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BeAware

Boosting Energy Awareness
with Adaptive Real-time Environments

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Table of Contents

1	Introduction	7
1.1	Verification	7
1.2	Deployment plan	7
1.3	Metrics for Validation	8
2	Verification	9
2.1	Component testing	9
2.1.1	How to read the verification scenarios	9
2.1.2	Verification scenario for sensor layer components (wp3)	11
2.1.2.1	Data storage component	11
2.1.3	Verification scenario for application layer components (wp4)	16
2.1.3.1	Mobile interface component	16
2.1.3.2	Mobile interface and ambient interface components	17
2.1.4	Verification scenario for service layer components (wp5)	21
2.1.4.1	Message Service component	21
2.1.4.2	Energy Profile Service component	23
2.1.4.3	Device Service component	28
2.1.4.4	Monitoring Service component	29
2.1.4.5	Community Service component	30
2.1.4.6	Consumption knowledge Base Service component	31
2.2	Integrated system testing	33
3	Deployment plan	34
3.1	Pre-first trial – phase 0	34
3.1.1	System functionalities available in phase 0	34
3.2	First trial – phase 1	35
3.2.1	System functionalities available in phase 1	35
3.2.2	Criteria for households selection	35
3.3	Second trial – phase 2	36
3.3.1	System functionalities and Criteria for Household selection in phase 2	36
3.4	Deployment shopping-list	36
3.4.1	Installation of ambient interface	39
3.4.1.1	Ambient Interface components	40
3.4.1.2	Safety	40
3.4.1.3	Supported light bulb types	40
3.4.1.4	Ambient interface addressing	40
3.4.2	Deployment installation team	40
3.4.3	User instructions and feedbacks	41
3.4.4	Agreement plans with household owners	41
3.5	Deployment models	41
3.5.1	Sensor layer deployment model	41
3.5.2	Application layer deployment model	43
3.5.3	Service layer deployment model	45
4	Determining metrics	46
4.1	Introduction	46
4.2	User Groups	46

- 4.2.1 Energy User 46
- 4.2.2 Energy Provider..... 46
- 4.2.3 Energy Life Community..... 46
- 4.3 Sourcing Metrics 46**
 - 4.3.1 System Design..... 46
- 4.4 Definitions 46**
 - 4.4.1 Required/Beneficial Metrics..... 46
 - 4.4.2 Direct/Indirect Metrics 47
 - 4.4.3 Hard/Soft Metrics 47
- 5 Metrics 48**
 - 5.1 System in general 49**
 - 5.1.1 Metric number 1 49
 - 5.1.2 Metric number 2 49
 - 5.1.3 Metric number 3 50
 - 5.1.4 Metric number 4 50
 - 5.1.5 Metric number 5 51
 - 5.1.6 Metric number 6 52
 - 5.1.7 Metric number 7 52
 - 5.1.8 Metric number 8 53
 - 5.1.9 Metric number 9 54
 - 5.1.10 Metric number 10..... 55
 - 5.1.11 Metric number 11 56
 - 5.1.12 Metric number 12..... 56
 - 5.1.13 Metric number 13..... 57
 - 5.1.14 Metric number 14..... 58
 - 5.2 Sensing, storing and tele-actuating..... 58**
 - 5.2.1 Metric number 1 58
 - 5.2.2 Metric number 2 59
 - 5.2.3 Metric number 3 60
 - 5.2.4 Metric number 4 60
 - 5.2.5 Metric number 5 61
 - 5.2.6 Metric number 6 62
 - 5.2.7 Metric number 7 63
 - 5.2.8 Metric number 8 63
 - 5.2.9 Metric number 9 64
 - 5.2.10 Metric number 10..... 65
 - 5.2.11 Metric number 11 65
 - 5.2.12 Metric number 12..... 66
 - 5.2.13 Metric number 13..... 67
 - 5.2.14 Metric number 14..... 67
 - 5.2.15 Metric number 15..... 68
 - 5.2.16 Metric number 16..... 68
 - 5.2.17 Metric number 17..... 69
 - 5.3 Game and application 69**
 - 5.3.1 Metric number 1 70
 - 5.3.2 Metric number 2 70
 - 5.3.3 Metric number 3 71
 - 5.3.4 Metric number 4 72
 - 5.3.5 Metric number 5 73
 - 5.3.6 Metric number 6 74
 - 5.3.7 Metric number 7 75
 - 5.3.8 Metric number 8 76
 - 5.3.9 Metric number 9 76
 - 5.4 Feedback 77**
 - 5.4.1 Metric number 1 77

- 5.4.2 Metric number 2 78
- 5.4.3 Metric number 3 79
- 5.4.4 Metric number 4 80
- 5.4.5 Metric number 5 80
- 5.4.6 Metric number 6 80
- 5.5 Awareness feedback..... 81**
- 5.5.1 Metric number 1 81
- 5.5.2 Metric number 2 82
- 5.5.3 Metric number 3 83
- 5.5.4 Metric number 4 83
- 5.5.5 Metric number 5 84
- 5.5.6 Metric number 6 85
- 5.5.7 Metric number 7 86
- 5.5.8 Metric number 8 86
- 5.5.9 Metric number 9 87
- 5.5.10 Metric number 10 88
- 5.5.11 Metric number 11 88
- 5.5.12 Metric number 12 89
- 5.5.13 Metric number 13 89
- 5.5.14 Metric number 14 90
- 5.5.15 Metric number 15 91
- 5.5.16 Metric number 16 92
- 5.5.17 Metric number 17 93
- 5.6 Saving feedback..... 94**
- 5.6.1 Metric number 1 94
- 5.6.2 Metric number 2 95
- 5.6.3 Metric number 3 95
- 5.6.4 Metric number 4 96
- 5.6.5 Metric number 5 97
- 5.6.6 Metric number 6 97
- 5.6.7 Metric number 7 98
- 5.6.8 Metric number 8 99
- 5.7 Visualization 100**
- 5.7.1 Metric number 1 100
- 5.7.2 Metric number 2 100
- 5.7.3 Metric number 3 101
- 5.7.4 Metric number 4 102
- 5.7.5 Metric number 5 102
- 5.7.6 Metric number 6 103
- 5.7.7 Metric number 7 104
- 5.7.8 Metric number 8 104
- 5.7.9 Metric number 9 105
- 6 Conclusions 106**

Executive Summary

The BeAware metrics for trials and validation (D6.1) describes the validation and evaluation actions that are required to be carried out in order to determine if the system fulfils the project objectives and the requirements outlined in:

- Specifications and Interfaces to and from sensing platform (D3.1)
- Application Requirements and Specifications (D4.1)
- Service design and architecture requirements (D5.1)

This document focuses on:

- The verification tests to be carried out on BeAware to ensure that the components described in D3.1, D4.1 and D5.1 and, on these basis, developed, are working as specified before entering user demonstrations, and, after the deployment at users premises, to leave a working system for pilots
- The deployment plan needed to perform the system installation in end-user households
- Validation metrics used to assess the system performance and usability once BeAware has been delivered to pilot users.

1 Introduction

This document aims to detail the validation and evaluation phases of the BeAware system prototype developed in work package 3-4-5. Within this document the tasks required to verify the system as a whole and as individual components are outlined and where appropriate, the results that are expected to be achieved by the verification process. In addition there are details of the metrics that are to be used as part of the evaluation, the methodology used in determining the metrics and the processes that should be carried out in order to evaluate these metrics. This contribute in the achievement of BeAware Obj no. 6 (Reduction of power consumption in 15% in a number of households up to 16) from BeAware DoW. The document also highlights what are the installation pre-requisites and the hardware characteristics of components in order to be able to perform the installation in end-users households. Also the households profile which will be the base for households selection is described.

1.1 Verification

Verification takes place during the development (in the way of unit tests) and on completion of development (integration tests), before the system is delivered to the pilot users. The purpose of verification is to ensure that each component works as expected and BEAWARE prototype components are related correctly through all expected scenarios. The verification process also offers an opportunity to test BEAWARE under extreme conditions such as realistic volumes of data, to give an indication of theoretical performance and ensure that the system is scalable to a sufficient degree when it is deployed to the users. In order to verify components, the Consortium has identified all components of the system and verification scenarios for each of them has been prepared.

Verification needs to be carried out on each component by way of unit tests etc. to be sure that the required functionality is achieved in the way that is expected and on the whole system to ensure that it achieves the required functionality, performance and reliability.

1.2 Deployment plan

The deployment plan highlights, for each macro layer of the BeAware architecture (sensor platform, services, application layer), the installation pre-requisites and the hardware characteristics of each component. Being a system that has the need to be also installed in end-users household, the physical houses characteristics and electric lines configuration has an impact on the feasibility of the installation itself. This statement is especially true for the phased deployment foreseen for the trials and for the prototype nature of some of the componentes whose sizes, in-itinere safety compliant certification etc., will have different pre-requisites and installation requirement along project lifespan.

1.3 Metrics for Validation

Evaluation takes place once BEAWARE has been delivered to the pilot users to assess how the system performs under a live situation. Evaluation covers areas such as the usability of the user interface; the type, quantity and quality of the data provided and overall use and usability of the system. The system will be evaluated following the metrics defined in section 5 of this document.

2 Verification

The verification process objective is to check that the whole system and each system component is working as expected. It takes place during the development in the way of unit tests and on completion of development through integration tests .

2.1 Component testing

The members of the Consortium have proceeded in the identification of all system components, both hardware and software, and for each of them the below template has been adopted, being able to fully describe the testing scenario. The next paragraph describes the tables template used to describe the verification scenario.

2.1.1 How to read the verification scenarios

In the following we will assume that each component can consists of zero, one or more sub-components. If there are no sub-components the testing scenario is related to the component itself, whereas in the other cases it will be related to each sub-component.

Moreover, each component (or sub-component) can have one or more verification scenarios.

Two cases can be distinguished:

1. Only one test for the component (or sub-component). In this case the following table template is used:

Component	Name of the component
Sub-component	Name of the sub-component
Component Behaviour	Brief description of the component behaviour
Pre-requisites	Working condition for the component in order to be able to execute the test
Test	Name of the test
Test ID	ID of the test
Test description	Condition that should be verified; Sequence of steps to perform the test

Expected results	The expected results from the execution of the steps described.
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2. More tests for the component (or sub-component). In this case the following template is used:

- a first template describing the component and identifying the tests that will be performed on that component, by attributing a TEST ID at each test;

Component	Name of the component
Sub-component	Name of the sub-component
Component Behaviour	Brief description of the component behaviour
Tests	List of the test ID

- a second template describing the test and the expected results.

Test	Name of the test
Test ID	ID of the test
Sub-component	Name of the sub-component
Pre-requisites	Working condition for the component in order to be able to execute the test
Test description	Condition that should be verified; Sequence of steps to perform the test
Expected results	The expected results from the execution of the steps described.

2.1.2 Verification scenario for sensor layer components (wp3)

2.1.2.1 Data storage component

Data storage is supposed to collect data from base station, store it, offer real time analysis and client interface for retrieving data. These tests are performed via HTTP requests and admin wiki access. Tests do not require technical training, but several programs should be installed, so it is recommended that beaware personnel perform these tests.

Tester will log into to the wiki with his own credentials and site credentials will be used for testing receiver and client interfaces. So in this document UID and PASSWD will refer to trial site specific, not tester's.

