Sustainable Energy Authority of Ireland

National Energy Research, Development & Demonstration Funding Programme 2018

FINAL REPORT TEMPLATE

SECTION 1: PROJECT DETAILS

Table 1.1 – Summary of Project Details

Project Title	Continuous Commissioning to Create High Performance Buildings
Lead Applicant (Organisation)	Inferrit Limited
Lead Applicant (Name)	Tony O'Keeffe
Final Report Prepared By:	Tony O'Keeffe
Total Project Duration (months)	12

Approved SEAI Funding	€ 90,377.92

	Name	**Organisation**
Partner Applicant(s)		
Collaborators	Pat Mehigan	UCC
	Dermot Walsh	Ervia
	Gerald O Callaghan	Dunnes Stores

Project Summary (max 500 words)
The aim of this project is to trial the RemoteHVAC software in real environments, so that new energy opportunities can be identified and acted upon, user feedback can be received and leveraged for further product development and real barriers to wide scale market entry can be uncovered and addressed. The proposed project already has a level of collaboration that is difficult to encapsulate within the bounds of this application, as the Inferrit team has assembled a stellar lineup of industry experts that are committed to seeing it succeed. The organisations and individuals were very carefully selected for their expertise and standing in the HVAC and Energy industry. Pat Mehigan (UCC), Dermot Walsh (ERVIA) and Gerald O

Callaghan (Dunnes Stores) are all well known industry experts in Facility and Energy Management. In addition, Richard Morrison (Optien Consultants) brings a level of experience, independent oversight and guidance that will bring massive credibility to the project. These engaged participants will ensure delivery of project goals, as well as supporting the accelerated market entry of the software. Ensuring that public funds are efficiently used to help Ireland reach its national targets in 2020.

The project will test the software on a range of systems, from modern open protocol BMS (Dunnes) to legacy systems with closed protocols (UCC). Data will come from a wide range of HVAC systems and configurations, this variability will help broaden the flexibility of the software. Lastly the energy saving benefits of continuous fault monitoring will be measured and demonstrated.

The key objective of this project was to enable the commercialisation and role-out of an Automated Building Commission software to achieve ongoing energy optimisations and improved comfort levels, across the entire life-cycle of new and existing buildings in Ireland. This enablement was to be achieved by working with real customers and live buildings/systems representative of the various building stock throughout Ireland.

The key result from the project is that the software and hardware is now up and running in all trial sites and has been providing insights and value to the collaborators on an ongoing basis for the past 12 months. These insights have been validated by the collaborators and continued improvements are being made to their systems and buildings as a result of the ongoing monitoring via the RemoteHVAC software.

Finally, the outcomes are numerous for the project. Issues have been identified via the software, acted on and case studies built around them which helped validate the effectiveness of the software as well as provide marketing material to promote rollout to further buildings in Ireland.
In addition, working with live trial sites and the collaborators has enabled the service/product to grow and provide even more functionality related to making buildings smarter,more efficient and productive.

Keywords (min 3 and max 10)	Automated Fault Detection & Diagnosis, HVAC, Energy, Data Analytics, Building IOT, Wellness, Productivity, Air-quality, Smart City, Intelligent Buildings

SECTION 2: EXCELLENCE & INNOVATION (max 5 pages)

2.1 Innovation / Novelty – Beyond State-of-the-Art

We feel we have a number of areas that are improvements to the current practices and the various current state of the art variations on HVAC, BMS and Building Performance Monitoring Systems that are out there. These include:

- Innovation 1: IOT Data Collection Device
  We have developed a multi-protocol data collection device which puts us in a unique position to gain access to a multitude of BMS systems. This allows us to scale and perform our analytics on a diverse range of systems to the needs of the market that is out there and deliver the full range of services to users without concerns for vendor or manufacturer of the BMS. Thus, resolving a challenge many facilities managers face today especially in large distributed estates.

- Innovation 2: Flexible Data Mapping Process
  Issues such as a lack of standardisation in naming conventions and development approaches in BMS software means that often it becomes very difficult to analyse the data from buildings. We have developed tools and software to help with this challenge thanks to the exposure to the various systems in this project.

