



Project no. **224609**

Project acronym: **Dehems**

Project title: **Digital Environment Home Energy Management Systems**

<b>Instrument:</b> <i>Please tick</i>	CA	STREP ✓	IP	NOE
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**ICT - Information and Communication Technologies Theme**

Deliverable reference number and title: D8.5 Living Lab Methodology for ICT System Development

Due date of deliverable (as in Annex 1): 31<sup>st</sup> July 2011

Actual submission date: 2<sup>nd</sup> September 2011

Start date of project: 1<sup>st</sup> June 2008

Duration: 38 months

Organisation name of lead contractor for this deliverable: Manchester City Council

Revision V.1.0

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
<b>PU</b>	Public	✓
<b>PP</b>	Restricted to other programme participants (including the Commission Services)	
<b>RE</b>	Restricted to a group specified by the consortium (including the Commission Services)	
<b>CO</b>	Confidential, only for members of the consortium (including the Commission Services)	



## Document Control

Work Package Leader: Manchester City Council

Document Owner: Manchester City Council

File Reference: D8.5 Dehems\_Deliverable.pdf

Date: 22 July 2011

Version: 1.0

### Version Control Record

Version	Date	Author	Comments
0.1		Martine Tommis	First draft
	10 Aug 2011	Martine Tommis	Revision
0.2	31 Aug 2011	Grahame Cooper	Revision
1.0	2 <sup>nd</sup> September	Martine Tommis	Final Format

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## Executive Summary

This document is a description and analysis of the Living Labs methodology developed in the course of the DEHEMS project. The context within which this exercise is carried out by ALTEC Consulting Report produced in March 2009 for DG INFSO entitled 'Study on the potential of the Living Labs approach including its relation to experimental facilities for future Internet related technologies.

The focus is on methodological lessons learned. Theory informed what was done but the emphasis is on a bottom approach which is grounded in what actually happened during the course of the DEHEMS project.

There are discussions about the practical issues and complexities involved in project definition, recruitment, managing methodological diversity maintaining user interest. In addition there is a section which deals with project management and an Appendix is provided which describes the original Living Labs Implementation Plan along with the lessons learnt from each cycle.

## Living labs and ICT System Development

The DEHEMS Description of Work (DoW) (Description of Work Annex I: page 11 of 108) states that:

*There is little relevant user testing or action research that indicates how users would respond to energy management systems that deliver the project's objectives. The most relevant state of the art for this objective is from action research methodologies that are applicable as a generic Living Lab process. In common with mainstream science procedures, the use of repeated cycles enable the action research to progressively iterate and achieve the projects' objectives*

*The learning during and from each research cycle feeds into the research and system development activity, dynamically shifting the baseline for subsequent research cycle activity. The core process undertaken by participants during each cycle is 'learning by doing', within a formal iterative progression. These cycles repeat to create a series of experiential-based learning episodes through which people can learn and create knowledge:*

- i) on the basis of their concrete experience.*
- ii) through observing and reflecting on that experience.*
- iii) by forming abstract concepts and generalisations about what to do next;*
- iv) by testing the implications of these concepts in new situations -- which will lead to new concrete experiences, and hence the beginning of a new phase series.*

The DoW also states that whilst work has been done on balancing the requirements of systems development and user analysis, at the time of writing there has been no use of Living Labs in the development of an IT system as opposed to participating in the development of technology demonstrators.

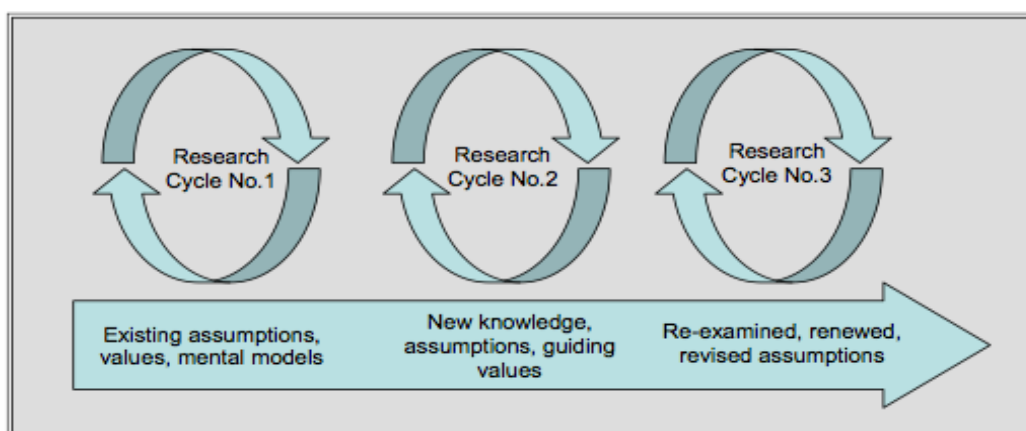


Figure 1 DEHEMS Iterative Cycles

## Living Labs: Institutional Structure and Context

In March 2009 ALTEC Consulting produced a report for DG INFSO entitled ‘Study on the potential of the Living Labs approach Including its relation to experimental facilities For future Internet related technologies’ and produced a working definition of a Living Lab:

*Under a purely institutional perspective, a Living Lab can be defined as “a system based on a business- citizens-government partnership which enables users to take active part in the research, development and innovation process. Products and services are developed in a real-life environment in a human centric and co- creative way, based on continuous feedback mechanisms between the developers and the users”. As Open Innovation platforms, European Living Labs aim “at creating a user environment where users are confronted with ideation and prototypes or demonstrators of technology from the early stages of the research, development and innovation process, not only at the end”, as it is the case “in more classical field trials or product testing approaches”.<sup>1</sup>*

The inclusion of the term ‘institutional’ is important and should be seen in the context of the setting up on November 20th,2006 of the European Network of Living Labs (ENoLL) under the Finnish EU presidency. The Altec report makes the point that the membership of ENoLL is characterised by a high degree variability and heterogeneity in terms of what constitutes a Living Lab.

