WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

FREEDOM

WPD_NIA_023

NIA MAJOR PROJECT PROGRESS REPORT

REPORTING PERIOD:

SEP 2016 – MAR 2017

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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, September 2016 to March 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 be more costly to run than 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 first progress report. It covers progress from initial registration on 27th September 2016 to the end of March 2017.

Below is a summary of the progress made so far particularly during the pilot phase of the project.

- Pilot Data: Following the pilot trial installations that took place in February, PassivSystems have installed metering and monitoring equipment to measure the performances of the hybrid systems. The data from the meters and monitoring equipment will provide the first indications of the hybrid installation performance. Further, PassivSystems has been conducting communication experiments with the hybrid systems to allow for their controls to work.
- Social Landlord Support: Through PassivSystems, we have enlisted the support of Wales and West Housing Association (WWHA) and Hafod Housing to provide housing units to aid with the Project.
- Hybrid System Supplier and Installation Contractor Review: PassivSystems is currently reviewing each hybrid system supplier and installation contractor following the pilot trial as well as conducting individual site "lessons learned" wash up meetings. The outcomes combined with the analysed data from the pilot trial hybrid systems and suitable project commercial terms will dictate which suppliers and quantities will be used for the main trial.
- Independent Installation Assessor: Through PassivSystems, we are in the final stages of completing a service level agreement and agreeing commercial terms with Gas Assessment and Training Ltd (GATC Ltd). GATC Ltd is to conduct independent assessments of each hybrid system installation in the main trial.
- Homeowner/Tenant literature: This has now been drafted. The literature and FAQ's will be sent to homeowners/tenants or placed in Bridgend public/community buildings and spaces.
- FREEDOM Project Branding: The project branding has been carried out by Synergy.
- PassivSystems Development team are currently working on five key areas: High-Level Design, Gas and Electric Metering, Events Service, Home Commissioning and Installation Tools.
- City University has been developing the wireframes or graphical explanations to aid with App development following feedback from PassivSystems.
- Delta-ee has been conducting surveys with homeowners following the pilot trial. 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 pre-trial initial results and also for the main 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,	Network Modelling Team led

	Dimitrios Papadaskalopoulos, Meysam Qadrdan, Predrag Djapic, Marko Aunedi	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	Pilot installations in Bridgend , South Wales	February 2017
ThermalEarth	MasterTherm heat Pump system	Pilot installations in Bridgend , South Wales	February 2017
Daikin	Daikin heat pump system	Pilot installations in Bridgend , South Wales	February 2017

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

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 enlisted to deliver the project. The trial will be conducted in domestic housing units in the Bridgend area.

The proposed project runs for 27 months and has been broken down into two phases, which are defined in 14 work packages. The work packages are broken down into 2 phases. 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. The original project plan on which the 14 work packages were based is tabled below:

Phase	Description	Start Date	End Date
Milestone	**Milestone description**	**Start Date**	**Finish date**
M1	WP1: System Modelling & Controls	01/08/16	31/12/16
M2	WP2: High Level Design	01/08/16	01/10/16
M3	WP3: Market Integration Strategies	15/08/16	31/12/16
M4	WP4: Consumer Engagement & Design	01/09/16	31/12/16
M5	WP5: Customer Recruitment and Pilot Installations	01/09/16	31/01/17
M6	WP6: Measurement Specification	01/10/16	31/12/16
M7	WP7: Metering and Data Processing	01/10/16	31/12/16
M8	WP8: Consumer Engagement/HHP Interface	01/10/16	31/12/16

M9	WP9: System testing and evaluation	01/12/16	31/01/17
M10	WP10: Supply & Installation	01/02/17	30/09/17
M11	WP11: Control Development and Testing	01/02/17	31/12/17
M12	WP12: Aggregation & Market Optimisation Consumer Interface	01/10/17	30/04/17
M13	WP13: Analysis & Reporting	02/10/17	31/05/18
M13	WP14: Project Shutdown	01/04/18	31/04/18

Table 4: Initial Outline Project Plan

2.2 Project Progress

2.2.1 Pilot trial installation

The pilot trial installations took place and were completed in the month of February. The four homes used for the pilot trial installations were very different and all faced different challenges. Below is a typical configuration of a hybrid heating system:

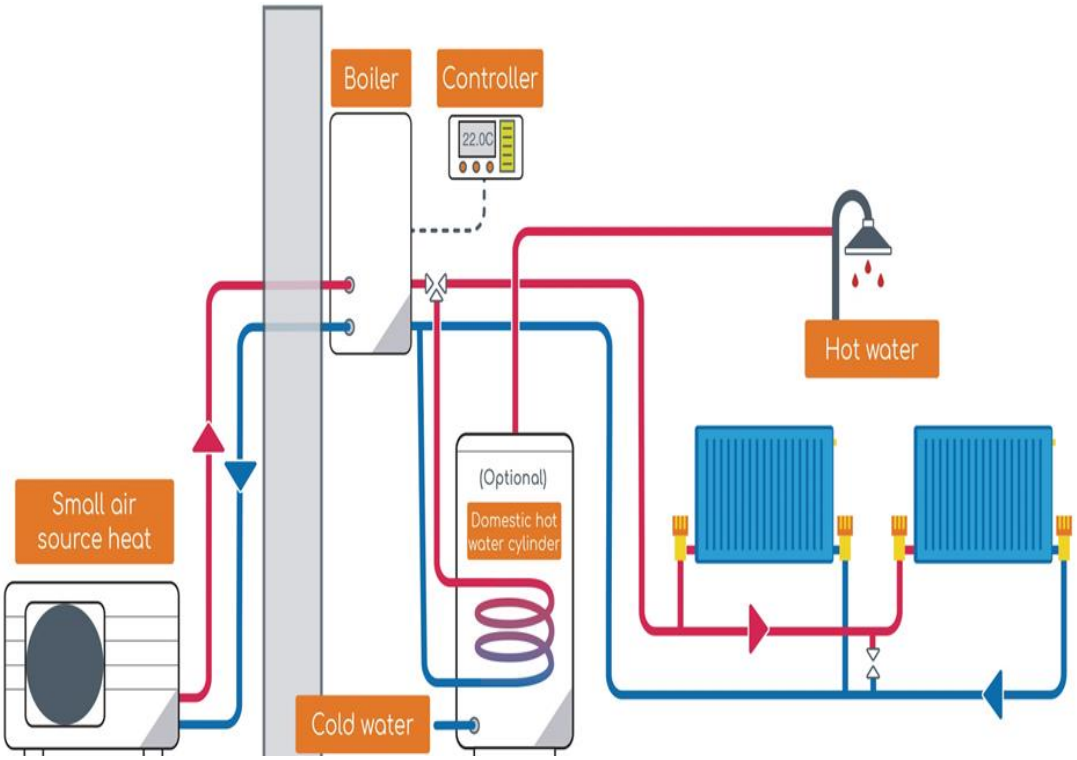

Figure 1: Configuration of a hybrid heating system

The summary of the pilot installations is given below:

- Samsung Heat Pump

The Samsung heat pump was installed by Spire Renewables. The installation includes the Samsung heat pump, the Samsung smart box, the Worcester boiler and the plumbing. The heat pump is installed outside the property; the plumbing goes under the path and connects to the new boiler inside the property.

Figure 2: Samsung heat pump

- Daikin Heat Pump

The Daikin pump was installed by WDS Clean Energy. The heat pump is mounted on the wall outside the property. The boiler and the various controls are installed inside the property.

Figure 3: Daikin heat pump

- MasterTherm Heat Pump x2 – Orchard Close & Wimborne Road

The 2 MasterTherm installations were carried out by Thermal Earth. The MasterTherm heat pump is mounted at the back of the house. The Valliant boiler and various controls are installed inside the property.

Figure 4: MasterThem heat pump

2.3 Next steps

Household recruitment is a key activity in the coming months and therefore project marketing, customer engagement, and consultation with social landlords will be the primary objectives. The two housing associations, WWHA and Hafod Housing, will soon be asked to formally communicate with their tenants about the project and how to participate in the trial. PassivSystems will be responsible for recording enquiries following the launch. Through PassivSystems we are working with Bridgend Council to secure private homes through leaflet/flyer distribution at Bridgend public/community buildings and spaces. We have also received some interest from Private Landlords following the pilot installations. The branding logo that will be used 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.