- Innovation 3: HVAC Configuration
  Currently there are publically available rules and analysis techniques for standalone configurations such as Packaged Rooftop Units. However standard conventional arrangements of HVAC include the use of VRF and terminal units. These systems are difficult to obtain data from and thus very limited rules and analysis exists in the public domain. We have developed rules and trend analysis techniques for these and other configurations.

- Innovation 4: Accurate Fault Diagnosis
  Root cause Fault Diagnosis is essential to the successful adoption of HVAC Analytics Tools. We have developed accurate and reliable fault diagnosis in the software utilizing the exposure we have gained from the real world test sites. The accuracy of our diagnosis has been validated by the collaborators and their maintenance teams.

- Innovation 5: Fault Prioritisation
  The insight into the resolution process gained from our test sites has allowed us to produce capabilities around the identification of common high impact issues with fast resolution times. This has allowed us to build a prioritize technique into our diagnosis and resolution suggestions that provide savings and efficiency improvements in the fastest times possible.

- Performance Scoring:
  Running analytics, fault detection and energy calculations on this rich dataset enables us to produce real time representations of the buildings performance from comfort, operational and energy perspectives in an easily digestible scoring system. This allows for benchmarking and identification of problem sites without the need of custom reports and skilled energy management personnel.

2.2 Project Objectives

In the Table below, list all project objectives as detailed in your application, and provide on update on their status. Have these objectives been achieved? What were the key outcomes or deliverables associated with each?

Table 2.1 – Summary of Project Objectives

No	Objective Description	Objective completed (Y/N) Justify your answer	Key Outcomes/Deliverables
1.	Identify and achieve full monitoring and analysis on a wide range of HVAC configurations and BMS Systems representative of the majority of commercial buildings in Ireland.	**Yes:** Connected and retrieving continuous data from the main BMS Vendors to Ireland (Siemens, Cylon and Trend)	Developed Strategy and Tools to allow us to connect to Siemens BMS, Trend BMS and Cylon BMS going forward.
2.	Produce validated and proven case studies on the results of automated building commissioning from well known organisations in Ireland. Aiming for findings of 10–30% savings in building system energy consumption in order to promote accelerated uptake in the Irish market.	**Yes:** See attached case studies. We have detected energy opportunities caused by poor BMS strategies and faulty equipment in two out of three of the trial organisations.	Findings Validated, Impact assessed and Case studies prepared and available for dissemination.
3.	Develop analysis techniques and fault detection rules for isolated and high energy consuming VRF systems.	**Yes:** Fault detection and monitoring has been accomplished on Mitsubishi VRF systems.	Monitoring technique developed. Further work identified.
	Highlight the benefits of ongoing building commissioning for energy efficiency and comfort and promote the need for improved standards in building commissioning, BMS open protocols and standardised naming conventions.	**Yes:** We have proven and demonstrated that by using open BMS protocols in buildings, data is made available that can allow analysis and improvements to efficiency and operations in the building. These findings and our insights have been discussed and disseminated.	ASHRAE presentations successfully completed. Event was hosted targeting industry professionals.
	Drive the test sites to become leaders in a new culture of productivity and wellness in Ireland via increased insights into comfort metrics, effectiveness of conditioning systems.	**Yes:** We have enabled the collaborators to gather useful information and baselines of how their occupants wellness needs are being met. This has evolved into new projects such as one with UCC where they are looking to build new awareness into the productivity and wellness of students in their library and study areas.	Key improvements made throughout test sites for improved comfort and wellbeing of occupants. New projects started with each trial site to further push their ability to provide comfort and wellness to their occupants.

SECTION 3: RELEVANCE & IMPACT (max 6 pages)

3.1 Relevance to the needs of the Irish Energy Sector and to SEAI

The European Union estimates that buildings account for 40% of final energy consumption **(NEEAP, 2014)**, therefore a large portion of the 2020 targeted savings are anticipated to come from energy efficiency improvements in the new and existing buildings. The RemoteHVAC tool helps to improve energy efficiency at commissioning stage of new buildings, as a retrofit tool to improve efficiency of existing buildings and as an Ongoing Commissioning tool to ensure that intended standards of efficiency are met and maintained throughout the entire life-cycle of the building.