ALTEC note that very few European Living Labs are currently involved in what could be called a permanent iterative process involving the development of a variety of systems, products and services which may or may not be connected. Whilst there are exceptions - for example in Lulea in Sweden and Oulu in Finland - at the moment most Living Labs are involved in the iterative process surrounding the development of a specific service or set of complementary services.

Not surprisingly, ALTEC endorses the current EU policy objectives of bringing Living Labs together to share information, methodologies and examples of best practice.

When the DEHEMS project was originally conceived in 2008 the intention was to use Living Labs methodology to share and learn from each other. The DEHEMS project members were aware of the work being done in other Living Labs across the EU and this informed the methodology adopted in the DEHEMS. Whilst the project has come to an end, the Living Labs continue.

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<sup>1</sup> ALTEC Report p6

The DG INFSO publication 'Living Lab methodologies - An update on Living Labs for user-driven open innovation in the ICT domain' was published in July 2010 (ISBN 978-92-79-14873-6) and complements the ALTEC document. Whilst the emphasis on the ALTEC Report is on Living Labs as institutions - possibly as a network - this second publication is more focussed on highlighting case studies and the methodologies that they adopted. In that sense it adopts a more bottom up approach. DEHEMS is itself one of the case studies highlighted.

The development of living Labs Methodology in DEHEMS has already been discussed in key elements of the DEHEMS documentation, notably:

- D7.1 Report on Community Engagement Models
- D7.2 Report on DEHEMS Implementation Model
- D7.3: Operation of the Living Labs
- D7.6 Project Cycle Analysis report for Cycle 2
- D7.7 Project Cycle Analysis report for Cycle 3

All of which are available from [www.dehems.eu/reports](http://www.dehems.eu/reports)

### Methodological Flexibility

There is no single Living Labs Methodology.

In the case of DEHEMS it became very clear from the start that there was no off the shelf solution to setting up a Living Lab. The process had to be interactive and managed in such a way as to keep the users i.e. Living Labs members involved whilst at the same time not losing sight of the objectives of the project.

### The DEHEMS model

In what might be called a more traditional Living Labs approach there is an element of implied passivity in the role of Living Labs members. Developers develop, Living Labs engage with what they produce and provide feedback and the pattern is repeated as the proposed service is improved via a series of iterative cycles.

DEHEMS is different in that members of Living Labs were actively collaborating in twin processes which are usually discrete. The first being the development of products and services, the second being the modification of their own behaviour as a result of using these same products and services that they had helped to develop.

### **Methodological Integration: a collaborative partnership**

Living Labs are an important part of DEHEMS but they are not the only part. They exist as part of a collaborative enterprise which as the ALTEC report points out tends to have a number of recurring elements:<sup>2</sup>

1. A University playing a leading role, to ensure a systematic and coherent implementation of underlying methodologies;
2. One or more local/global industries are involved as technology providers, interested in designing, testing or validating their prototype products and services;
3. The Open Innovation concept is assumed, postulating that there is more value to companies in “sharing and spreading” rather than “storing and protecting” the knowledge created by their various internal and external sources, such as employees, customers, suppliers, etc.;
4. A real-life testing environment is established, where users’ feedback on innovation is collected and aggregated while it is emerging from the seamless and spontaneous interaction between people and technologies. This is the most authentic connotation of the Living Labs approach, something that looks totally different from the traditional, laboratory based, prototype testing environment;
5. A user centric approach to innovation is implemented, which amounts to putting people’s feedback at the core (or as integral part) of the product and service design/development/validation/marketing process, especially in the earlier stages of it;
6. An external funding entity (typically a public one) makes all of the above financially feasible, and
7. An ‘umbrella’ organisation acts from the background, either virtual (like an informal network) or a real one, named “XYZ Living Lab” and being a public/private partnership composed of several local and global stakeholders, each of them with some degree of relevance and/or expertise in the areas of e.g. territorial marketing, technology transfer, R&D promotion or business incubation, and the like.
8. Another crucial element of a Living Lab should logically be the establishment of a ‘permanent’ community of users, who are iteratively asked to become integrated in some stages of the design/development/validation and marketing process, and whose feedback is collected by

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<sup>2</sup> ALTEC p9

means of various socio-ethnographic research methods (from focus groups to surveys, from TV recorded debates to web based interviews and polls).

The DEHEMS partnership largely mirrors this description. The problem that has to be addressed stems from the fact that a Living Lab exists in a complex system of socio-economic relationships. All the partners in this intricate web have their own sets of ontological assumptions which traditionally have helped define their methodological approach to doing things. Software engineers will usually have evaluative criteria which differ from those of social psychologists. Market researchers and marketing researchers - they are not the same - also approach issues differently. Lastly, users grouped in Living Labs will also have their own evaluative criteria.

Put another way, the eight recurring elements identified in the ALTEC document have a duality. At one level they constitute the defining characteristics of a successful Living Lab. At another they offer areas of potential conflict of interest between members of the consortium in what should be a collaborative partnership.