Component	Data storage
Sub-component	Receiver agent
Component Behaviour	Receiver agent offers a data import interface to the data storage. Each access is authenticated and data from base stations is stored under relevant channel.
Tests	Wp3.1, wp3.2, wp3.3

Test	Receiver agent configuration
Test ID	wp3.1
Sub-component	Receiver agent
Pre-requisites	Receiver agent configured to data storage, credentials for receiver and client interface supplied. Tester has curl and google protocol buffer protoc installed
Test description	1)Download test.bup from http://wiki.hiit.fi/display/BeAware/Workpackage+3+Sensing+Infrastructure 2) use program curl (or similar) to send data to receiver agent: proto >curl -u uid:passwd -X PUT --data-binary @test.bup http://a1.beta.c.basen.net/babup/ protoc --decode_raw

Expected results	<p>The decoded babup packet should read:</p> <pre> 1 { 1: "reply" } 2 { 1: 0x00000001 2: 0x00000000 } 3000 { 1: 0x000000000000177ba </pre> <p>This means that data was received successfully. This confirms that receiver agent has been successfully configured to accept measurements.</p>
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Test	Admin wiki configuration
Test ID	Wp3.2
Sub-components	Receiver agent
Prerequisites	Login credentials supplied for user
Test description	<ol style="list-style-type: none"> 1) Open browser to page https://beta.fortn.net/beaware/Wiki.jsp?page=TrialX, where X is the id of the trial installation. 2) Log in with testers account
Expected results	<p>Wiki page should open. Tet box "LogDisplay of raw data" should display text:</p> <pre> authentication { username: "user" } babupVersion { major: 1 minor: 0 } dataReply { id: 96186 data { channelName: "test" value { time { relativeTime { range: NOW } } doubleValue: 1.0 } } } </pre>

Test	Test base station connection
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Test ID	Wp3.3
Sub-components	Receiver agent
Prerequisites	Receiver agent configuration done, user can login to site. Base station connected to power supply, base station connected to internet. Sensors online, wireless receiver connected to base station
Test description	<ol style="list-style-type: none"> 1) Power on sensors and base station 2) Log in to https://beta.fortn.net/beaware/Wiki.jsp?page=TrialX, where X is the id of the trial installation. 3) In less than 5 minutes (depending on base station boot speed, connection speed etc), text box “LogDisplay of raw data” should start displaying more data. Base station has now successfully connected to the data storage 4) Under wiki page heading “Data for each individual sensor”, check each link. 5) For each page, the first plot should contain data
Expected results	Each wikipage for sensor should contain data.

Component	Data storage
Sub-component	Real time analysis
Component Behaviour	Real time analysis is part of the data storage analysing the incoming data.
Tests	Wp3.4

Test	Test real time analysis configuration
Test ID	Wp3.4
Sub-components	Real time analysis
Prerequisites	Previous tests have been run successfully
Test description	<ol style="list-style-type: none"> 1) Log in to https://beta.fortn.net/beaware/Wiki.jsp?page=TrialX, where X is the id of the trial installation. 2) Check that under heading Real-time analysis each row of table normal alerts has a non-grey status. And there are at rows for

	“Babup received” and at least one more for each sensor. This means that data flow from each sensor is being monitored.
Expected results	All sensors are online and monitored.

Component	Data storage
Sub-component	Client interface
Component Behaviour	Client interface gives an authenticated and authorized access interface to measurement data collected from measurement sites.
Tests	Wp3.5 wp3.6

Test	Data storage client interface has been configured
Test ID	Wp3.5
Sub-components	client interface
Prerequisites	User has curl and google protocol buffer protoc installed
Test description	<p>1) Download <code>getDevices.bup</code> from page http://wiki.hiit.fi/display/BeAware/Workpackage+3+Sensing+Infrastructure</p> <p>2) Use curl (or similar) to send the following: <code>curl -u uid:passwd -X PUT --data-binary @getDevices.bup https://beta.fortn.net/beaware/client/ protoc --decode_raw</code></p> <p>3) Curl should return 1 { 1: "reply" } 2 { 1: 0x00000001 2: 0x00000000 }</p>

	<pre>1004 { 1: "trial1" 2: 0 }</pre> <p>where trial is is the allowed device (base station) name for usr</p>
Expected results	Client interface functions for the user.

Test	Java client functionality
Test ID	Wp3.6
Sub-components	Client interface
Prerequisites	User has java 1.6 jre installed. User client interface connectivity has been tested. User has installed the BAProtocols jar and other associated java libraries as specified in http://wiki.hiit.fi/display/BeAware/BasestationUserProtocol
Test description	<pre>run java -cp BAProtocols.jar:commons-httpclient3.jar:log4j.jar:commons-logging-api.jar:protobuf.jar:commons-codec.jar net.basen.beaware.client.BabupCSVExporter 10 beta.fortn.net /beaware/client/ UID PASSWD DEVICE/</pre> <p>1) where UID and PASSWD are the supplied credentials and DEVICE is the same as UID (note the slash after DEVICE)</p> <p>2) Output should be similar to #trial1/trial1 test</p> <pre>1240485091484,1.0 1240485101352,1.0 1240485126645,1.0</pre> <p>Where the number of rows is at least one.</p>
Expected results	Client interface functions for the user.

2.1.3 Verification scenario for application layer components (wp4)

2.1.3.1 Mobile interface component

Component	Mobile interface
Sub-component	Device picture Device circle menu
Component Behaviour	You navigate in the menu by flipping between the pictures in the device circle menu by using your finger. (The menu can be navigated in both directions).
Pre-requisites	Information about what picture that is connected to what sensor has been provided to the system. The mobile application can get information from the sensors.
Test	Test the connection between device and mobile application
Test ID	WP4.1
Test description	<p>Have the device circle menu open</p> <ul style="list-style-type: none"> ➤ look at the device pictures, if the picture of a device in the mobile application is black and white, the device (connected to sensors in the house) should be turned off. ➤ If the device picture is in color de device in the house should be turned on. <p>Turn on a device in the room that is turned off (and have a sensor connected to it).</p>
Expected results	(mobile interface): The device picture connected to the sensor that have been turned on will change from black and white into color – the W number in the bottom of the picture will also change. (This change should take no longer then 5 seconds)

Component	Mobile interface
Sub-component	Device circle menu Device picture

	main menu
Component Behaviour	You navigate in the menu by flipping between the pictures in the device circle menu by using your finger. (The menu can be navigated in both directions). By tapping a device picture the picture will flip and the main menu for this device will be available.
Pre-requisites	
Test	Test the connection between device and mobile application
Test ID	WP4.2
Test description	<p>Have the device circle menu open</p> <ul style="list-style-type: none"> ➤ Tap on one device picture, it will flip and the main menu will be available <p>Use the device circle menu and see if it is possible to enter the main menu form all the different device pictures..</p>
Expected results	The device picture will flip and the main menu will be available. The choices in the menu should be: <i>Historic analyze. Tools, Quiz, Advices, Settings</i> and all the choices should be active.

2.1.3.2 Mobile interface and ambient interface components

Component	Mobile interface + Ambient interface
Sub-component	Device circle menu Device picture main menu tools menu Ambient interface
Component Behaviour	<p>You navigate in the menu by flipping between the pictures in the device circle menu by using your finger. (The menu can be navigated in both directions). By tapping a device picture the picture will flip and the main menu for this device will be available.</p> <p>In the tools menu that can be found in the main menu, the user can choose between the tools set alert or set guard.</p> <p>Set guard is a tool that the user can use if he or she would like to set a alarm if the device is in use more than a specific time (for example a guard on the TV could give a alarm through the ambient interface if it</p>

	<p>is used more than two hours during a day).</p> <p>Ambient interface – Using the existing light (lamps in kitchen, living room and hallway) to communicate to the user.</p>
Pre-requisites	<p>It is possible to set a time guard on a specific device. The connection between mobile interface and ambient interface works.</p>
Test	Test to set and activate a guard (mobile and ambient interface)
Test ID	WP4.3
Test description	<p>Preparation: Have the device circle menu open</p> <ul style="list-style-type: none"> ➤ tap on one device picture (it will flip and make the main menu for that device available) ➤ tap on tools> tap on time guard> set time> set the time for 2 minutes. <p>Test: Turn on the device (in the house) that you have set a guard on and let it be on for over 2 minutes.</p>
Expected results	<p>Expected result (ambient interface): The ambient interface will blink three times. (once)</p> <p>Expected result (mobile interface): The device picture (of the device that have the time guard) in the device circle menu will blink in a series of blink three times – pause - blink three times – pause it continues until the user tap on the device picture and get a information message about the alert (and the ability to turn it off).</p>

Component	Mobile interface + Ambient interface
Sub-component	<p>Device circle menu</p> <p>Device picture</p> <p>Ambient interface</p>
Component Behaviour	<p>You navigate in the menu by flipping between the pictures in the device circle menu by using your finger. (The menu can be navigated in both directions).</p> <p>The device picture is the polaroids that have pictures representing the different sensors in the device circle menu.</p> <p>Ambient interface – Using the existing light (lamps in kitchen, living</p>

	room and hallway) to communicate to the user.
Tests	1. WP4.4 2. WP4.5

Test	test to go over the consumption limit
Test ID	WP 4.4
Sub-component (or component if there is no sub- component)	Device circle menu Device picture Ambient interface
Pre-requisites	<i>This test can only be done if the test period is going on for longer than 2 days.</i> The daily consumption of a device are updated every night and are compared to a base value. The connection between the ambient interface and the mobile interface works. The ambient interface gets the information about if the user have consumed more then the limitation the day before and react by fading in the light.
Test description	Test: Use the device with a the pre-set consumption limit over excessively during a day (more than normal consumption for this device)
Expected results	Expected result (ambient interface): During the next day (the day after over consumption) every time the user turns on a light (connected to the BeAware system) the light will fade in instead of just lit. Expected result (mobile interface): The device picture (of the device that have the limit) in the device circle menu will when entering the menu fade in, instead of just appear. Tap on it and you will get feedback on whatis consuming above limit, you will be redirected to historic analyze.

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Test	Check if the limit indicator and the historical analyze works
Test ID	WP 4.5
Sub-component (or component if there is no sub- component)	Device circle menu Device picture Ambient interface
Pre-requisites	<i>This test can only be done if the test period is going on for longer than 2 days.</i> The historical data of the devices consumption are being updated in the mobile phone. The system present a preset consumption limitation for a specific device.
Test description	<i>The color of the square in the upper right hand corner (mobile phone) indicates if the device is consuming below (green), close to (yellow) or over (red) the limited consumption. There will be an hourly countdown next to it example: (72 H left)</i> Have the device circle menu open <ul style="list-style-type: none"> ➤ tap on one device picture with the limitation and it will flip to main menu for this device ➤ tap historical analyze.
Expected results	There should be a time indication of how much time is left. Check if the daily bars have the right color (same color as for the indicator – indication under/close to limit/ over limit)

2.1.4 Verification scenario for service layer components (wp5)

This paragraph describes the verification scenarios for web services components.

It's important to remark that:

1. All the services have been developed by using the JAX-WS JSon extension, which allows to provide web services which can be accessed by Javascript clients (e.g. thin clients, mobile applications) through the Web;
2. All the services are released as Web Archive package (i.e. *.war file) which may be deployed on any web application server and hosts which have jdk 1.6 upgrade 3 or greater;
3. All the services are currently tested on the Sun Glassfish v2 J2EE server.

2.1.4.1 Message Service component

Component	Message Service
Sub-component	<i>AdvicesManager</i>
Component Behaviour	<p>The AdviceManager functionality is to provide advice to the user related to each sensed device when a certain event occurs (e.g. threshold overcoming, goal attainment, to be not on a path towards the target, overconsuming, gap from the baseline).</p> <p>Advices are marked as Read or Unread. (this is NOT displayed in the mobile interface).For that reason, the system handles the associations between events and advices: it means that for each event that occurs, the system is able to notify to the user a specific advice.</p>
Pre-requisites	The system is able to display all user's advice.
Test	Advice Test
Test ID	WP5.1
Test description	<ol style="list-style-type: none"> 1. Create an event, which is handled by the system according to the specification; 2. Check if a new advice incomes; 3. Check if the new advice is the expected one (i.e. relative advice for the specific occurred event); 4. Check if the advice is marked as "read".
Expected	<ol style="list-style-type: none"> 1. The advice associated to the specific event is arisen; 2. After reading of advice, that is marked as read.

results	
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Component	Message Service
Sub-component	<i>ToolManager</i>
Component Behaviour	<p>This component returns to the user all the available/unavailable tools that he/she can employ to monitor and to understand the electricity consumption of a device. Moreover it allows to enable the chosen tool.</p> <p>Tools are:</p> <ul style="list-style-type: none"> • Above threshold guard (alert when a device is above threshold); • Stand-by guard (alert when a device is on standby); • Consumption guard (alert when a device consumes more than a preset consumption); • Time guards (alert when a device is in us more than a preset time); • Automatic switch off a device – available for the second phase of trials <p>List of tools, both available and unavailable ones, is provided together with the documentation of the released component.</p>
Tests	<ol style="list-style-type: none"> 1. WP5.2 - Available Tools Test 2. WP5.3 - Unavailable Tools Test

Test	Available Tools Test
Test ID	WP5.2
Sub-component	<i>ToolManager</i>
Pre-requisites	The system is able to provide the list of available tools.
Test description	<ol style="list-style-type: none"> 1. Check if all the available tools, of the specific component release, are displayed; 2. Check if the chosen tool is enabled.
Expected results	<ol style="list-style-type: none"> 1. The list of all the available tools; 2. Activation of a chosen tool.