Inferrit have now completed trials of the RemoteHVAC Tool to multiple large organisations who have a significant impact on he Irish Energy Sector, including a large Irish Energy Supplier who are exploring how the Tool can support their business goals under the **Energy Efficiency Obligation Scheme (2014)**. The Energy Supplier is already actively delivering energy improvement services to its clients and they recognise the value that our building monitoring and analysis tool will bring to that process. The RemoteHVAC analysis tool helps to analyse and benchmark building performance before any upgrade works are carried out, in order to assess how well internal environmental conditions are being met and identify energy savings opportunities. And After upgrade works have taken place the RemoteHVAC tool helps to ensure the buildings continue to maintain the same levels of occupant comfort and deliver the intended levels of energy efficiency by fault findings issues on a continuous basis. Thus protecting the Energy Supplier's investment. The real world trials and development which were undertaken in this project have proved instrumental to the progress of this market opportunity. The project has produced clear evidence of energy savings achieved in working buildings, validated by our collaborates who are all esteemed Facility and Energy managers, which has given us confidence and the ability to launch this tool/service to the wider market and thus help other large energy consumers make their portfolios more efficient.

Ireland's Energy Efficiency Fund was amassed to support building energy efficiency improvements and overcome market barriers in the non-domestic sector. The fund had particular focus on supporting Energy Performance Contracts (EPCs) and Energy Performance Related Payment Contracts as a means to deliver upgrades. The author has experience managing EPCs, and recognises that one of the most significant barriers to uptake by clients and service providers is risk management. The client needs to know that its business will not be impacted by the efficiency measures and the Service provider needs to know they can recover their investment and earnings. The RemoteHVAC Tool provides the monitoring and analytics capabilities to manage both of these concerns and ensure the success of these types of projects. Inferrit are collaborating with a HVAC and BMS Service provider in relation to delivery of EPCs and Building Performance Management services to the commercial and industrial sector.

The Part-L building regulations are an important standard for improved building energy efficiency levels. However, greater clarification and standards are required for new and existing Building Commissioning….as commissioning is widely recognised as critical for buildings to achieve their intended levels of operating efficiency and performance. The output from the project and the energy savings benefits produced by the RemoteHVAC tool has been disseminated via multiple recognised industry bodies such as ASHRAE in order to help raise awareness around building performance and commissioning. The Tool has provided the data and evidence to demonstrate how buildings are performing and where issues are arising, which has enabled us to make valuable arguments and insights in informing policy and decision making in the future.

3.2 Project Impact

Economic Benefits

Lower Operating Costs for Consumer
Several studies estimate that HVAC energy savings of 15-40% could be made in commercial buildings by closely monitoring and analysing BMS data and related energy-usage (Salsbury & Diamond 2000). Automated Fault Detection and Diagnosis identifies HVAC issues that are difficult and expensive to do with more manual investigative methods. This has proven to be the case as can be seen in our attached case study on Fault Detection and Diagnosis. The temperature set point hunting fault is one that can go undetected indefinitely if the zone conditions are relatively stable which can be seen in the findings. However by looking at the BMS data appropriately using our rule sets it is clear to see that the behavior of the equipment is faulty and leads to large amounts of energy wastage.

Extended Equipment Life for Consumer
Studies have shown that approximately 50% of Packaged Commercial AHU will have significant faults, leading to increased cooling demands for the building (Wiggins & Broderick, 2012). HVAC system faults can degrade the overall asset efficiency leading to longer run hours to meet space conditioning demands. Again this can be seen in our attached case study on fault detection. Here the components of the equipment are rapidly moving causing excessive wear and tear and thus minimizing the lifespan of the equipment. Using FDD to find this quickly leads to a longer lifespan.

More Efficient Maintenance for Consumer & Maintenance Provider
The real time monitoring of Cloud-based FDD means that faults are identified faster than other methods, ensuring fault impacts and costs are minimised. Automated FDD allows building managers to move away from Planned Preventative and Reactive Maintenance to a needs based and predictive maintenance plan. FDD also supports fast and accurate diagnosis of root cause issues as opposed to retrospective manual investigations. Again in the case study example, we detected the fault prior to a quarterly maintenance visit by the maintenance provider. This allowed the maintenance provider to resolve the problem faster as no upfront manual investigation was required.