The experience with DEHEMS is conclusive. The potential differences in approach between the various parties needs to be acknowledged from the start in order to achieve a level of methodological integration which will allow the project to succeed.

### **Living Labs Methodology: Lessons learned**

The focus of this section is to avoid detailed repetition of the content of other deliverables such as D7.7 by examining the DEHEMS experience in order to establish a set of principles which could be replicated by other practitioners who are thinking of using Living Labs.

To do this a bottom up approach has been adopted. The principles that emerge are therefore grounded in the every day experience of users and researchers in the DEHEMS project but have a wider application in terms of methodology.

This is not designed to be a toolkit to be produced, however the principles derived in practice can be easily adapted to a toolkit format.

The headings below are of a typical set of dependent as opposed to independent variables which have to be taken into account when defining an appropriate Living Labs Methodology.

### **Project Definition**

This should include the provision of job specifications and person specifications of all the key personnel together with an organisational chart which makes clear how responsibility is allocated within the project plan. This is particularly important where a project is complex and combines

different groups of people who may initially have a very narrowly defined view of the project. For example DEHEMS had to integrate the efforts of ICT developers, software engineers, social scientists, different groups of users and the DEHEMS management team.

Clarity is essential from the start. This is particularly true when the project has a multiplicity of goals. DEHEMS was about behavioural analysis and behaviour change as well as being about the development of a range of different technologies. Included in this was an important iterative process which had to be implemented and analysed in each of the project cycles.

An agreed definition of what the project is about is essential before setting up the individual Living Labs.

### **Project Design**

The Description of Work defines what has to be done and the timeline in it constrains what is done and when. Beyond that there are a number of options to be considered from a methodological point of view.

In DEHEMS it was considered useful to carry out a baseline study so that changes in behaviour and service delivery could be measured as the project developed over the course of three years.

Strategic project design assumes that the project team knows where it is and approximately where it wants to be by the end of the project. As part of this process it needs to consider questions of scalability. DEHEMS involved a small number of Living Labs but as the Evaluation Report shows, the outcomes are eminently scaleable. For example, Australia's Smart Grid Smart City Project uses similar end user engagement technology for 50,000 homes.

One problem that emerged in DEHEMS is that by recruiting people to participate in Living Labs or in a control group, all were alerted to what the project was about. The control group also reduced their energy consumption because by agreeing to participate they also became self aware of their own situation. This has been termed 'the DEHEMS effect' by researchers involved in the project.

A baseline study therefore has limitations but is essential. In DEHEMS this was partly compensated for by using a variety of methods which enabled the results to be triangulated in order to test their veracity. The diagram below makes the point. Results from the empirical data derived from the DEHEMS sensors could be triangulated with data obtained from Focus Groups and answers derived from questionnaires.

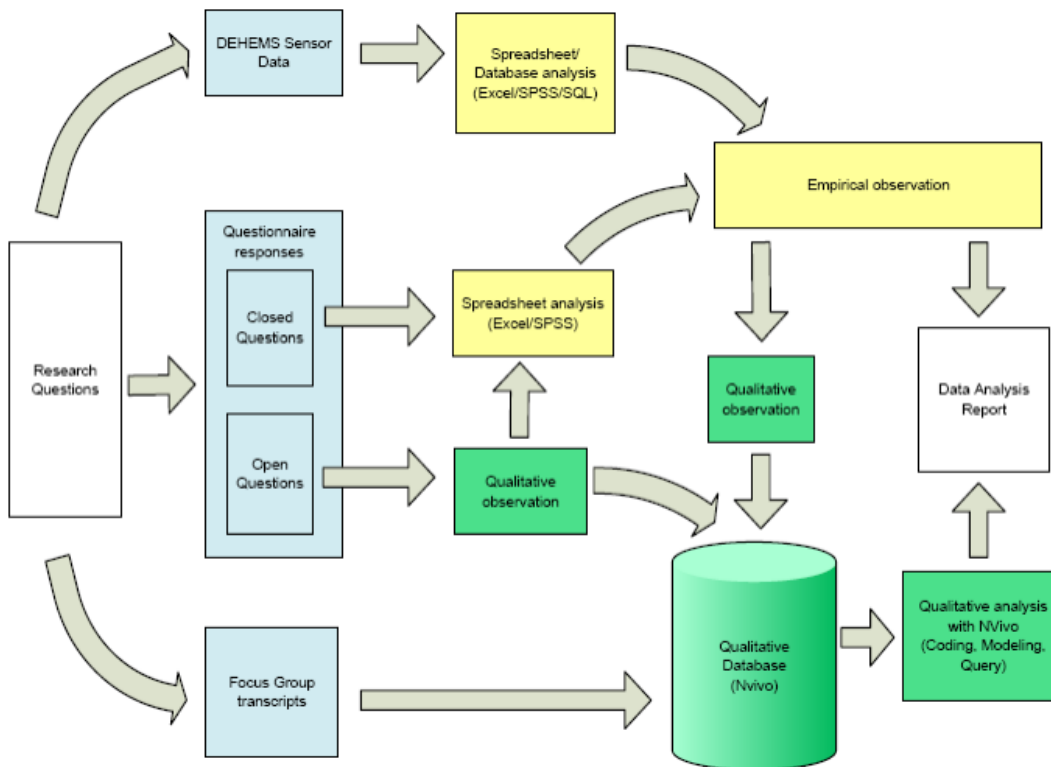


Figure 2 Living Labs Data Flow

### Living Labs: from Typologies to Methodology

In terms of methodology it can be argued that the most suitable type of Living Lab format will be dependent on the type of ICT service or product that is being developed.