Test	Unavailable Tools Test
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Test ID	WP5.3
Sub-component	<i>ToolManager</i>
Pre-requisites	The system is able to provide the list of unavailable tools
Test description	1. Check if all the unavailable tools, of the specific component release, are displayed; 2. Check if the chosen tool is un-enabled.
Expected results	1. The list of all the unavailable tools; 2. The inability to activate a chosen tool.

Component	Message Service
Sub-component	<i>QuizManager</i>
Component Behaviour	This component manages the quizzes that users can do to increase their awareness score. [How, when, what a quiz is provided: needs for further details]
Pre-requisites	The system is able to display the list of available quizzes.
Test	Quiz Test
Test ID	WP5.4
Test description	1. Get the list of available quizzes; 2. Select a quiz; 3. Select the wrong answer for the quiz and check if score decreases; 4. Select the same quiz; 5. Select the right answer for the quiz and check if score increases; 6. Check for both answers the feedback from the system.
Expected results	1. List of available quizzes for the user; 2. Awareness Score and feedback for the user.

2.1.4.2 Energy Profile Service component

Component	Energy Profile Service
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Sub-component	<i>HouseholdProfileManager</i>
Component Behaviour	This component allows the user to access and manage his/her household profile, environmental parameters, location and privacy settings.
Tests	1. WP5.5; 2. WP5.6; 3. WP5.7; 4. WP5.8;

Test	Household Data Test
Test ID	WP5.5
Sub-component	<i>HouseholdProfileManager</i>
Pre-requisites	The system is able to provide household data.
Test description	1. Access household data; 2. Modify existing household data; 3. Insert a new household data;
Expected results	1. List of household data; 2. Update of household data;

Test	Environmental Parameters Test
Test ID	WP5.6
Sub-component	<i>HouseholdProfileManager</i>
Pre-requisites	The system is able to provide environmental parameter
Test description	1. Access environmental parameters; 2. Modify existing environmental parameters; 3. Set new environmental parameters.

Expected results	<ol style="list-style-type: none"> 1. List of environmental parameters; 2. Update of environmental parameters.
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Test	Location Test
Test ID	WP5.7
Sub-component	<i>HouseholdProfileManager</i>
Pre-requisites	The system is able to provide location data
Test description	<ol style="list-style-type: none"> 1. Access location; 2. Modify existing location; 3. Set new location.
Expected results	<ol style="list-style-type: none"> 1. Display location; 2. Update of location.

Test	Privacy Settings Test
Test ID	WP5.8
Sub-component	<i>HouseholdProfileManager</i>
Pre-requisites	The system is able to provide household's privacy settings.
Test description	<ol style="list-style-type: none"> 1. Access privacy settings; 2. Modify existing privacy settings; 3. Set new privacy settings.
Expected results	<ol style="list-style-type: none"> 1. List of privacy settings; 2. Update of privacy settings.

Component	Energy Profile Service
Sub-component	<i>UserProfileManager</i>
Component	This component allows users to access and manage their profile and

Behaviour	privacy settings.
Tests	1. WP5.9; 2. WP5.10;

Test	User data Test
Test ID	WP5.9
Sub-component	<i>UserProfileManager</i>
Pre-requisites	The system is able to provide user data.
Test description	1. Access user data; 2. Modify existing user data; 3. Insert a new user data;
Expected results	1. List of user data; 2. Update and setting of user data.

Test	User Privacy Settings Test
Test ID	WP5.10
Sub-component	<i>UserProfileManager</i>
Pre-requisites	The system is able to provide user's privacy settings.
Test description	1. Access user privacy settings; 2. Modify existing user privacy settings; 3. Insert a new user privacy settings;
Expected results	1. List of user privacy settings; 2. Update and setting of user privacy data.

Component	Energy Profile Service
Sub-component	<i>GoalsManager</i>

Component Behaviour	When a user wants to know how close he/she is from the next level should access the goal settings page that provide all the information about the target saving needed to reach the next level, the time that he/she has to keep the actual reached saving and the gap between the actual target and the next level.
Tests	1. WP5.11; 2. WP5.12;

Test	Increase Energy Test
Test ID	WP5.11
Sub-component	GoalsManager
Pre-requisites	The system is able to display target information
Test description	1. Access target information; 2. Check if maintenance time and gap change if the user increase his/her energy consumption (i.e. switch off/on all devices for a specific test period).
Expected results	1. List of target information; 2. Update of target information (i.e. maintenance time and gap).

Test	Decrease Energy Test
Test ID	WP5.12
Sub-component	GoalsManager
Pre-requisites	The system is able to display target information.
Test description	1. Access target information; 2. Check if maintenance time and gap change if the user decrease his/her energy consumption (i.e. switch off/on all devices for a specific test period).
Expected results	1. List of target information; 2. Update of target information (i.e. maintenance time and gap).

2.1.4.3 Device Service component

Component	Device Service
Sub-component	<i>ConfigurationManager</i>
Component Behaviour	The ConfigurationManager configures the household's devices assigning them to respective sensor.
Pre-requisites	The system is able to display the list of available devices.
Test	Configure Device Test
Test ID	WP5.13
Test description	<ol style="list-style-type: none"> 1. List all available devices 2. Select a new device which has to be configured; 3. Configure new device (i.e. set device name, device type, device picture, device category, assign sensor, etc.). 4. Check if the new device provides the right information (i.e. state of device, device consumption, etc.)
Expected results	Configuration of new device.

Component	Device Service
Sub-component	<i>RemoteControlManager</i>
Component Behaviour	The scope of this component is to remotely change the state of a chosen device in the household.
Pre-requisites	The system is able to display the list of devices
Test	Remote Control Test
Test ID	WP5.14
Test description	<ol style="list-style-type: none"> 1. Select an available device; 2. Check the state of device; 3. Change the state of device; 4. Check the new state of device.
Expected results	Change in the state of device.

2.1.4.4 Monitoring Service component

Component	Monitoring Service
Sub-component	<i>ConsumptionManager</i>
Component Behaviour	This component manages all the data related to device consumption both current and historical.
Test description	1. WP5.15; 2. WP5.16.

Test	Device Consumption Test
Test ID	WP5.15
Sub-component	<i>ConsumptionManager</i>
Pre-requisites	The system is able to display the list of devices.
Test description	<ol style="list-style-type: none"> 1. Select the device to be monitored; 2. Read the current consumption of the device; 3. Check the current device consumption with the measurement from an external power meter; 4. Repeat the test for checking the consumption during a specific period.
Expected results	<ol style="list-style-type: none"> 1. The energy measures with the BeAware system is the same that is measured with an external power meter. 2. The energy consumption monitored for a specific period is the same that is measured, in the same period, with an external power meter.

Test	Household Consumption Test
Test ID	WP5.16
Sub-component	<i>ConsumptionManager</i>
Pre-requisites	
Test description	<ol style="list-style-type: none"> 1. Select the household to be monitored; 2. Read the current consumption of the household; 3. Check the current household consumption with the measurement from an external power meter; 4. Repeat the test for checking the consumption during a specific period.
Expected results	1. The energy measures by the BeAware system is the same that is measured with an external power meter.

	2. The energy consumption monitored for a specific period is the same that is measured, in the same period, with an external power meter.
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2.1.4.5 Community Service component

Component	Community Service
Sub-component	<i>TeamManager</i>
Component Behaviour	This component manages the possibility to add a team member inside the community only for the administrator. Users can obtain the list of all member of a team and the team energy consumption.
Tests	1. WP5.17; 2. WP5.18.

Test	Community Service
Test ID	WP5.17
Sub-component	<i>TeamManager</i>
Pre-requisites	The system show the list of teams.
Test description	1. Administrator adds team member; 2. Check if new member is added; 3. Check if the add feature team member is not available for the User role; 4. Check the list of all team members; 5. List and check team energy consumption (a more detailed explanation of this feature will be reported in the refined specification)
Expected results	1. List of team members; 2. Updated team members list; 3. Team energy consumption.

Test	Community Service
Test ID	WP5.18
Sub-component	<i>TeamManager</i>
Pre-requisites	The system show the list of teams.
Test description	1. Administrator removes team member; 2. Check if new member is removed; 3. Check if the remove feature team member is not available for the

	User role; 4. Check the list of all team members; 5. List and check team energy consumption (a more detailed explanation of this feature will be reported in the refined specification)
Expected results	1. List of team members; 2. Updated team members list; 3. Team energy consumption.

Component	Community Service
Sub-component	<i>BlackboardCommunityManager</i>
Component Behaviour	The BlackboardCommunityManager functionality is to provide advices to teams in the community. The community advices are answers, questions, tips (messages) about energy consumption that team members can exchange between them.
Pre-requisites	The system is able to display all the community advices.
Test	Advice Team Test
Test ID	WP5.19
Test description	1. Submit a message to the community as member of a community; 2. Check if the message is available in the community blackboard; 3. Access the community blackboard as a different member; 4. Check if the message is received.
Expected results	1. Submission of a message to the community blackboard; 2. Reception of a message from the community blackboard.

2.1.4.6 Consumption knowledge Base Service component

Component	Consumption Knowledge Base Service
Sub-component	<i>EnergyFootprintManager</i>
Component Behaviour	This component extracts the energy footprint (which is characterised by the Maximum Peak Energy and Duration, Energy Offset, the Energy Trend and other significant properties) from the raw data of the sensing layer. The energy usage footprint allows to identify the “usual” energy consumption of the household in a specific period. It may be monitored for checking its evolution in the time.

Pre-requisites	The system is able to get energy raw data for a specific device. The system is able to display the list of devices.
Test	Energy Footprint Test
Test ID	WP5.20
Test description	<ol style="list-style-type: none"> 1. Select a device; 2. Change the state of the device (i.e. switch on/off) with a specific frequency; 3. After a specific period, get and check the energy footprint for a specific device during that period.
Expected results	1. Extract Energy Footprint for a specific device.

Component	Consumption Knowledge Base Service
Sub-component	<i>PatternRecognitionManager</i>
Component Behaviour	Using footprint, timespan, frequency and notes this component provides the energy pattern for a specific household.
Pre-requisites	The system is able to get energy raw data for a specific device. The system is able to display the list of devices.
Test	Pattern Recognition Test
Test ID	WP5.21
Test description	<ol style="list-style-type: none"> 1. Repeat the “EnergyFootprintManager test” for more times; 2. After that, the system provides the sequence of energy footprint as a suitable pattern; 3. Add notes to the pattern.
Expected results	1. Identification of a pattern.

2.2 Integrated system testing

As well as testing each individual component, the system will also be tested as a whole unit to validate its overall behaviour. Testing will be covered in the following areas:

- End user is shown both current and history data from sensors in his household
- Ambient interface installed in household reacts correctly
- Alerts are passed to correct personnel if any of the system hardware stops responding

A detailed integrated testing procedure will be sketched, during phase 0 of the project. The testing procedure will be based on the successful chain of verification scenarios described in Section 2 of this document.