Ongoing Commissioning and Monitoring
The RemoteHVAC tool has proven its ability to monitor the effectiveness and condition of equipment prior to and after any Energy Upgrade projects. This means that any organisation undertaking these types of projects such as large Energy Suppliers will limit their risks by providing greater transparency on the building performance and increasing the likelihood that their investment will deliver the intended energy efficiency benefits. The work done in the trials has led to the further development of the software and its tools which is instrumental to support and accelerate these types of opportunities.

Societal Benefits

Urbanisation
The rapid urbanisation of our populations and growth in cities means that buildings will play an ever more important role in our lives. By 2050 66% of the world's population will live in cities (United Nations, 2014). High performing buildings can help improve the quality of the people who occupy them and reduce the impact on existing electricity resources, helping to provide better energy access, reliability, and security for society.

Wellness

A host of Facility and Energy Managers were interviewed as part of initial research for the proposed software product. When asked how Managers monitor the environmental conditions within their buildings the overwhelming answer was that they do not. Occupants complaints are used as the barometer of comfort. However, with the growing awareness around the importance of human productivity, health and wellness, FM Managers are seeking new ways to measure and monitor air-quality, temperature and humidity in order to track building performance. Throughout this project we have helped FM Managers move away from the reliance on occupant complaints and now they actively preempt occupant issues by using data analytics, visualisation and the wellness scoring provided by the RemoteHVAC Tool. This has led to an overall increase in occupant satisfaction as can be seen in our attached case study on comfort and wellness.

Policy-oriented

Building commissioning is a mature but not well recognised part of the building management industry. The energy efficiency and societal benefits that will arise from the use of Ongoing Commissioning tools, as proposed in this application, will support policy changes in this area.
The challenges to accessing essential BMS and Energy data will also highlight the importance of Open Protocols (i.e. BACnet and Modbus) for the industry and Standardisation such as Semantic naming conventions (ASHRAE Haystack).

The project has helped in this regard by providing real life exposure to us in relation to the challenges in accessing data from multiple different BMS vendors, protocols and data naming standards. We have discussed these issues in depth in the ASHRAE presentations and will continue to promote the usefulness of open protocols and semantic naming conventions as we approach new customers.

Scientific Enhancements

Inferrit has successfully accessed the raw and meta building performance data on a scale that is not possible for any dedicated research organisation or University. With the anonymisation of this building data and the agreement by the data owners we will now be in a position to share this data with interested parties. This will allow in-depth research to be performed on the different system configurations and asset types in real building stock. Performance comparisons and benchmarking of energy efficiency will lead to further research and potential influence policy.

Gathering optimization results and data from multiple sites, system types etc could lead to identification of trends around these system configurations, asset types and building designs that may lead to further research opportunities. i.e. Wet HVAC systems vs Fridge systems.

As a company working with innovative and disruptive technology we will be well placed to actively contribute or lead European FP9 projects. A number of team members have significant experience with FP7 projects.

References

- Wiggins, M & Broderick, J., 2012. Emerging Technologies: HVAC Fault Detection, ASHRAE Journal, vol. 54, no. 2
- Salsbury, T., & Diamond, R., 2000. Performance Validation and Energy Analysis of HVAC Systems using Simulation. Energy and Building , 32 (1), 5-17.

- Scott, S., 2004. Investigation of Energy Service Companies in Ireland. Economic and Social Research Institute, Working Paper 155.

3.3 Communication, Dissemination and Exploitation

Our outreach plan to engage our audience will involve the creation and distribution of digital content in the form of published case studies. (All attached in this final submission) These case studies include detailed information on the benefits gained from each of our test sites. With the added benefit of verification and sign off from trusted and well known organisations.

In the final stages of this project we spoke at various industry body meet-ups and hosted a technical talk event to demonstrate the software its benefits and the challenges of Automated Ongoing Commissioning in the HVAC and BMS industry. The material for these demonstrations was built around the key findings of the project. It helped to simulate interest in the uptake of our solution and other similar ones in reducing energy consumption and improving building performance at a very practical level in Ireland.