The terms Living Labs is generic. Whilst it is possible to define the characteristics of a Living Lab in principle, there will be a range of variables both within and between each individual Living Lab. One way of conceptualising this is to think of each Living Lab as being on a continuum.

At one end is a Living Lab of 1000 people who were recruited on line at random. They never meet on a face to face basis and communicate only with project personnel and not with each other.

At the other end of the continuum is a small Living lab of 10 - 12 individuals or households who already know each other and who regularly communicate on a face to face basis.

In the case of DEHEMS, the Living Lab in Ivanovo (BG) was not unlike the latter case, i.e. people knew and met each other before being recruited to the DEHEMS project. By contrast, the Living Lab in Manchester was very different. It was much more atomised and those recruited to it did not initially know each other. There are positives and negatives to be found in both. Where people know and regularly interact with each other they will probably reinforce behavioural change by offering a subtle pressure to conform to group norms. Where they don't know each other the

response to different options being discussed in a focus group are likely to be more individual and varied as the pressure to conform is not so obvious.

### **Living Lab Recruitment**

The definition and design of the project will have an impact on the recruitment policy for each Living Lab. A project which is aimed at developing a Web2 social media service/application aimed at people in the 18 - 25 age cohort is likely to have a very different recruitment base to a service which is designed to assist people with a range of physical disabilities who live in relative isolation from each other and other family members.

In either case there are methodological issues about motivation to consider. Building an ICT product or service in conjunction with users who volunteer their services out of interest suggests that they might be lacking in objectivity from the start. Early adopters do not usually make the best guinea pigs. However, the levels of enthusiasm to be involved in the task which they bring should not be underestimated.

In DEHEMS recruitment took place in different ways which in turn allowed comparisons between the use of different models and strategies. The statistical ideal might have been to recruit Living Lab members at random with a control group against which the impact of the proposed interventions can be measured. In reality there are a number of constraints to implementing this approach. These range from the need for all users to have a fast broadband internet connection to knowledge of the existence of suitable users to recruit. In the case of DEHEMS Living Lab members were recruited via the participating Local Authorities in the UK and Bulgaria., hence they fall on different parts of the typological continuum.

This also highlights one of the dilemmas in recruitment policy, e.g which objective is the most important?

If behaviour change is the key objective people need to be recruited for the duration of the project so that attitudes and behaviour can be measured during each iterative project cycle.

If the development of a product or service is to be given priority, a case can be made for recruiting different sets of users for each project cycle. The DEHEMS Dashboard is a good example. The reactions of new users who are unfamiliar with previous versions of the product might be more useful to the developers because they would give a fresh, immediate reaction uninfluenced by the past. Whilst this might make the life of the developers easier, it would make the task of the social scientists carrying out a longitudinal study of behaviour change in the same people over three years impossible.

DEHEMS demonstrates very clearly that there are no simple methodological solutions to Living Labs recruitment. Ultimately a methodological compromise is likely to be inevitable.

### **Equipment installation: Methodological basics**

Some programmes that use Living Labs are almost entirely software based. In DEHEMS equipment had to be installed and users trained. Where users are extremely tech savvy the process might be perceived as being non-problematic.

In DEHEMS, as for most programmes that use Living Labs, the installation of equipment was often challenging. It is therefore important to get it right from the start and draw up an equipment delivery schedule which is designed to reassure users and train installers.

The equipment to be installed needs to be robust and the installers, both male and female, need to be trained in both technical and people skills. If equipment is battery driven, as it was in DEHEMS, then the batteries need to last the length of the project. Similarly if the equipment relies on radio communications between sensor and data collector, this should be tested to make sure that it works in typical domestic settings and not just in the laboratory.

Put another way, the focus needs to be on the user and not simply the equipment. Attention has to be paid to maintaining a very high level of customer service from the initial involvement of the individual user.

The two points above suggest that a small scale roll out as a pilot can reduce potential future problems.

### **Overcoming user concerns**

People may have concerns about the cost associated with participation in a Living Lab.

If the equipment needs a permanent i.e. 24/7 internet connection then this needs to be explained from the start and reassurances given to those who imagine this to be costly.

Provision needs to be made to back up the initial training session and users need to be provided with very clear instructions as to how they can access future support. Users are human. They often try to please those who they perceive as trying to help them. In DEHEMS it was observed that even if users claimed to understand what they had to do, they didn't. A second visit was sometimes required to ensure that the equipment was functioning correctly. A user helpline is needed from the start of the project so that people know that assistance is just a phone call away.

User support can take many forms. Following the initial installation a set of written instructions about equipment set up and/or rebooting in simple language should be left with all users. Web

support is also essential. At a minimum this should include a list of FAQs and a version of the original installation instructions. Video tutorials on Youtube should also be considered. Realtime access to a human being via voice and email is also vital. In DEHEMS it became clear that such a service should be provided outside as well as during normal working hours - particularly at the start - and that some female users preferred to deal with a female service operator.

### **Maintaining user interest**

By definition, users are mission critical to Living Lab methodologies. In DEHEMS it was found that they sometimes did not conform to the expectations of those who designed and defined the project. This is normal. On occasion this takes the form of withdrawal from all or part of the project.