Overall testing will include:

- Performance
- Reliability
- Failure, Recovery
- Security

3 Deployment plan

The deployment plan identifies the households characteristics needed for trials, the installation pre-requisites and the hardware characteristics of each component.

The Consortium has identified the following deployment phases:

Pre-first Trial	Phase 0	Beg. July 2009	1,5 months
First Trial	Phase 1	Beg. Sept. 2009	3-4 months
Second Trial	Phase 2	To be defined	To be Defined

3.1 Pre-first trial - phase 0

The pre-first trial phase foresees to have the system installed in one controlled environment (one household per country) to test all installation procedures that will take place in the first and second trial phase. The pre-first trial has the following purposes:

- Test how long it takes to prepare 1 household in
 - Finland
 - Italy
- Check the "real-life" differences and be sure that it is possible to have the same toolset installed in the two countries and, if not, change accordingly
- Verify how many people and who is actually needed to perform the installation
- Test each components according to the verification scenarios
- Test the system as a whole

The pre-first trial will have a duration of 1,5 months and will start in July.

In this phase the households will be selected according to the following rules:

- In Finland the pilot household will be chosen between a series of candidates from the Helsinki University of Technology.
- In Italy the pilot household equipped will be belonging to one member of the Consortium (from the University of Padova).

3.1.1 System functionalities available in phase 0

Phase 0 will have the same set of functions of phase 1 (see paragraph 3.2.1) since it will occur when the system is ready to be deployed. During phase 0 the advices quiz functionality will be available.

Moreover, the user interface will be available in different languages according to the location of the trials (Italy and Finland).

3.2 First trial - phase 1

During phase 1 the system will be installed in 8 households (4 in Italy and 4 in Finland). Probably it will start on September 2009 and will have a duration of 3-4 months. Once sensors and base station are installed in the households, the electricity consumption during the first month of the trial will be measured. During that month the sensing system will be active but the feedback system will not be. Moreover, Also the Hawthorne effect will be measured.

3.2.1 System functionalities available in phase 1

The features for the phase 1 are constantly updated and available in

<http://wiki.hiit.fi/display/BeAware/SWImplementationPlan>

3.2.2 Criteria for households selection

The households that will participate in the first trial need to have a high electricity saving potential, to be among the most frequent types of household of a certain country, and to be so in all countries where the trial takes place. After collecting several sources of information, all reported in BeAware deliverable D2.1, a profile was recommended; it is described below, along with additional requisites emerged during the Padova Consortium meeting in March 2009.

- Location
 - Country. Observation and automatic data collection will occur in both Italy and Finland, to allow data comparison. Sweden will not participate in this first trial for explicit preference expressed by Swedish partners.
 - Area. Urban areas are preferred (see BeAware deliverable D2.1).
- Households
 - composed by 2-4 people. This characteristic was identified in D2.1 and was further specified during the Padova Consortium Meeting as follows:
 - family consisting of two adults and one or two children. This kind of household seems to have a high energy saving potential; in addition, family dynamics (husband/wife, parents/children) related to energy efficiency have not been studied in depth so far. Observing them would fill a knowledge gap in the field of energy consumption behaviour.

- people aged 8 to 60; people younger than 8 were excluded for safety reasons and people older than 60 were excluded because they might need technology with special accessibility characteristics, which are not foreseen in the project.
- equipped with all the most common and typical devices of the country, to study energy efficiency issues that are relevant for that country. In particular:
 - household are equipped with air conditioning in Italy. Space heating by electricity is planned to be included in the Finnish sample, in parallel with air conditioning in Italy, but not in the first trial, because the sensing apparatus for heating consumption is not included in the first EnergyLife prototype.
- of medium/high income according to national income classes (see BeAware deliverable D2.1), since they have higher saving potential and the project tries to separate electricity conservation from other goals or values such as money curtails. Income classes for Italy and Finland have been outlined in the users' questionnaire elaborated by WP2.
- Multi-flat buildings are preferred since they do not have electric heating. Since electric heating will not be monitored in this first trial, then it should not be present in the dwelling, it would be responsible for too large a part of the household consumption.

3.3 Second trial - phase 2

Phase 2 foresees to have the system installed in 16 households distributed half in Italy and half in the north (Finland). It will start approximately on early 2010 with a duration of six months. Criteria for household selection and household requirements will be better defined after having observed and collected results obtained from the running of the first trial. In Phase 2 the application will run also on Symbian mobile phone. Trials phone types for phase 2 will be defined after phase 1.

3.3.1 System functionalities and Criteria for Household selection in phase 2

System functionalities and Criteria for household selection for phase 2 will be detailed at the end of phase 1.

3.4 Deployment shopping-list

In order to be able to deploy the system in households, each of them should be so equipped:

- Concerning the network, the following requisites are needed:

- adsl or cable broadband connection
 - No static public IP or VPN for two-way data transfer and communication are needed
 - Wireless router
 - Service provider that allows multiple computers to use same connection.
 - WLAN Connection.
 - Proxy configuration for the connection, if needed, must be known in advance
-
- Concerning the electrical devices, this is the minimum list required:
 - Fridge
 - TV sets
 - Washing machine
 - Microwave
 - Computer

The choose of the above electrical devices as minimum requirement has been done both by considering what are the parts in an average household which need the most energy, and by taking into account what has been specified into the D2.1 document.

Moreover, the BeAware Consortium will provide the household with an installation comprising of :

- The sensing platform, which requires
 - A base station unit
 - A set of 8 plugwise sensors (8 for pre-first trial and first trial. In later trials more sensors will be used). It is a USB stick to be inserted in the base station with 8 plug sensors using a ZigBee mesh network. Five of these sensors will be assigned to the five electrical devices mentioned above, plus a sensor for North-South specificity that will be determined when looking at the pilot houses and another sensor to be assigned according to end user preference.
 - A BeAware household sensor

- Ambient interfaces. The ambient interface on lights will make three lights communicate with users in the following locations:
 - Entrance
 - Kitchen
 - Living room

- 4 iPod Touch per household

The system also requires (not installed in each household)

- Data storage capacity configured into the BaseN grid.
- Access point and credentials for each trial site configured into Data Storage Receiver and Client interface
- Admin wiki configured to BaseN grid – for the first trial this will reside in <https://beta.fortn.net/beaware> and later trials in <https://fortn.net/beaware>
- Necessary BeAware personnel granted access to admin wiki
- Another pc server used to host web services and the configuration storage.

The following figures represent, in pictorial and UML respectively, the shopping list of what is needed in the household for the deployment.

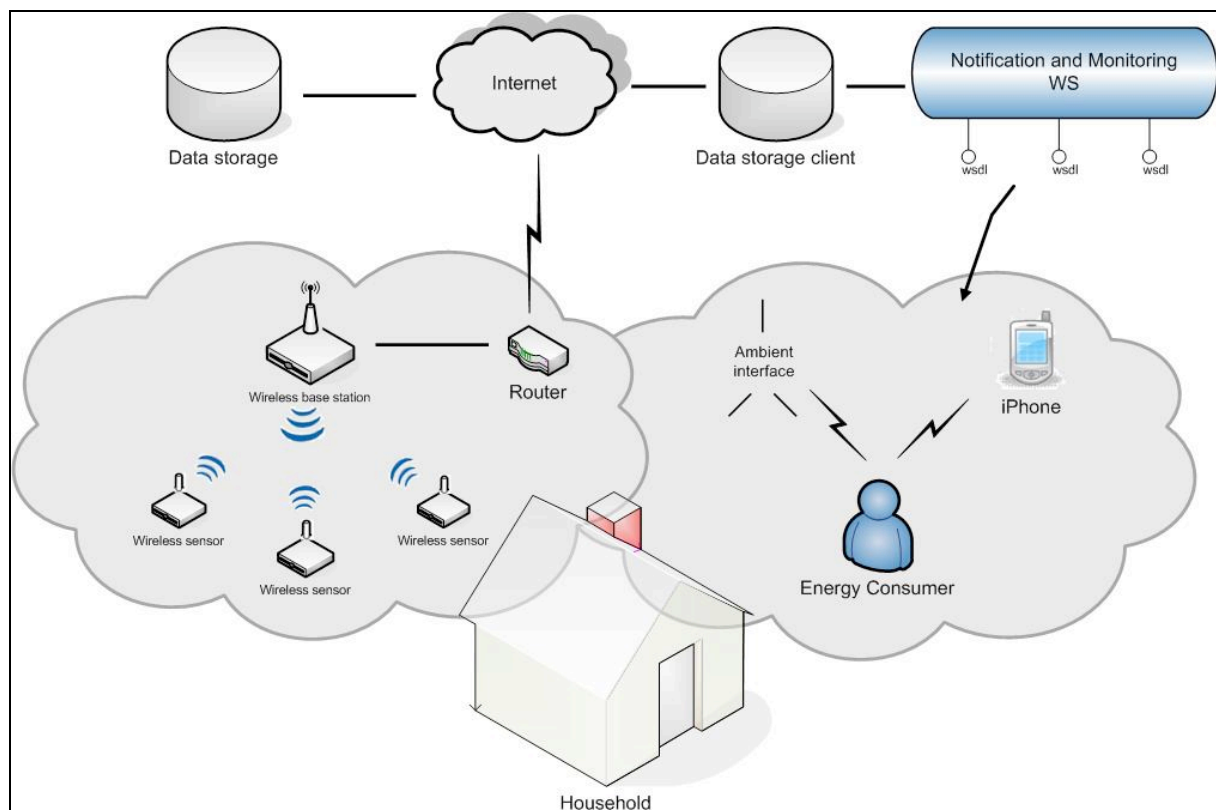


Figure 1 – shopping list of tools/software/hardware to deploy

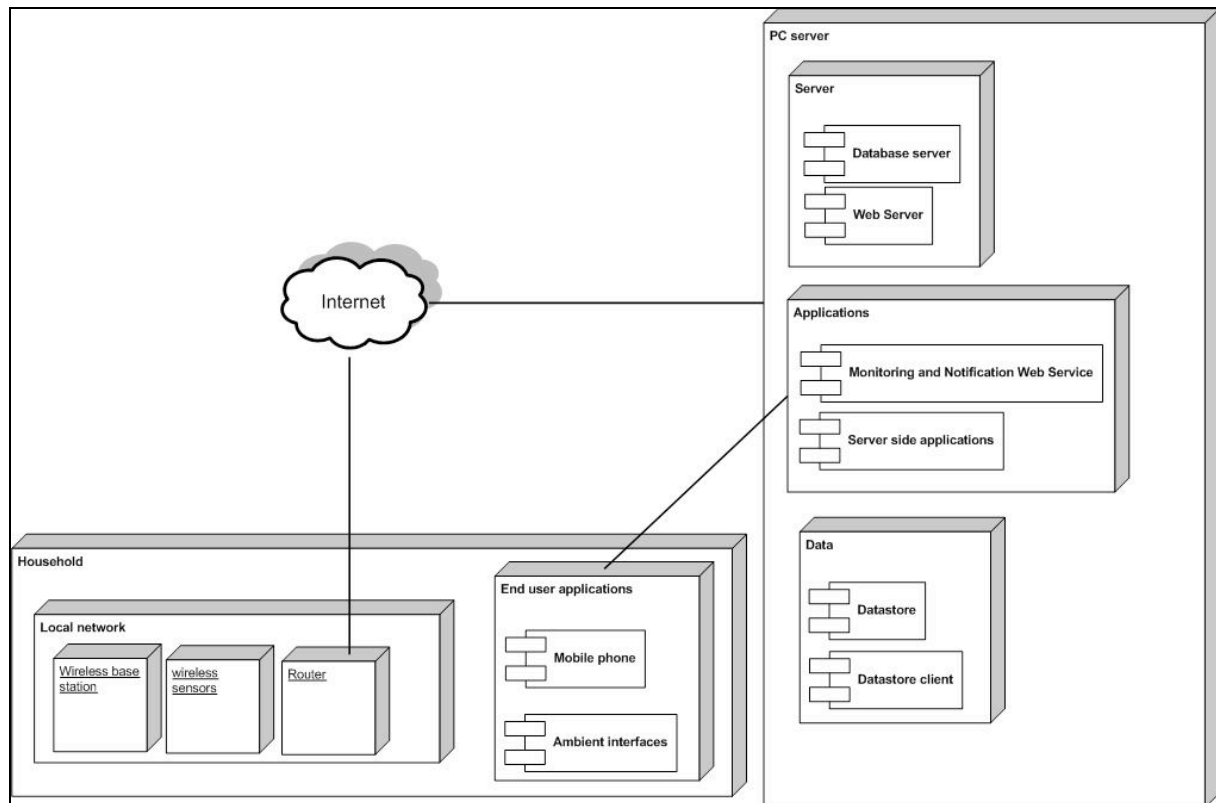


Figure 2 – UML shopping list

3.4.1 Installation of ambient interface

There are four holes in the casing for the ambient interface. Each one is for a cable to be connected. This is done by opening up the case by removing the four screws on the bottom of the casing. The cables to be connected are two cables from the lamp that is going to act as the ambient interface; the other two is from the ceiling that is connected to the lamp when the ambient interface is not. The cables that are going to be connected are phase and neutral. If there is a protective earth that one should be connected directly to the lamp, since the protective earth is not needed by the electronics of the ambient interface.