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	70,000	13,645	13,645		
Project Partner Project Costs	1,562,447	458,387	458,387		
BRANDING FEES	4,000	2,165	2,165		
TOTAL	**1,636,447**	**474,197**	**474,197**		

Table 5: Progress against budget

4 Progress towards Success Criteria

Expected success	How this is being achieved
Present a comprehensive review of the technology	PassivSystems conducted an RFI and a series of interviews in December 2016 to select the heat pump technology. The units have since been installed in the pilot phase of the project. The technology is currently under review.
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 PassivSystems have just completed the pilot installations and are in the process of obtaining data.
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	Recruitment has only started. However, we have a portfolio of over 300 customers to choose from. Wales & West Housing Association and Hafod Housing have given us written confirmation that they will provide 100 and 44 households respectively. This is in addition to a pool of private landlords that have expressed interest by word of mouth.
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. But as we are yet to analyse and understand the interoperability with other units. The architecture is not yet fully proven.

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.
- A lack of information pre-pilot - Following the survey conducted by Delta-ee it was highlighted that not much information was made available to the land owners during the trial. All 4 homes were/are very enthusiastic about the project and wanted to know more than was anticipated.
- Project partners would want to change the scope of the project whilst it is ongoing. This can potentially lead to unexpected increased project costs.
- 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. This was a great learning from the installation ensuring that the right components were used at the right time especially for the main trial.
- If the project requires a CEP and has to be approved by Ofgem, it is always important to be mindful that additional questions could be asked of the project and may delay the project.
- Post installation work: Following the pilot trial installations, through PassivSystems we have been reviewing each supplier and contractor and understanding the lessons learned. The results from the pilot trial will be a good basis to understand and develop the necessary skills for a mass rollout of the remainder of the project.

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.

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**Error! Reference source not found.**, 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	Major	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.	Started
Poor hybrid heat pump technology used	Moderate	PassivSystems (with support from Delta-ee) will deliver a thorough procurement process which will include an RFI, an assessment, ITT and a pilot trial review. Based	Pilot trial review and the type of housing will determine the apportionment of how many of each type of heat pump to use. The thinking is to have 25

		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.	from WWHA, 25 from Hafod housing and 25 private land lords.
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 information meetings with all triallists to ensure they are clear on project aims and the planned customer journey. Passiv to work with the collaboration to agree acceptable outcomes for consumers. Including subsidies	Not yet started.

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

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

		0	0	0	0	0
		0	0	0	0	0
		0	0	0	0	1
		0	0	0	0	0
		4	5	7	1	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	16	1	0	1	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.

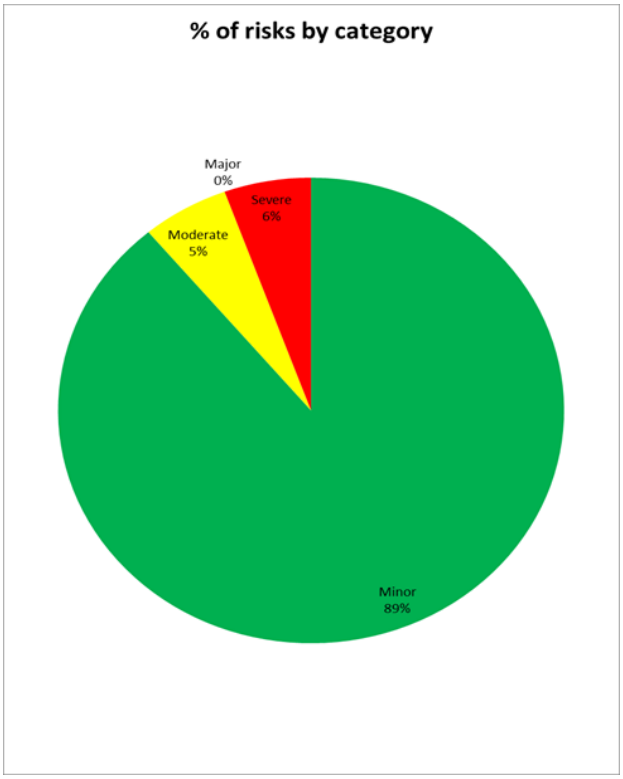

Table 7-3: Percentage of Risk by category

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	Major	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

Field trial results fall short of model expectations	Minor	Minor	Robust System Design specification and Development plan to be implemented. Commercial exploitation plan can't be achieved and further re-work required at PassivSystems cost	Pilot installations to take place in February 2017. Three suppliers have been recruited for this exercise: 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.