One example concerns the response rate to the online surveys at the end of Cycle 2 and Cycle 3. At the end of cycle 2 the response was 64%. In itself this is a good response rate to an online survey but DEHEMS personnel sought to improve it for Cycle 3 of the project. This they did by a combination of phone calls and personal visits to reassure those who were not happy with the online survey tool.

Using the same online survey tool they achieved a response rate of 86.5% for Cycle 3.

In addition to involving users in an iterative exercise to develop a range of technologies, DEHEMS developed a Living Labs methodology to create, measure and attempt to explain behavioural change. The combination of research paradigms used offered some interesting insights. The majority of users, 88%, were particularly enthusiastic about comparing their current energy use with their past energy use.

Clearly some of the assumptions made by the researchers were not apparently shared by all the users but 40% is a significant minority and this undoubtedly contributed to the overall success in getting people to consciously reduce their energy consumption.

The generic point to be made here is that when it comes to maintaining user interest, Living Labs Methodologies need to combine a variety of techniques which taken together will yield a positive outcome.



## **Managing Methodological Diversity**

The key to managing methodological diversity and containing the problems that it might create is effectively executed project management.

The core members of the DEHEMS management team are certified PRINCE2 practitioners. There is no contradiction in arguing that there is no single methodological guide to running a successful Living Labs whilst at the same time arguing the case for a generic set of project management principles of which PRINCE2 is one of the best known examples.

PRINCE2 methodology describes how a project is divided in manageable stages enabling efficient control of resources and regular progress monitoring throughout the project. The various roles and responsibilities for managing a project are fully described and are adaptable to suit the size and complexity of the project, and the skills of the organisation.

Project planning using PRINCE2 is product-based which means the project plans are focused on delivering results and are not simply about producing Gantt charts and mileposts indicating when the various activities on the project will be done.

In projects such as DEHEMS where many different groups are involved, PRINCE2 provides a common language across all the interested parties.

In DEHEMS, PRINCE2 has had a considerable impact in defining D7.1 Report on Community Engagement Models, D7.2 Report on DEHEMS Implementation Model and D7.3: Operation of the Living Labs. It is important to note that Living Labs Methodology operates in a project context. If the overall project is managed according to general PRINCE2 principles, then the probability is that this will be reflected in the methodology of the Living Lab as it clearly is in DEHEMS.

In summary, PRINCE2 provides a structure for managing methodological diversity within a project consortium. It concentrates on process which starts with the initial Project Definition Workshop which leads to the development of the Project Initiation Document (PID). It ends with a Decommissioning Implementation Plan. In between it offers structured insight into Project Assurance, Project Support, Risk Management and the Control of Change. The latter is important because it is based on the assumption that few projects end up as they were supposed to according to the PID.

## Conclusion: ALTEC on Methodology

It could be argued that a Living Lab is shorthand for a specific methodology. Before coming to any conclusions about the methodological implications of what has been done in the course of the DEHEMS project, it is worth recalling what the ALTEC Report<sup>3</sup> had to say about Living Labs as a result of their survey of different types of Living Lab across the EU:

*From the survey conducted, three main categories of benefits emerge as being a common basis to many Living Labs.*

*(i) Firstly, the generation of innovation in its different forms and shapes (creation of new services, improvement of services and development of new tools/approaches).*

*(ii) Secondly, the promotion of collaboration. In this respect, Living Labs may be considered as “catalysers of interaction” providing a meeting place for actors with complementary knowledge assets.*

*(iii) The final type of benefit is a direct consequence of the previous one and has to do with a more fluid circulation and dissemination of knowledge, making the participation to Living Labs activities an important learning opportunity for all stakeholders.*

*The fact that private companies are the most interested (or targeted) customers provides an indication that what Living Labs offer is actually satisfying a real business need. As self-interested and profit oriented actors, companies would not make use of Living Labs if they did not perceive the possibility to extract some value out of them.*

*The presence of public administrations as users sheds some light on a new role of Living Labs as potential policy testbeds. This type of use of Living Labs has gone mostly undetected so far, but may gain momentum in the future. This may be easily understood if we consider the recent decision of the European Commission to stimulate the use of ICTs for participated policy simulation practices.*

*For what concerns research consortia – and in particular those aimed at developing new technological solutions - Living Labs may prove to be an important asset to lower the financial and organizational costs of testing their solutions feasibility.*

As a description of how Living Labs methodology has operated in the context of DEHEMS this requires no editing. Genuine innovation has been generated in a variety of forms from software

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<sup>3</sup> Ibid, p18

and hardware design through to voluntary behaviour modification in terms of energy consumption.

Collaboration between different stakeholders with complementary knowledge assets has been manifest. Local Authorities, private sector companies, Higher education institutions and private citizens are all part of the DEHEMS mix and all have gained from membership.

DEHEMS has provided an important learning opportunity for all of them. The technology has been taken further and can rightly be called state of the art. The HEIs have developed the knowledge base. The Local Authorities have gained some practical insights into reducing their carbon footprint. The citizens have gained self knowledge and also saved some money.