The two holes with accompanying screw terminal (inside the ambient interface) to the left-most side of the casing (marked OUT) is to be connected to the lamps two cables. The other two holes (marked IN) are for connecting the cables coming from the ceiling. It doesn't matter how the phase and neutral is connected. As long as the cables from the ceiling is connected to the IN terminal part and the lamp is connected to the out terminal part.

3.4.1.1 Ambient Interface components

The ambient interface only consist of one component. One small box to be connected as stated above for each lamp that should act as an ambient interface.

3.4.1.2 Safety

Although not tested/certified for CE-certification the ambient interface is designed to comply with the certification requirements. There should not be any risk of electrocution.

The ambient interface is equipped with a fuse of 2 Amperes inside the casing. This limits the power that can be connected to the ambient interface to about 400 watts. That is; a lamp that uses more than 400 watts can't be controlled by the ambient interface.

The ambient interface can't be used with a wall dimmer, only wall switches are supported.

3.4.1.3 Supported light bulb types

- Incandescent lightbulbs are supported.
- Dimmable energy saving light bulbs are supported. The energy saving light bulbs must support to be dimmable by a regular dimmer that some households use. Non-dimmable energy saving light bulbs are not supported.
- LED-light bulbs that support dimming by a regular wall dimmer is supported. Other LED-light bulbs are not supported.

3.4.1.4 Ambient interface addressing

Each ambient interface will have its own address so that the base station will know which ambient interface to communicate with. There are three addresses that should all be marked on the ambient interface;

- Base station address; the specified address to the base station, in case several base stations exist nearby.
- Hardware ambient interface address; this address is used by the hardware communication components. Should be the same for all ambient interfaces.
- Software address; this address is unique for every ambient interface.

3.4.2 Deployment installation team

The BeAware deployment in households requires an installation team able to

- Install/assign sensors to devices

- Install main meter reading
- Install ambient interfaces
- Initialize the system

For this purpose the BeAware personnel will be suitably trained before the pre-first trial, with an assisted and manual installation.

3.4.3 User instructions and feedbacks

End users will be properly trained for a correct use of the system. In order to investigate how understandable is the approach used by the Consortium and the system itself, during Phase 0 a series of tasks will be assigned to users. This approach is used as a way to receive user feedbacks and to train consortium end users (mainly UNIPD) on how the platform should be used.

3.4.4 Agreement plans with household owners

Household owners testing the BeAware platform will be requested to sign an informed consent that explains the risks on the platform installation. User will have to accept before the installation can take place. The Consortium will test each device following the procedures of CE certification and TTK will issue a conformity to CE certificate for each manufacture device. The Consortium is investigating the possibility of covering the installation sites with a specific insurance so that end users can be more prone to accept the installation of the apparatuses in their homes.

3.5 Deployment models

3.5.1 Sensor layer deployment model

For the Sensing Layer, BaseStation, Sensors and Ambient interface will resied in customer premises, everything else in BaseN premises.. The base station will be preconfigured before customer installation – manually for the first trials, remotely later on. The BaseN grid will be configured via admin wiki. Admin wiki configuration will include:

- Access credentials for receicer and client interface for each customer
- Guard configuration for each sensor and base station

- Admin access
- Ambient interface configuration (will be specified when AI is ready)

The following image shows the deployment model for the sensor layer. BaseStation is a Via ARTiGO Pico-ITX running Linux OS with python 2.5 software. It consists of following functionality:

- Sender communicates with data Storage via HTTP, sending data from Message Queue after each configured interval
- Message queue storing measurement data data from sensors for sending. Queue is non-volatile and data is only removed when Data Storage has acknowledged data receipt
- Receiver communicates with the wireless receiver. It stores data from all recognized sensors under specified channel
- Ambient Control will be specified later, as interface itself is still under construction

Currently Base station is configured via local configuration files, later on system should use remote configuration.

Sensors are plug and play, they are connected to socket and will automatically start sending data.

Data Storage in BaseN grid, for the deployment purposes contains these parts:

- Data receipt (Receiver agent) listens to messages from base stations, authenticates each message and stores in to storage
- Real time analysis monitors all incoming data and raises an alert if guard value has been passed
- Client interface allows data retrieval from the system via http

All these are configured via admin wiki.

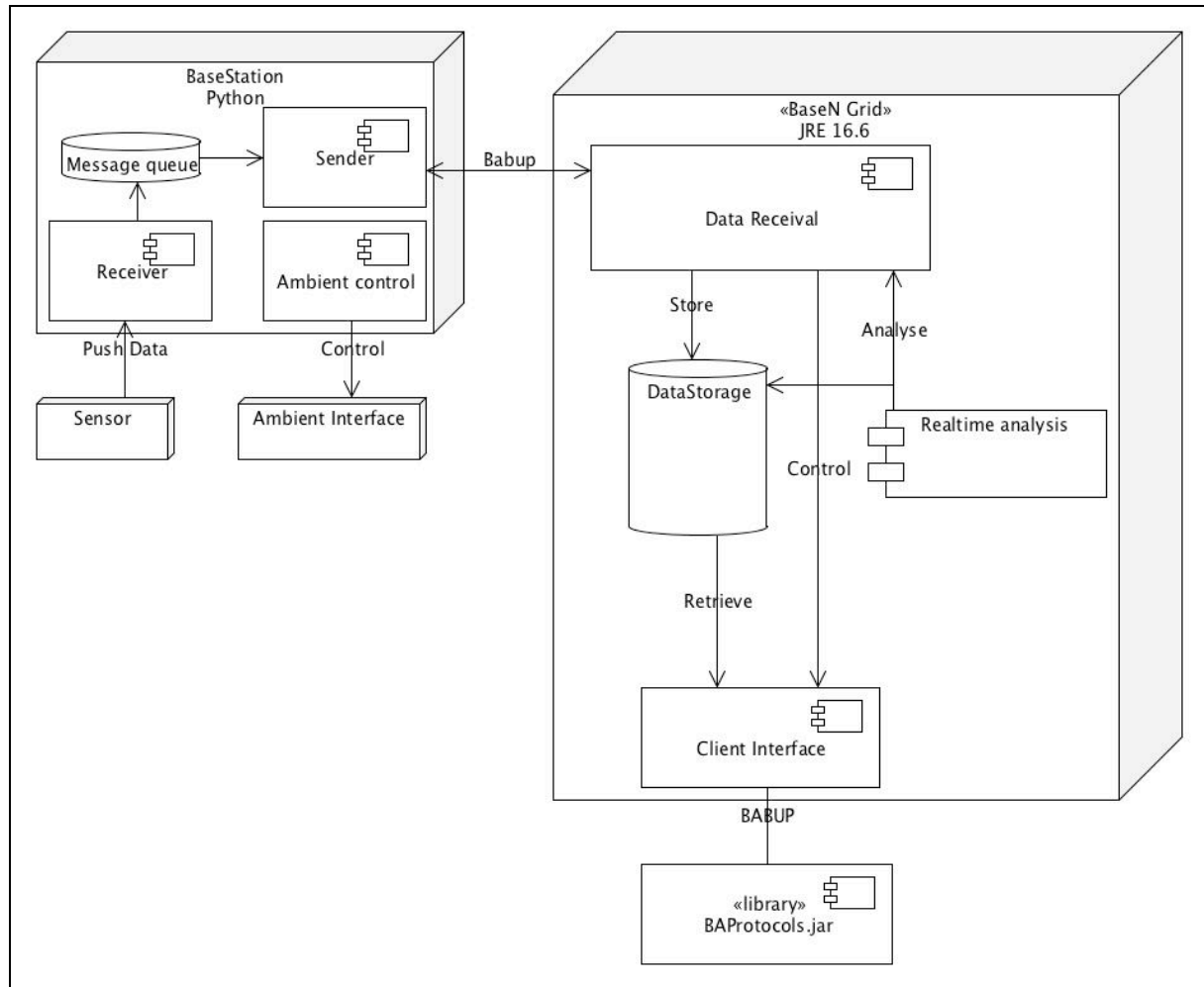
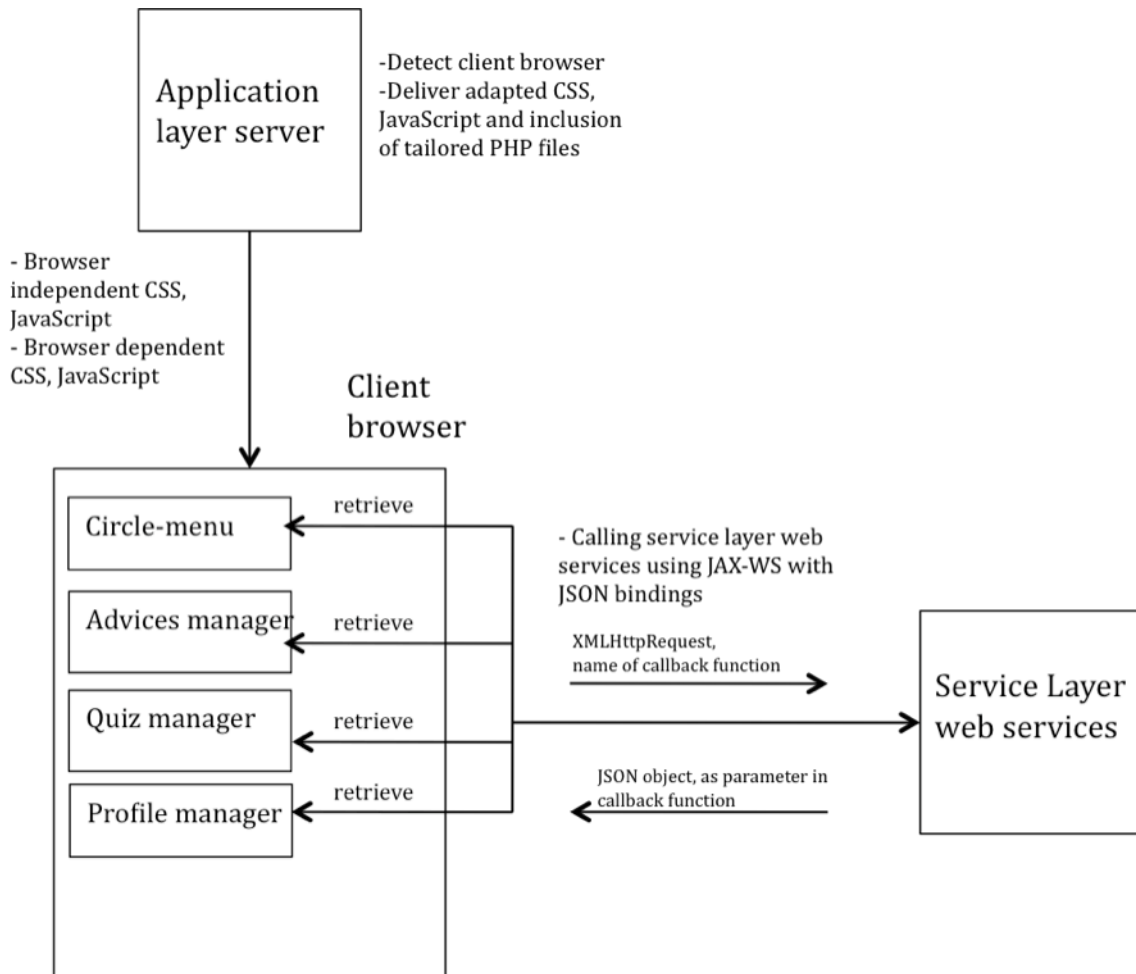


Figure 3 – Deployment model for sensor layer

3.5.2 Application layer deployment model

The application layer consists of software that resides in TKK premises. Each household will obtain 4 iPod Touches that connect to the application layer via a WLAN connection. The Application Layer server delivers custom CSS and JavaScript that will in future version enable most web clients to operate the system. In the first trial, the application runs on iPhone and iPod Touch. Client side JavaScript running in the client web browser builds the user interface and communicates with the Web services provided by the Service Layer. Calls are made in short intervals to update the consumption data, state change and information whether appliances are overconsuming or off target. Calls are also made to check for new advices and available quizzes.