Event/Content	Details	Date
Technical Talk at ASHRAE Ireland Event	RemoteHVAC spoke at the ASHRAE Ireland technical evening. The topics covered "Health and wellbeing in buildings - Social and technological solutions". https://www.linkedin.com/feed/update/urn:li:activity:6506217280064540672/	25th Feb 2019
Website Blog posts	https://www.remotehvac.com/insights.html	Ongoing
Brochure	Brochure attached in submission.	2019
Technical Talk at ASHRAE Ireland Event	RemoteHVAC were the lead speakers at ASHRAE Ireland technical evening. The topic covered was "High Performance in Building Operations" Presentation attached in submission. https://www.eventbrite.com/e/high-performance-in-building-operation-tickets-83825196419?ref=enivtefor001&invite=MTg0NjY5ODEvdG9ueS5va2VIZmZIQHJIbW90ZWh2YWMuY29tLzA%3D%0A&utm_source=eb_email&utm_medium=email&utm_campaign=inviteformalv2&utm_term=eventpage#	10th Dec 2019
Abstract Submission to International Industry Event	Conference: IAQ 2020: Indoor Environmental Quality Performance Approaches https://www.ashrae.org/conferences/topical-conferences/indoor-environmental-quality-performance-approaches Abstract attached in submission.	23rd Dec 2019

Dissemination Summary Tables

Table 3.1 – List of Scientific Publications

Title	Main Author	Journal Title	Number, Date or Frequency	Publisher	Year of Publication	Is/Will open access be provided? If you marked "will", provide an estimate of the date	Peer-reviewed (Y/N)?

Table 3.2 – List of Dissemination Activities

Type of Activity	Main Leader	Title	Date/Period	Location	Type of Audience*	Size of Audience
Conference	Tony O'Keeffe	Health and wellbeing in buildings - Social and technological solutions	25th Feb 2019	Dublin, Ireland	Industry, Consultants	30+
Conference	Tony O'Keeffe	High Performance in Building Operations	10th Dec 2019	Cork, Ireland	Industry, Consultants	21
Submission to International Industry Event	Tony O'Keeffe	IAQ 2020: Indoor Environmental Quality Performance Approaches	23rd Dec 2019	Athens, Greece	Industry, Civil Society, Policy makers, Medias	Unknown
Website Blog posts	Brian Caul	Various Topics	Ongoing	Online	Industry	Unknown
Targeted Disseminatio n of Brochure	Tony O'Keeffe	Achieving High Performance Buildings	Ongoing	Ireland	Industry	Unknown

**Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).*

3.4 Intellectual Property Management & Exploitation

If applicable, please provide details of any patents or IP generated as a result of this research award, or patents/IP which you think may eventuate as a result of the pr

SECTION 4: WORK PLAN

4.1 Work Plan

Please provide your list of work packages in Table 4.1 below, as detailed in your original Application Form, and include a status update for each.

Table 4.1 – List of Work Packages

No.	Title	Status Update
1	Secure Data Connections to Multiple Sites BMS	Complete
2	Support Variety of HVAC Configurations and BMS Systems	Complete
3	Fault Identification HVAC Configurations and BMS Systems and Impact Assessments	Complete
4	Validation & Resolution of Faults and Value Proposition	Complete
5	Report and Dissemination	Complete

In Table 4.2, please include details for each work package (copy and replicate the Table for each work package as required). Please provide an update on the progress achieved, the specific milestones and deliverables achieved, and clearly identify any deviations from the original proposed work packages.