## Appendices

### Appendix 1: Living Labs Implementation Plan

#### 1 Equipment:

- 1.1 Serial numbers (on data collectors) to be entered on spreadsheet and database.
- 1.2 Assign a household reference for each participant in the format: LL\_House\_No (e.g. Birm\_Summerfield\_01) - Reference for the address, to be kept locally (not centrally) because of data protection issues
- 1.3 Log what kit went into what household (house reference) for each piece of equipment – incl. time installed/removed. Hildebrand to specify data required
- 1.4 Kit testing: does the current cost meter connect to the data connector and send to the internet? Create one login and connect equipment as installation guide – to test next set of kit, change only the display unit and re-associate new display with the energy meter (using reset button on meter).
- 1.5 Check household connectivity upgrade requirements
- 1.6 Identification stickers with EU to be sent out to LL's and attached to equipment
- 1.7 Check that network cable data collector to BB router is available

#### 2 Installation:

- 2.1 Brief installation partners
- 2.2 SLA with installation partners signed off (confirm public liability insurance in place)

#### 3 Welcome pack:

- 3.1 Welcome letter (big picture, motivational, not detail), participation & informed consent agreements to be circulated
- 3.2 Confirm ethical approval requirements met.
- 3.3 For information: participation & informed consent agreements can be waived at LL partners' discretion. If so, this must be documented

#### **4 User support & issue tracking**

- 4.1 Level 1: FAQ's: to be finalised, agreed & included with welcome pack
- 4.2 FAQ's to include images & use same terminology as install guide. Install guide to be added
- 4.3 FAQ's to include detail on if the system can be maintained after project end (e.g. on MDDA server)
- 4.4 FAQ's to include instructions on using dashboard
- 4.5 Level 2: Helpline in place, numbers published
- 4.6 Knowledge base database will available through DEHEMS web site. Will require 1 person per LL to update issues eg. monthly. DE to manage centrally.
- 4.7 Overview of support process and management to be drafted & circulated (incl. contact points, responsibilities, response timescales, problem resolution, etc)
- 4.8 Database for energy data, check that the current analysis is meaningful and the graphs are displayed correctly. Confirm scalability to include more households. How will the system track change of kit for one household. Get answer from Hildebrand
- 4.9 Level 3: Need to agree escalation route with technology partner
- 4.10 Issue tracking: Need to integrate user group & technical group (see also D2.6)
- 4.11 Install guide to cover settings of display unit (rates, currency, etc)
- 4.12 Upload completed FAQ and instruction guide

#### **5 Householder Survey:**

- 5.1 Survey A – info needed for installation. Draft to be circulated
- 5.2 Survey B – household baseline information
- 5.3 LL's can implement survey B in whatever way suits their client group
- 5.4 Description of participants groups documented by each LL eg. demographics, selection process, previous experience, context, etc

## **6 DEHEMS dashboard:**

- 6.1 Current version has things missing (eg. back buttons) – everyone should review & comment
- 6.2 Support documentation needs to include how to use the dashboard website
- 6.3 Confirm with technology partner what data the dashboard asks for at registration
- 6.4 Issue over questions on consumption, current rate, tariffs (time-based / volume-based).  
Need to ensure that questions deal with this issue & link to FAQ's
- 6.5 Feedback box: needs to be dealt with centrally
- 6.6 Need a disclaimer for financial information
- 6.7 Adhoc Issues that arise during implementation to be circulated for discussion

## **7 Insurance:**

- 7.1 Check product liability insurance and circulate to partners

## Appendix 2: Lessons Learnt By Cycle

Cycle 1 Lessons Learnt	Actions for Cycle 2
<b>1 Recruitment</b>	
1.1 Household requirements – need for broadband; PC; basic it skills	Ensure explicit when recruiting
1.2 Vary recruitment methods - existing groups; word of mouth; residents groups; web advert; mailing	Plan early; use different channels
1.3 Surveys concerned some users - viewed it as test	Review survey and information given
1.4 Delays with equipment deployment and drop out of commitment	Ensure equipment almost ready when recruit
1.5 Motivation for involvement is broader than project e.g. general interest in green	Link in to other initiatives
1.6 Tariff information	Request prior to installation
<b>2 Installation</b>	
2.1 Skill set for installers – define clearly	Training/ Installation teams
2.2 User support; coaching – do not underestimate	Add to Living Lab installation process
<b>3 Equipment</b>	
2.1 Advanced knowledge of household configuration	Revise pre installation questionnaire
2.2 Many plugs and wires - extra mains sockets required to power monitoring equipment	Reason to simplify equipment
2.3 Interest in mobile display as well as web based	Opportunity for research

<b>4 Other Technical - Including Dashboard</b>		
4.1	Disconnections, kit needing rebooting	Include auto reboot function C2
4.2	Misleading cost savings to avoid - complex tariff situation	Disregard financial info – focus on energy used
4.3	Revisions to user interface - help button on each page; FAQs	Revised interface
<b>5 Maintaining Interest / Engagement</b>		
5.1	Households should feel part of a broader project	Newsletters; news items
5.2	C1 users "luke warm" on social media - DEHEMS assumes social media knowledge	Use case; watching brief
<b>6 User Support</b>		
6.1	User support only available office hours	Monitor in C2
<b>7 Data Capture</b>		
7.1	Energy savings against external temperate - Bulgarian requirement due to heating and cooling	Further investigation; C2 specification
<b>8 Communications</b>		
8.1	Clarity of communications with users - prioritise information	C2
8.2	Ensure simple messages e.g. Climate change - installation document to include high level benefits	C2
<b>9 Project Design</b>		
9.1	Clear definition of responsibilities	C2
9.2	Think about how can create an identity that is marketable rather than just project acronym	