A link to the application is set on the iPhone/iPod Touch devices of the users and is accessible via one click from the home screen. When that button is pressed, the application is opened in full screen mode without browser navigation menus.

Creating a full screen home screen link is done by opening the application URL using the Safari browser on the device and pressing the “+” button in the browser where an option to add the page as a bookmark or as an icon on the home screen appear. By choosing the option “Add to home screen”



3.5.3 Service layer deployment model

The following image shows the deployment model for the service layer.

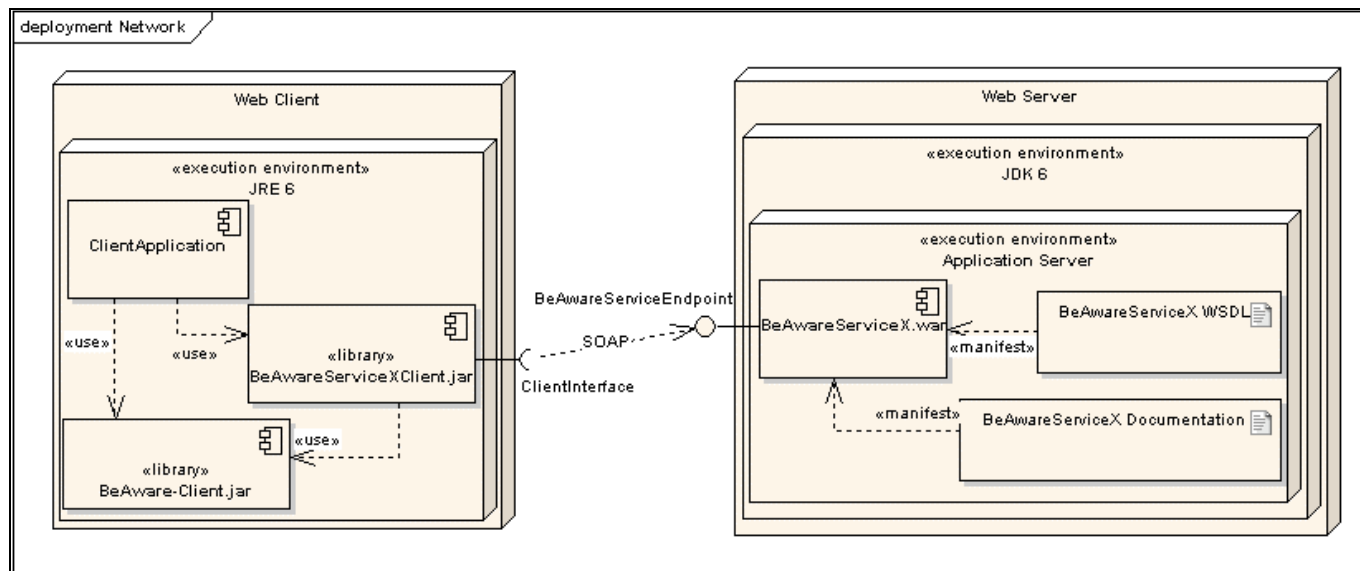


Figure 4 – Deployment model for service layer

4 Determining metrics

4.1 Introduction

Once the system has been verified and deployed at the user sites, a period of evaluation will take place during which a number of metrics will be assessed either by quantifiable measurements or by way of a questionnaire/interview.

4.2 User Groups

The evaluation process will be used to target the pilot users of BeAware, it will be approached from a number of different perspectives but can be categorised broadly into the following roles:

4.2.1 Energy User

The member of household that consumes electrical energy by using appliances or other electrical devices.

4.2.2 Energy Provider

The energy provider provides electrical energy, through a commercial contract, to the Energy User.

4.2.3 Energy Life Community

It represents the team in which a Community Member is involved in order to share knowledge about Energy User data.

4.3 Sourcing Metrics

The metrics that need to be evaluated have been sourced from a number of locations detailed below:

4.3.1 System Design

Some of the goals covered in this document are based largely on those outlined in D4.1 Application Requirements and Specifications. Some requirements could arise from D3.1/D4.1/D5.1 design documents.

4.4 Definitions

All the metrics have been classified by three different factors, and are detailed below:

4.4.1 Required/Beneficial Metrics

A **Required** metric is considered to be a metric which should be applied to the project and the results will have a direct effect on the success of BeAware whereas a **Beneficial**

metric is when any measured benefit may assist with the commercial exploitation of BeAware but not have a direct impact on its success.

Examples:

It is required that the system is reliable but it can be beneficial if the system is more reliable than other existing systems on the market.

4.4.2 *Direct/Indirect Metrics*

A direct metric can be applied to BeAware in isolation and any effect from outside factors will not have effect the result. An indirect metric can be applied to BeAware however; the metric can be affected by numerous external factors so cannot be a pure measure for BeAware.

Examples:

Reducing energy consumption is an indirect metric, as whilst BeAware could assist in reducing this, other measures such as changing bulb types could also affect the result.

Create awareness is a direct metric, especially in the case the user was, before the installation of the pilots completely unaware of energy consumption.

4.4.3 *Hard/Soft Metrics*

A metric is considered hard (quantitative) if the metric can be measured purely by the use of data and give a pure statistical result. Soft (qualitative) metrics are more subjective in that it relies on people's opinions such as results from user questionnaires.

Examples:

And hard metric is, for instance the accuracy of measurements of energy consumption. If, i.e., the target is 5% of accuracy and the system is able to have more accuracy than the metric is perfectly met.

A general evaluation about system usability is a soft metric if the system itself does not implement methods for quantitatively measure it (as, for instance, a measure similar to the Web site [bounce rates](#) typical for Google Analytics).

5 Metrics

This section describes the metrics identified for the Sensor layer, Application Layer and Service Layer Key Components. By adopting the proposed descriptive table, a set of predefined information is reported.

Moreover, a brief textual description of the metrics is given, together with the “how to” validate the metrics and actions to be done for refining the specification and validation process.

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
CATEGORY/NUMBER/TITLE	D4.1	ID
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC

Starting from the list of BeAware Features and Requirements described in D4.1, it's possible to identify seven CATEGORIES of requirements (METRIC TYPE):

- General / System (ID=R1.x);
- Sensing, storing and tele-actuating (ID=R2.x);
- Game and application (ID=R3.x);
- Feedback (general) (ID=R4.x);
- Awareness feedback (ID=R5.x);
- Saving feedback (ID=R6.x);
- Visualization (ID=R7.x);

For each CATEGORY , every requirement is identified by:

- A number
- a TITLE (TAG).

5.1 System in general

5.1.1 Metric number 1

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 1 / PROVIDE INFO	D4.1	R1.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

System should be able to provide information on consumption in less than 2 minutes from user request. Or, in case the user is not requesting information he should be advised by the Ambient Interface within 30 seconds. Data displayed should be coherent in time so that the user can be convinced of their validity. I.e. If the user is monitoring fridge consumption and the fridge is still off he should be able to request fridge consumption and get a value near to zero. If then the fridge is turned on the value should change. Given the fact that this is a web technology it may happen that the user turns on the fridge but the page is not refreshed on his mobile phone. This can give the user the sensation of unreliability and should be avoided (i.e. Making use of Ajax or similar asynchronous web methods).

User should be notified of what is going on on the system (i.e. “gathering the information you requested message”).

The user is alerted that the system is working (i.e. with a pulsing icon) , namely that the command has been taken and soon the output will arrive

RESPONSIBLE PARTNER: TKK

5.1.2 Metric number 2

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 2 / STABLE SYSTEM	D4.1	R1.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC

REQUIRED	DIRECT	HARD
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Stability and accuracy. System's stability and accuracy is ensured and tested.

System is considered stable if it does not crashes frequently. System is perceived as unstable if it crashes once a day. The time needed to recover the system should be not more than within minutes. However, system layers should be able to store data they produce in non-volatile memory, even if some other parts of the system crashes momentarily.

RESPONSIBLE PARTNER: ALL DEVELOPER PARTNERS

5.1.3 Metric number 3

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 3 / STABLE SYSTEM	D4.1	R1.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Stability and accuracy. System's stability and accuracy is ensured and tested.

The system is stable if it is able to handle 10 household and 10 sensors per household (first trial phase). During the final trial the system is considered stable if it is able to handle 100 concurrent households and 100 sensors per households. Since it will not be possible to test this metrics during the system trials the project team will create the conditions for a simulated stress test under the above mentioned circumstances.

RESPONSIBLE PARTNER: ALL

5.1.4 Metric number 4

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
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SYSTEM / 3 / SUSTAINABLE SYSTEM	D4.1	R1.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD/SOFT

Environmental awareness. Environmental sustainability of the system: all components are built with sustainable criteria and material.

Tests conducted on the system must prove longevity, recoverability, favorable life cycle costs and the utilization of state of the art technologies, such as web services infrastructure.

RESPONSIBLE PARTNER: ALL DEVELOPER PARTNERS

5.1.5 Metric number 5

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM/ 4 / LOG OUT	D4.1	R1.3
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Escape function: users are able to immediately exit from the system.

The web application accessible from iPhone/iPod Touch must have a log out function as part of the main menu, that allow the user to immediately and easily exit from the system. That is, the logout button must be easily reachable by the user, regardless of the current page he is visualizing.

The user must be able to also switch off the ambient interfaces functionalities and/or the system as a whole. Each time the base station or any sensor goes offline, the trial manager should receive an alert. This function will be available in Phase 2.

RESPONSIBLE PARTNER: TKK

5.1.6 Metric number 6

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM/ 5 / SYSTEM SWITCH OFFS	D4.1	R1.4
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

On-Off: users can switch off the system; System switch-offs must be monitored and regulated.

The user must be able to switch off the system as a whole. It must be possible also to turn off unused parts of sensor electronics without any problems, in order to further minimise power usage, to rest of the electronics or to measurement accuracy. This means that the user can remotely change the state of a chosen device in the household. It's possible through the following functionalities:

- Select an available device;
- Check the state of device;
- Change the state of device;
- Check the new state of device.

The successful control of the state of device depends from the interaction with the sensing layer which is responsible for managing the hardware.

RESPONSIBLE PARTNER: BASEN

5.1.7 Metric number 7

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 6 / SYSTEM SAFETY	D4.1	R1.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Safety: The system must be safe to the house members (including children) and with respect to current standards for safety.

This means that it must not be dangerous for the household users, and must ensure that safety prescriptions are fulfilled regarding safety for electrical devices. Each device placed between the power inlet and the home appliance must not damage the appliance.