Table 4.2 – Summary of Work Packages

WP No. & Title	WP1 - Secure Data Connections to Multiple Sites BMS		
Start Month No.	1	**Finish Month No.**	3
WP Lead:	Tony O'Keeffe		
WP Contributors	Marcello Valentini, Brian Caul, Subiya Tamreen, Richard Morrison		
Objective(s)	WP1-O1: Data flowing from Ervia Colvill House	Status: Complete	
	WP1-O2: Data flowing from Ervia Webworks.	Status: Complete	
	WP1-O3: Data flowing from Ervia Foley Street.	Status: Complete	
	WP1-O4: Data flowing from UCC Postgrad Library.	Status: Complete	
	WP1-O5: Data flowing from Dunnes Bishopstown.	Status: Complete	
	WP1-O6: Data flowing from Dunnes Patrick Street.	Status: Complete	
	WP1-O7: Data flowing from Dunnes Douglas Court.	Status: Complete	
Description (max 200 words)	The aim of this work plan is to have the BMS and network works completed and all the available BMS and energy meter data available for collection. This will allow us to achieve support for an arrangement of different hvac configurations, BMS systems and building types (Commercial, Office, Public etc) which are a fair representation of the national building stock.		
Milestones	WP1-M1: Site Surveys	Status: Complete	

	WP1-M2: Hardware Installs and Network Upgrades	Status: Complete
	WP1-M3: IOT Appliance Deployed and Connected	Status: Complete
Deliverables	WP1-D1: Report compiled and issued on all sites connectivity.	Status:Complete
	WP1-D2: Verification letter from external consultant on all sites data collection.	Status:Complete
Deviations from planned WP (if applicable)	WP1-O3: Completed at a later stage in the project than planned as delays by third party maintenance provided meant that the BMS upgrade was delayed and not available to us until later in the year.	
Key Outcomes	Ability to gather data from multiple vendors, sites and BMS protocols developed and proven.	

WP No. & Title	WP2 - Support Variety of HVAC Configurations and BMS Systems		
Start Month No.	3	**Finish Month No.**	5
WP Lead:	Tony O'Keeffe		
WP Contributors	Brian Caul, Frank Caul, James Byrne, Nicholas Sotiriou		
Objective(s)	WP2-O1: Achieve analysis and FDD on Mitsubishi VRF systems	Status:Complete	
	WP2-O2: Achieve analysis and FDD on Daiken VRF systems	Status:Complete	
	WP2-O3: Achieve analysis and FDD on Energy Meter data	Status:Complete	
	WP2-O4: Achieve analysis and FDD on Terminal Units (FCUs)	Status:Complete	
Description (max 200 words)	The aim of this work plan is to have complete analysis and FDD available for VRF systems, energy metering and terminal units alongside our existing capabilities on standard AHUs, RTUs, Boilers and Chillers. This will allow us to detect mechanical faults and identify energy efficiency opportunities on an arrangement of different hvac configurations typically found in the national building stock around Ireland.		
Milestones	WP2-M1: New Systems Communicating to RemoteHVAC platform.	Status:Complete	
	WP2-M2: Identification of New Properties and Data Points	Status:Complete	
	WP2-M3: Mapping of New Systems Data	Status:Complete	
	WP2-M4: Software Improvements to enable analysis and FDD on new systems	Status:Complete	
Deliverables	WP2-D1: Report compiled and issued on new systems analysis and FDD	Status:Complete	
	WP2-D2: Demonstration of full building visibility on the RemoteHVAC platform to appropriate collaborators.	Status:Complete	
	WP2-D3: Initial Feedback Review and Letter of Verification from collaborators.	Status:Complete	
Deviations from planned WP (if applicable)	Change of WP contributors due to staff turnover.		

Key Outcomes	Library of reusable rulesets built and running against various hvac configurations which has resulted in fault detections. Performance analysis algorithms built and running against various hvac configurations helping to identify areas of possible improvement in building stock.