Cycle 2 Lessons Learnt	Actions for Cycle 3
<b>1 Recruitment</b>	
1.1 There are no Plovdiv / Ivanovo households with a natural gas supply.	No gas monitoring in Bulgaria in C3
1.2 Planned for C1 users to be part of C2, new users are more useful for research	Review feasibility
1.3 Recommended to use internet for recruitment	Explore web based channels
1.4 Issues with recruiting in regeneration/social exclusion and connectivity	Not a social inclusion project
1.5 Need to start recruitment early to ensure households ready	Not applicable
1.6 Distinguish between digital engagement project vs. finding users engaged in project idea	Note for gas recruitment
<b>2 Installation</b>	
2.1 Use of commercial IT organisation for installation worked well for some Living Labs	Maintain this approach for C3
2.2 Video for self-install - created	Similar evidence for gas to be considered
2.3 Training the installation team with the help of IT professionals beneficial	
2.4 Wireless solution makes installation more straightforward	
2.5 The equipment not "plug & play" – hence need professional help	Refer to for gas metering and mobile app
2.6 Large scale deployment has been successful with a combined approach	
2.7 Delay in equipment installations led to users dropping out	Delay C3 until technical solution is ready
2.8 Up-to-date communications on equipment development & shipment to manage installation team	

2.9	Need to avoid multiple visits & retro-fitting	Robust technical solution required for C3
2.10	Need for co-ordinated training programme	Bear in mind for gas metering and mobile app
2.11	Bulgaria: Meters are in cabinets external to apartments/houses owned by power supply companies	Work with Bulgarian supply companies
2.12	Bulgaria: Wires to consumer unit/fuse boxes are channelled into the walls requiring partial dismantling	Work with Bulgarian supply companies
2.13	Bulgaria: For above reason, Dehems fitting requires electrical contractors	
2.14	Bulgaria: Consumer unit/fuse box is often exposed and householders reluctant to add ancillary equipment	
2.15	Bulgaria: lack of unification in the power supply systems	
2.16	To avoid retro-fit & disruption to users, all kit should be available before installations commence	Bear in mind for gas metering
2.17	Issue over whether to offer out-of-hours appointments	Does not form part of Cycle 3 requirements
2.18	Need to keep detailed log of what equipment has gone to which users	
2.19	Install base unit & Plugwise unit at the same time before turning on	
2.20	Need for more quality testing of equipment	Robust technical solution required for C3
2.21	Distance of router from electricity supply can be 4 floors in old houses	Not suitable to install in all homes
2.22	More time needs to be allocated to allow for real-life problems encountered in technical implementation	Mindful of this when fitting gas metering
<b>3</b>	<b>Equipment</b>	
3.1	Problems with equipment has led to some users dropping out	Ensure equipment resilience
3.2	Issue about delivery - Plugwise delays in coming to market	
3.3	Issue regarding mailing electronic equipment to Bulgaria/overseas	

3.4	Need to recover equipment at end of each cycle unless agreed otherwise with users	
3.5	Need to print EU FP7 labels & attach to equipment	
3.6	Batteries: need to insert quality batteries before installation	
3.7	Batteries: also long-term issue over battery life & therefore need user guidance	May impact on quality of cycle 3 data
3.8	Clamp unit serial numbers: need to convert hexadecimal to decimal	
3.9	C2 equipment - purchase price need to align with budget	
3.10	Plugwise unit may require USB extension to separate equipment and avoid interference	
3.11	Plugwise unit does not always communicate properly (is this related to 3.9?)	
3.12	Plugwise installation (incl. dashboard registration) is time-consuming and complex	
3.13	Manual internal soldering required for data collectors meant that unit's could not be reflashed	
3.14	Confusion existed over whether Cycle 2 kit would work with Cycle 1 installs i.e.. Cost monitors & clamps	
<b>4 Other Technical - Including Dashboard</b>		
4.1	Wireless solution is popular with users – eliminates wires	
4.2	User interface development process successfully progressed from user requirements to deployment	Incorporate into Cycle 3 outcomes
4.3	User interface: lack of feedback from outside the UI development team resulted in details missed	User interface to be updated for Cycle 3
4.4	Delays in delivery of intelligent tips engine	Intelligent tips to be available for Cycle 3
4.5	Unclear integration between different software components	Technical team input
4.6	User feedback on dashboard: can feel overwhelmed by information	Incorporate into cycle 3 outcomes

4.7	Need a technical / feedback support system in place to capture technical / user insights	
4.8	Due to timescale change, WP2 activities needed to be reassessed with research objectives	Reflected in WP2.8 Use Cases
4.9	Potential issues regarding use of ZigBee licensing and ability to release DEHEMS as open source	
4.10	System does facilitate a response to users who submit comments to energy-saving tips	Updated within cycle 3 use cases
4.11	There are day-time and night time tariffs in Bulgaria	
4.12	Research needs a broader social / economic context	
4.13	More effort is required allow for real-life problems	
4.14	Built environment knowledge is critical to energy monitoring	Cycle 3 data collection
<b>5 Maintaining Interest / Engagement</b>		
5.1	Maintaining communications with users to keep them engaged - e.g.. newsletter	Cycle 3 communications
5.2	People are interested to engage with energy efficiency	
5.3	RSS feeds to dashboard	Would be good to have
5.4	Link to Energy Saving Trust	
5.5	Electricity usage awareness greater in Bulgaria where bills are monthly and actual readings	Investigate as part of C3 UI development
5.6	Number of households dropping out has been more significant in UK than Bulgaria	Maintain communications with users
<b>6 User Support</b>		
6.1	Need capacity to deal lots of small queries	
6.2	Need to provide ongoing support - e.g. email	