Each device must be in line with the CE certification procedure in order to have the system safety. Devices could be not CE marked but in line with the same process CE uses for certifying safety. TKK will produce written evidence that each device has been tested according to CE specs.

RESPONSIBLE PARTNER: TKK/ELE

5.1.8 Metric number 8

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 7 / PRIVACY POLICY	D4.1	R1.6
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Privacy. Data storing and recording must obey BeAware privacy policy and be in line with the informed consent.

Data storing and recordings must obey BeAware privacy policy:

- Data collected with any tool is anonymized; this means that participants have to be identified only with a code, the association between participants and codes has to be kept in a different file, securely stored, to be destroyed when BeAware project ends. The *identity* information is stored separately by the unit responsible for the collection. Any data that cannot completely be separated from the identity of the owner (e.g. videorecordings) is stored in locked rooms and publicly displayed only if-and according to what - expressly allowed in the informed consent.

- Identity information and data are *accessible* only to BeAware researchers for purposeful reasons connected and compatible with BeAware goals, who have permission from the people storing the data.
- Data will be collected only upon signing an *informed consent*.

At the first use, the system must show terms of use and must allow to accept these terms in complete agreement with national privacy regulations (e.g. Italian national law 675/96).

This requirement can be verified by ensuring that data storing respect privacy policy, and that terms of use are provided during the first use of the system.

RESPONSIBLE PARTNER: BASEN

5.1.9 Metric number 9

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM/ 8 / USABILITY, USER-FRIENDLINESS	D4.1	R1.7
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Usability: the interaction with the system is easy and intuitive.

The system must be easy to use and understandable for the user. The user should easily interact with the system, for example, through the interface available on the iPhone/iPod Touch.

Case 1: Energy Life must show devices through photographs chosen by the user, for an easily comprehension.

Case 2: Main functionalities are always visible on the main window. These functionalities refer to the game level, savings, on-off target indicator, device categories, main menu and log out.

For initial test period the following will NOT be displayed in the interface:

- levels (since just level 1 will be tested)
- device categories (since there will only be individual devices/sensors)

Case 3: Each screen must be clear, not confusing. Textual information must be represented using big and clear alphabetic characters.

Case 4: Any tip/message sent to the user must be clearly signalled, either through flash / dimming or through information spotted as 'new', depending on the specific case.

Moreover, energy users should be trained for the use of the system (i.e. iPhone/iPod Touch and ambient interfaces) and the system must be set up for the user.

The system must satisfy the above cases in order to be easy and intuitive. This requirement can be checked by users.

RESPONSIBLE PARTNER: TKK/ENG

5.1.10 Metric number 10

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 9 / COHERENCE	D4.1	R1.8
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Coherence: internal consistency is ensured between data, updates and preferences contained in different parts of the system.

There is the need to design and implement a set of software procedures aimed at checking internal consistency of data selecting, for instance, a random record in one of

the system components and its consistency with the same information in other system components.

5.1.11 Metric number 11

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 10 / SELF-MONITORING	D4.1	R1.9
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Energy consumption self-monitoring: the system monitors (detect and store) its own electricity consumption.

For this purpose the system must have suitable tools able to detect and store its own electricity consumption. These tools should store electricity consumption data in a centralized way, as it is done in the case of energy consumption for appliances in the household.

The ability of the system to detect and store this kind of information can be measured by analyzing data stored in an appropriate database.

RESPONSIBLE PARTNER: BASEN

5.1.12 Metric number 12

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 11 / AVOID OVERLOAD	D4.1	R1.10
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Avoiding cognitive overload: Any tip, message and communication pushed to the user is recognizable, but not intrusive.

The user interface must allow the user to easily understand that a new message has arrived, avoiding to be annoying. Example: The user fails to maintain the goal over a spate of time so the system produces an advise. In order to inform the user about such an event the user interface should show the appliance icon flashing on the front of the screen, possibly with a sound alarm that inform about the event. If the user does not take immediately an action the user interface should avoid to continuously produce or let the icon to flash. It should only continue to show the icon on the front, indicating that an action has to be taken, for 4 seconds.

RESPONSIBLE PARTNER: TKK

5.1.13 Metric number 13

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 12 / NO INTERACTION WITH THE SYSTEM	D4.1	R1.11
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Interaction: the user's interaction with the system (e.g. webbased, phonebased) and with other users is possible yet not necessary for the system to function; necessary is only the users' interaction with the electric devices in the household

If the energy consumption of a device is not on target, the user can be alerted via the mobile phone: the device category that is off target will be shown dimmed at the front. It must not be the only way available to inform the user, in fact he should also be alerted when he switches on/off the light in the home: in such a case the lighting must start to fade up/out.

RESPONSIBLE PARTNER: TKK/ENG

5.1.14 Metric number 14

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM / 13 / TERMINOLOGY EXPLANATION	D4.1	R1.12
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
BENEFICIAL	DIRECT	HARD

Terminology: full explanation of acronyms and technical terms must be provided somewhere in the interface (e.g. CO₂, KW, KW/H)

In order to allow the user to fully understand feedbacks and reach a good awareness /saving score, s/he must know the meaning of acronyms and technical terms used by the system. For example, when he is informed via mobile phone that the energy consumption in the household is 1000KW, he must be aware of the fact that this refers to the real-time electricity consumption. At the same way, if the user interface provides the information “your consumption is 100KW/h”, the user must be aware of the fact that this refers to measures consumption over time.

In order to fulfill this requirement the application in the mobile phone must provide a full explanation of acronyms and technical terms.

This functionality will have to be added to the mobile interface, as part of main menu.

RESPONSIBLE PARTNER: TKK/ENG

5.2 Sensing, storing and tele-actuating

5.2.1 Metric number 1

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSING SYSTEM/ 1 / SENSOR	D4.1	R2.1

INSTALLATION		
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
BENEFICIAL	DIRECT	SOFT

Sensors are easy to install in the home

Sensors must be installed easily and installation must need no special skill or other equipment.

This requirement can be verified taking into account the time spent to install a sensor in the home (that is connecting the sensor to electric outlet), during the pre-first trial phase. The installation of the main meter should take not more an hour, whereas a simple sensor installation should take no more than one minute. The ambient interface installation should take not more then half an hour.

Installation of Ambient Interface requires some knowledge of electrical installations. No electrician is required in Sweden or Finland.

The ambient interface installation should take not more than half an hour. This can be verified during the pre-first trial phase

RESPONSIBLE PARTNER: TKK/ELE

5.2.2 Metric number 2

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSING SYSTEM/ 2 / VERSATILE	D4.1	R2.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Versatile: Sensors suit all kinds of electric device and are added to new devices purchased by households during the trials. A special solution is found in order to sense electric devices that plug in the electric system directly, without sockets.

This requirement is satisfied if, during trials, each electrical device in the household can be sensed. It must be possible also to add sensors to new devices later, once the sensing platform has been installed and sensors added to a first set of devices.

RESPONSIBLE PARTNER: TKK/ELE, BASEN, ENG

5.2.3 Metric number 3

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSORING SYSTEM/ 3 / SENSITIVE	D4.1	R2.3
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Sensitive: sensors can be activated by electric devices that spend a lot of energy as well as from electric devices that spend little energy.

Sensors must be able to measure device power consumption regardless of the amount of energy spent by the device. In order to verify this requirement take into account the following devices:

- Electric fire (a lot of energy)
- Electric alarm (little energy)

Sensors must be added to both the devices. The test is passed if the user performs a consumption request for both devices and consumption values are displayed for both cases. This means that sensors are being able to measure both large energy consumption and little energy consumption.

RESPONSIBLE PARTNER: TKK/ELE

5.2.4 Metric number 4

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSORING SYSTEM/ 4 / NON-INTRUSIVE	D4.1	R2.4
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Non-intrusive: sensors and ambient interface hardware do not disrupt everyday family habits by requiring additional actions just to cope with them.

Sensors have been thought to not require user interactions, once they have been installed. The only requirement is that a new electrical device need to be added to a sensor in order to have its consumption measured by the sensor. The test is passed if the user confirms that sensors does not annoy nor require maintenance and that the only required user interaction is the one mentioned above.

The ambient interface hardware will require no user interaction once they are installed. They do not annoy or require any maintenance.

RESPONSIBLE PARTNER: BASEN, TKK/ELE, ENG

5.2.5 Metric number 5

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSORING SYSTEM/ 5 / COMPATIBLE	D4.1	R2.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Compatible: sensing system and ambient interface hardware is compatible with the house appearance, and do not require the modification of the furniture arrangement in the house. In case modifications are needed, then they will be minimal, safe and reverted to the original setting if the users require so at the end of the trial.

Plugs that are too big will not fit behind electrical devices such as refrigerators and stoves. In this case people would have the need to rearrange the room to have space to plug in the system. This is a very annoying situation for people and must be avoided. Plugs have to be small enough not to disturb.

This requirement is passed if plugs do not require any furniture arrangement and modifications in the house during the installation.

The ambient interface hardware will fit in most ceiling cups that cover the ceiling wiring and lamp connections. In case they do not fit, they will be place outside of the cup and hanged on the lamp hook. The ambient interface casing is in a discrete colour.

RESPONSIBLE PARTNER: TKK/ELE

5.2.6 Metric number 6

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSORING SYSTEM/ 6 / LOW ENERGY	D4.1	R2.6
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Low energy: the sensing system electricity consumption is proportional to its benefit and can still deliver 15% energy reduction.

The energy consumption of the sensing system must not affect the household energy saving. In order to fulfill this objective the sensors average power usage must be less than 50mW. The requirement can be verified by ensuring that the stored system consumption is not more than the above average power usage.

RESPONSIBLE PARTNER: TKK/ELE

5.2.7 Metric number 7

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSORING SYSTEM/ 7 / UNIVERSALITY OF HARDWARE CONNECTIONS	D4.1	R2.7
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Universality of hardware connections: the sensors support all kinds of hardware connection in the region where the trials take place (sockets, ...).

Ambient interface connections is done by normal wiring and thus makes it easy support the correct plugs.

Protective earth is not needed by the ambient interface hardware, but may be needed by the lamp. That requires one to connect the protective earth wires outside of the ambient interface hardware.

RESPONSIBLE PARTNER: TKK/ELE

5.2.8 Metric number 8

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSORING SYSTEM/ 8 / UNIVERSALITY OF HARDWARE CONNECTIONS	D4.1	R2.8
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Multiplatform system: the tele-actuating system is able to work on a web site and on a mobile phone alike, and coherence across these different versions is ensured.

The user must be able to allow the user interaction both through a mobile phone and a web site. The architecture of Service Layer contributes on that. Infact it is delivered as a standard web application which may be deployed on any web application server, on top of jvm.

The supported browser are Internet Explorer, Firefox.

The two versions (web site and mobile phone) must be able to provide the same functionalities.

5.2.9 Metric number 9

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSORING SYSTEM/ 9 / PRIVACY	D4.1	R2.9
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Privacy: Internal privacy (with respect to other family's members) and External privacy (with respect to people external to the household) is ensured compatibly with the system core needs (e.g. competition in the game, ...).

The system must guarantee privacy through authentication, encryption and privacy settings functionality to set the visibility of data of the energy user to the community. However, this must not affect certain essential system functionalities, e.g. competition in the game.

Example: A user can decide to make not visible to other members information such as his profile picture, the number of household members. He is, in any case, not hide the number of sensors in the household, and cannot avoid the visibility of his score, as it is required in the game for the competition with other members.

This requirement is satisfied if the above consideration are taken into account and the system behaves in such a way.

RESPONSIBLE PARTNER: ALL

5.2.10 Metric number 10

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
STORING/ 10 / HOUSEHOLD PROFILE	D4.1	R2.10
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Household information to be stored: Time, Electric devices in the house, Region (Finland, Italy, Sweden), Dwelling size, Composition (number of people permanently leaving in the house).