WP No. & Title	WP3 - Fault Identification HVAC Configurations and BMS Systems and Impact Assessments		
Start Month No.	6	**Finish Month No.**	6
WP Lead:	Tony O'Keeffe		
WP Contributors	Brian Caul, Frank Caul, James Byrne, Nicholas Sotiriou		
Objective(s)	WP3-O1: Identification of new fault detection opportunities from available data	Status:Complete	
	WP3-O2: Implementation of FDD rules to increase findings with market rollout.	Status:Complete	
	WP3-O3: External validation on faults & associated energy/cost calculations.	Status:Complete	
Description (max 200 words)	The aim of this work plan is to conduct analysis and a review on the fully visible systems across the test sites and identify any new fault detections and efficiency opportunities in order to increase the library of FDD we can offer to the Irish market on rollout. Also gaining validation and advice from an external energy consultant on our findings and impact calculations will help us produce more accurate energy wastage calculations for each of the new faults.		
Milestones	WP3-M1: Identify and implement additions and improvements to fault library	Status:Complete	
	WP3-M2: Consultant sessions for new faults and impacts.	Status:Complete	
Deliverables	WP3-D1: Report on new FDD capabilities for roll out to market.	Status:Complete	
	WP3-D2: Letter of validation from external consultant on findings and impacts.	Status:Complete	
Deviations from planned WP (if applicable)	Change of WP contributors due to staff turnover.		
Key Outcomes	Library of reusable rulesets and fault detection including impact calculations validated and proven by third party.		

WP No. & Title	WP4 - Validation & Resolution of Faults and Value Proposition.		
Start Month No.	7	**Finish Month No.**	8
WP Lead:	Tony O'Keeffe		
WP Contributors	Brian Caul, Frank Caul, James Byrne, Nicholas Sotiriou		
Objective(s)	WP4-O1: Give end users/collaborators tools to monitor and improve buildings.	Status:Complete	
	WP4-O2: Gather feedback and references from end users/collaborators on value of tool	Status:Complete	
	WP4-O3: Get issues from each building actioned by maintenance provider for resolution	Status:Complete	

Description (max 200 words)	The aim of this work plan is to hand over the tool with all of its full level of capabilities to the end users and building owners in order for them to review the value proposition of the tool and provide us with references to promote roll out of the product to the rest of the market. As part of this validation review we will be pushing the users to get their maintenance providers/teams to action any high impact issues in order to achieve positive results on their buildings performance.	
Milestones	WP4-M1: Give end users access and conduct onboarding sessions	Status:Complete
	WP4-M2: Achieve Investigation of faults and actioning for resolution.	Status:Complete
	WP4-M3: Gather feedback on fault detection and analytic capabilities of the tool	Status:Complete
Deliverables	WP4-D1: Report on initial faults and findings from trial sites	Status:Complete
Deviations from planned WP (if applicable)	Change of WP contributors due to staff turnover.	
Key Outcomes	Reports and findings provided to all collaborators. Fault findings addressed and resolved. Feedback from end users gathered.	

WP No. & Title	WP5 - Report and Dissemination.		
Start Month No.	9	**Finish Month No.**	12
WP Lead:	Tony O'Keeffe		
WP Contributors	Brian Caul, Frank Caul, James Byrne, Nicholas Sotiriou		
Objective(s)	WP5-O1: Gather metrics and confirmation on building efficiency improvements.	Status:Complete	
	WP5-O2: Achieve market entry with references, validation and case studies.	Status:In progress	
	WP5-O3: Dissemination of all findings and issues to the national & international building performance community.	Status:Complete	
Description (max 200 words)	The aim of this work plan is to produce the material required for a smooth and rapid market entry for the product in order to improve the efficiency and wellness of as much of the national building stock as possible. Also we want to produce well distributed articles on the findings and results of the trial sites, the solutions we created to the technical barriers and the benefits achieved in order to promote further work in the field and become a credible source in the industry.		
Milestones	WP5-M1: Gather measurements on improvements in comfort and energy levels.	Status:Complete	
	WP5-M2: Case studies and reports written for each test building.	Status:Complete	
	WP5-M3: Marketing material produced and published.	Status:Complete	
	WP5-M4: Demonstrations to public industry bodies on building performance opportunities.	Status:Complete	
Deliverables	WP5-D1: Reports issued on levels of improvement achieved across buildings	Status:Complete	
	WP5-D2: Case studies available on each of the test buildings.	Status:Complete	

	WP5-D3: Public article(s) available on the challenges, findings and results.	Status:Complete
Deviations from planned WP (if applicable)	Change of WP contributors due to staff turnover.	
Key Outcomes	Marketing material and case studies produced and shared. Blog posts on challenges written and shared. Dissemination activities undertaken with Industry Bodies.	