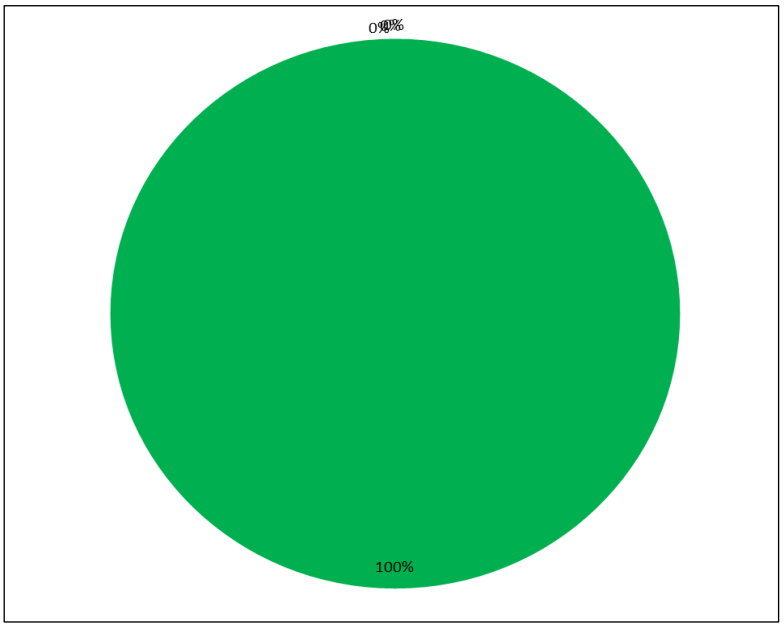

Table 7-3: Percentage of Risk by category

7.2 Update for risks previously identified

Descriptions of the most significant risks, identified in the previous six monthly progress report are provided in Table 7-4 with updates on their current risk status.

Details of the Risk	Previous Risk Rating	Current Risk Rating	Mitigation Action Plan	Progress
Ability to recruit sufficient homes	Moderate	Minor	Passiv and Delta-ee will create a thorough recruitment strategy and engagement strategy which we will plan to. Invest significant time and resource in customer engagement. Offer incentives (e.g. Free tablets) if necessary to boost numbers.	Started/On track
Field trial results fall short of model expectations	Minor	Minor	Robust System Design specification and Development plan to be implemented. Commercial	Pilot installations to take place in February 2017. Three suppliers have been recruited:

			exploitation plan can't be achieved and further re-work required at PassivSystems cost	Daikin, Samsung and Thermal Earth
Poor consumer understanding of project aims and interventions	Minor	Minor	Early engagement with partners and suppliers has provided support for the timely need for the project.	Stakeholder engagements planned to understand the level of interest
Poor hybrid heat pump technology used	Minor	Minor	Will have a second or third supplier available if the hybrid systems are not performing well.	Early identification of the hybrid pump through a meticulous Procurement process.
Customer Engagement Plan Delays	Minor	Closed	Customer Engagement Plan approved by Ofgem. Decision letter received on 17th January 2017	Decision letter from Ofgem gave authorisation to contact customers

Table 7-4: Risks identified in the previous progress report

8 Consistency with Project Registration Document

The scale and timeframe of the project has remained consistent with the registration document, a copy of which can be found here: www.westernpowerinnovation.co.uk/Document-library/2016/Registration-Forms/NIA_WPD_023_5128_Project-Registeration.aspx

However, the scope of the project has been extended to develop 3 hybrid systems instead of 1 as initially agreed. PassivSystems and WWU will provide the financial contribution to allow the project extension to take place. They will contribute £15,000 and £45,000 respectively. WPD will not be contributing to the cost of the project extension.

9 Accuracy Assurance Statement

This report has been prepared by the FREEDOM Project Manager Faithful Chanda, reviewed and approved by the Future Networks Manager (Roger Hey).

All efforts have been made to ensure that the information contained within this report is accurate. WPD confirms that this report has been produced, reviewed and approved following our quality assurance process for external documents and reports.