6.3	Technical support required a highly skilled network engineer with knowledge of TCP/IP, SSH tunnelling etc	
<b>7</b>	<b>Data Capture</b>	
7.1	Need for incremental roll-out of user survey	Undertaken in Cycle 2 and will be again in C3
7.2	Delays in implementation led to delay in availability of data	Will not impact Cycle 3
7.3	Success: questionnaire development methodology	Will be highlighted in Cycle 3 outcomes
7.4	Timeline for data evaluation	Need to build in slippage time
7.6	Methodology needed to capture and process ongoing feedback from users	Uniform method required
7.7	Need to ensure that data protection regulations are met	All Living Labs built this into practice
7.8	User anonymity needs to be managed differently per living lab	
<b>8</b>	<b>Communications</b>	
8.1	Newsletters - effective - need to be short, succinct	
8.2	Need for good communications between database & evaluation teams	
<b>9</b>	<b>Project Design</b>	
9.1	Ensure all tasks have an owner	

Cycle 3 Lessons Learnt		Actions for D2.15 (Cycle 4)
<b>1</b>	<b>Recruitment</b>	
1.1	Manage users' unrealistic expectations of prototype kit	√
1.2	Use male/female installers for BME families; installation team needs mix of technical & communication skills	√
1.3	Recruit communities of interest - e.g. people that work in the same place (e.g. Ivanovo)	√
<b>2</b>	<b>Installation</b>	
2.1	Some users confused over cubic feet/metres - intervention by staff s required	√
<b>3</b>	<b>Equipment</b>	
3.1	Improved solution (hardware) required for gas	√
3.2	Wider roll-out not be possible due to limitations of current monitoring devices	√
3.5	Gas unit needed specialist installation team and also special user briefing	√
3.6	Some users felt unable to provide feedback because the system was too complex	√
3.7	C3 required a reliable product so users can develop "normal" consumer behaviours around it	√
3.8	Quality, long life batteries to prevent equipment failure	√
3.7	Need to create confidence in the system - robust equipment	√
3.8	Reliability of some system components	√
3.9	Need to keep users online all the time – some users turned off routers	√

3.10	System should be self-install / plug & play. Householder could be incentivised to install.	√
3.11	Learn from Google Power Meter (ceased operating July 2011)	√
3.12	Radio communication between sensor and data collector is unreliable in large flats & houses	√
3.13	The more experimental the technology is the less reliable are the data on behavioural change	√
3.14	Gas metering technology – the need for maturity to ensure robust reliability	√
3.15	Close down and equipment disposal strategy – ways to retrieve equipment	√
<b>4</b>	<b>Other Technical - Including Dashboard</b>	
4.1	Dashboard is too complicated	√
4.2	Simplify the dashboard	√
4.3	Minimise technological development, keep it simple, not too clever with artificial intelligence	√
4.4	Alerts must be well defined and meaningful	√
4.5	More energy saving tips in relation to gas consumption	√
<b>5</b>	<b>Maintaining Interest / Engagement</b>	
5.1	Need to strengthen team aspect of carbon saving aspects	√
5.2	Importance of personal contacts, playing in teams, awards	√
5.3	Alerts & features help to keep people interested	√
5.4	More direct incentives- e.g. dinner invitation, community events, cost reimbursement	√
5.5	Need to ensure commitment and ongoing engagement of end users	√

5.6	Competition drives change and helps engagement	√
5.7	Need a realistic baseline (other than 1st weeks usage)	√
5.8	Carbon trading needs more meaningful on larger scale (neighbourhood, city, region)	√
5.9	Participants' loyalty was with the local organisers rather than project partner or the project	√
<b>6</b>	<b>User Support</b>	
6.1	Helpdesk needs to be properly resourced	√
6.2	1st, 2nd & 3rd line support must carefully planned and managed	√
6.3	Consider out of hours to accommodate working people	√
<b>7</b>	<b>Data Capture</b>	
7.1	Focus group questions need to be meaningful and clear	√
7.2	Questions on ethnicity & income upset some users & refused to complete on questionnaire	√
7.3	Managing LL's locally resulted in users dealt with differently in each location and possible inconsistent results – need for common methodology and terms but allowing for diversity	√
7.4	More fuzzy rules to be introduced in association with thermo model	√
7.5	Data sets should be modelled as services to facilitate data fusion	√
7.6	Thermo model should include user comfort level	√
7.7	Risk availability of data management on servers – consider cloud for collected data	√
7.8	Different models of community engagement - existing communities / random recruitment	√

7.9	Unique aspect - introduced people into product development and used their feedback	
8	Communications	
8.1	Similar products/systems are now available on the market - need to create a unique identity	√
9	<b>Project Design</b>	
9.1	Divide (a) product development, and (b) behaviour research	√
9.2	Methodology issues e.g. if we recruit people that are already interested, results are biased	√
9.3	Results are much richer through integrating into own life/household patterns	√
9.4	Use a stable group of participants engaged over 3 cycles to see them grow with the product	√
9.5	Recruit a new set of users each cycle - see each product version fresh	√
10	<b>Planning for Cycle 4</b>	
10.1	Widen community engagement - work with offices, businesses, schools (3 phase supply issues)	√
10.2	Include water monitoring – is the technology available?	√
10.3	Use orbs or other signalling system	√
10.4	Facebook app should enable other users to be identified	√
10.5	Increase family involvement by including more child friendly features	√
10.6	Recruit "super users" - part of a wider Living Lab e.g. "be a part of your city's future"	√
10.7	Convenience - e.g. mobile app, smart phone essential	√

### Appendix 3: Consumer Behaviour and Energy Consumption References

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