The household profile section in the iPhone/iPod Touch must be able to permit the user to set and, consequently, store into the configuration storage the following information:

- the time of the setting
- electric devices into the household
- the region of the household (Finland, Italy, Sweden)
- Dwelling size
- the number of people permanently leaving in the house

In order to verify that the previous information is really stored, the setting and getting functionality of the household profile must be tested. At first, the setting functionality must give the possibility to set the above information, and then, in order to verify that they have been stored into the database, the getting functionality can be used to visualize what has been stored.

RESPONSIBLE PARTNER: ALL

5.2.11 Metric number 11

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
STORING/ 11 / CONSUMPTION DATA	D4.1	R2.11
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Consumption data: sensors record consumption of every (connected) appliance in the house as well as the general consumption in the house at a certain moment.

Each sensor installed in the house must be able to measure and record the consumption of each connected appliance. Moreover, all sensors must register the consumption of the whole household, i.e. the consumption of all appliances at a certain moment. This requirement can be checked with a user test through the use of the iPhone/iPod Touch: he/she should be able to request and visualize the current energy consumption of a particular appliances (obviously connected to the sensor), and the current consumption of the whole household.

RESPONSIBLE PARTNER: BASEN

5.2.12 Metric number 12

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
STORING/ 12 / HISTORICAL CONSUMPTION	D4.1	R2.12
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Historical consumption: The system stores information on the household electricity consumption during the year prior to the trial. This information will be used for statistical purposes but the functionality will NOT be provided to the end user. Customers will be asked to provide this information to the BeAware Consortium (also add this point to the customer agreement).

5.2.13 Metric number 13

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
STORING/ 13 / SYSTEM CONSUMPTION	D4.1	R2.13
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

BeAware local consumption: amount of electricity used for the local functioning of BeAware system and charged on the household bill is stored.

BeAware tools able to detect the amount of electricity used for the functioning of the system must be able to store this information. This requirement can be verified by checking that the system stores his energy consumption. During the first trial an approximation of this energy consumption will be provided testing each component before the trial.

RESPONSIBLE PARTNER: BASEN

5.2.14 Metric number 14

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SENSING SYSTEM/ 14 / ENCRYPTION	D4.1	R2.14
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Anonimity: encryption is ensured since the lowest level of data collection (base station). See also Metric 7 (System / 7 / Privacy policy)

RESPONSIBLE PARTNER: ALL

5.2.15 Metric number 15

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
STORING/ 15 / WEATHER	D4.1	R2.15
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Weather: Regional average weather is collected from an external database.

The system must be able to know daily the average temperature in the morning, in the afternoon and in the night, and weather condition of the region of the household, in order to provide customized feedback. This information must be collected from an external database, in particular from the *accuweather.com* domain.

RESPONSIBLE PARTNER: ENG

5.2.16 Metric number 16

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
STORING/ 16 / NATURAL AMBIENT LIGHT	D4.1	R2.16
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Natural ambient light: Regional average lightening hours is stored from an external database.

The system must be able to get the average lightening hours information from an external database

RESPONSIBLE PARTNER: ENG

5.2.17 Metric number 17

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SYSTEM/ 17 / TEAMS	D4.1	R2.17
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Teams: the system allows to define teams grouping several households.

The system must allow to manage team members and team Energy consumption. In particular:

- The list of team members;
- The list of team energy consumption;
- The possibility to check team energy consumption;

Only for user with role of administrator, the system must provide following additional functionality:

- Add/remove a new team member.

This requirement is satisfied if these functionalities are provided

RESPONSIBLE PARTNER: TKK

5.3 Game and application

5.3.1 Metric number 1

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 1 / USER-SYSTEM INTERACTION	D4.1	R3.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

User-system interaction: the user can interact with the BeAware system by operating on the electrical devices connected to the sensing network, and through actions on the virtual elements of the game (hybrid system).

The system must allow two kinds of interactions between the user and the system:

- Interaction through the use of games and web-based applications, accessible from the mobile phone
- Direct interaction, or better with electrical devices, through the ambient interface.

RESPONSIBLE PARTNER: TKK

5.3.2 Metric number 2

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 2 / USER-USER INTERACTION	D4.1	R3.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Social interaction (user-user): users can have (traceable) exchanges of messages and information through the BeAware system

The system must allow user to user interaction. Main interactions are:

- Exchange of messages. The application on the mobile phone must allow the user to send messages both to other users of the community and whole teams. Also reply functionality must be provided.
- The system have to allow goal oriented team building
- People will be sharing experiences and discuss advices. The same communication must be possible between teams.

This will not be tested in first trial period.

RESPONSIBLE PARTNER: TKK

5.3.3 Metric number 3

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 3 / LEVELS	D4.1	R3.3
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Levels: The game is divided into levels in order to simplify learnability and to separate motivators. Each level allows to access new functions in the user-system and user-user interaction. The first level allows basic participation.

The game must be divided into three levels (plus a base level, named level 0, aimed at the system installation and the measurement of the baselevel consumption). Each level must present new functions in the user-system and user-user interaction, and must have a different difficulty and learnability grade (increasing according to the increase of level). The first level (Level 1) has the aim to let the user understand and learn the basic

functionalities of the system. Each next level must not be accessible from the user if he/she has not completed the previous one.

RESPONSIBLE PARTNER: TKK

5.3.4 Metric number 4

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 4 / USER-SYSTEM INTERACTION LEVELS	D4.1	R3.4
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

User-system interaction levels. The features of user-system interaction available at the different levels are the following:

Level one: only a few sensors are active. (we can have all sensors active)

Level two: same as level one, plus more sensors and functions.

Level three: same as level two, plus more sensors and functions (e.g. remote control).

Each level must present the following functionalities concerning user-system interaction:

- Level 1: The system works with *all sensors active*. At this level the user can explore device categories one at the time. After he/she has reached the target he/she can explore the next device category. Once the user has explored all device categories (according to the active sensors) he/she can advance to level 2. At this level the only feedback available must be the one coming from the ambient interface indicating a target out of bound.

Mainpoint here is that the users explore ONE categories at the time

- Level 2: The system must work with all sensors active. At this level the user must

be able to explore the consumption of all device categories at once. Moreover, feedbacks provided to the user must come both from the ambient interface and mobile phones.

Mainpoint here is that the users explore ALL categories at the time

- Level 3: All the sensors must be active. At this level the user must be able to explore the consumption of all device categories at once. He/she can decide to create and explore new devices category.

Mainpoint here is that the users can create their own new categories and function as a team.

This requirement will not be tested during first trial since there will be only between 5-8 sensors per household.

RESPONSIBLE PARTNER: TTK

5.3.5 Metric number 5

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 5 / SOCIAL INTERACTION LEVELS	D4.1	R3.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Social interaction levels. The features of user-user interaction available at the different levels are the following:

- Level one: users can communicate.

- Level two: same as level one plus users can visualize other households' awareness and saving scores (competition between single households)

- Level three: same as level two plus users can create teams and receive/visualize feedback at a team level (collaboration within households in the same team).

Each level must present the following functionalities concerning user-user interaction:

- Level 1: At this level users must not be able to communicate each others (no exchanges of messages, etc.). He must be able to visualize his/her own score.
- Level 2: A user is able to send (or reply to) a message, post quizzes and advices to other users of the community. The game at this level foresees competition between single households. This means that a user must be able to visualize the awareness and saving score of users in other households of the community. Obviously the user can also visualize his/her own score.
- Level 3: At this level there are the same functionalities as level 2. Moreover, a user belonging to a team must be able to:
 - send messages and post quizzes to single users of his team
 - send messages and post quizzes to the whole team he/she belongs to
 - send messages and post quizzes to other teams
 - visualize his/her own awareness and saving score, the score of the team he/she belongs to, and the score of the other teams.
 - visualize the performance of each user of his team and the corresponding position with respect to the team target.

RESPONSIBLE PARTNER: TKK

5.3.6 Metric number 6

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 6 / SCORE	D4.1	R3.6
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Scoring system/feedback: Users' performance is measured through two different kinds of indices, Awareness and Saving. The first measures knowledge about energy conservation practices, the latter measures the energy consumption activity. They are meant to foster each other.

The system must provide two measurement indices:

1. awareness score. It measures knowledge about energy conservation practices
2. saving score. It measures the energy consumption activity

The requirement is satisfied if there is no divergence between the two scores.

5.3.7 Metric number 7

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 7 / UPGRADING	D4.1	R3.7
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Upgrading: Passage to a higher level (once technically available during the life of the project) depends on reaching the saving goal (15%) in terms of total consumption (not of single device) + a minimal awareness level, and on maintaining this achievement over a certain spate of time (e.g. seven days).

The requirement needed to advance to the next level is:

reaching the 15% saving goal on the total household consumption and the minimal awareness level so calculated: $(\text{max limit} - \text{min limit}) / 2$. This performance must be maintained daily over the period of time specified by the user at the starting of the level.

RESPONSIBLE PARTNER: TKK

5.3.8 Metric number 8

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 8 / DOWNGRADING	D4.1	R3.8
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Downgrading: Downgrading to a lower level depends on falling below the saving level (15%) in terms of total consumption (not of single device) + a minimal awareness level over a certain spate of time (e.g. seven days).

If the user does not manage to maintain the 15% saving level on the total consumption and the minimal awareness level [$(max\ limit - min\ limit) / 2$] over the period of time preset by the system, he/she downgrade to a lower level in level 1 and 2. The level cannot be downgraded only if the current level is the first one. Level 1 is a learning stage and the user should not be able to fail here, they just get a result saying if they managed or not.

RESPONSIBLE PARTNER: TKK

5.3.9 Metric number 9

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
GAMES AND APPLICATIONS/ 9 / PENALTY, SYSTEM TURNED OFF	D4.1	R3.9
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Penalty: if the system is turned off, a penalty is introduced.

If the whole system is turned off for more than 12 hours, the pre-set period of time during which the user should maintain the target must be reset. That is, as the user turns on the system the awareness and saving score are reset and the period of time is restarted at the first day.

RESPONSIBLE PARTNER: TKK

5.4 Feedback

5.4.1 Metric number 1

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
FEEDBACK / 1 / PLEASANTNESS, ANNOYING FEEDBACK	D4.1	R4.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Pleasantness: the feedback does not irritate/annoy/offend the user.

Case 1: The energy consumption is not on target. This imply that when the user switch on the light in the home it slowly fades up to full luminance, and, in the opposite case, when one is turning off the lights, the lamps slowly fade out to indicate the same problem. In order to not irritate the user the fading should last 3 seconds.

Case 2: The users can set an alarm to guard the consumption on the different appliances/sensors. I.e the TV can be set to just be switched on for a total of 4h/week. When the time is up the lighting in the home starts to blink. This can possibly annoy the user if he is doing something important in that room. In order to not be annoying, the blinking should last 3 seconds.

Case 3: The feedback which occur everywhen there is a lack of goal fulfillment must not contain words or phrases that could offend the user.

The requirement is satisfied if the schedule mentioned on case 1, 2 and 3 are fulfilled. This must be verified by users.

RESPONSIBLE PARTNER: TKK

5.4.2 Metric number 2

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
FEEDBACK / 2 / USABILITY	D4.1	R4.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD/SOFT

Usability: the feedback is easy to understand and to use.

Feedbacks to the user, both in the form of messages received via iPhone/iPod Touch and in the form of advices via ambient interfaces, must be understandable by the user. The objectives described in the following cases must be fulfilled in order to have feedbacks understandable:

Case 1: The text of the message received on iPhone/iPod Touch must be clear, concise, must use a terminology understandable by the user (for technical words the user can see the terminology section available on the menu) and must be expressed using quite big and legible characters.

Case 2: Advices received on the iPhone/iPod Touch must be personalized according to the type.

This requirement can be measured both by ensuring that the system behaviour is the one described in all above cases, and with the user perception when using the system. This requirement can be verified by users.

RESPONSIBLE PARTNER: TKK/ENG

5.4.3 Metric number 3

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
FEEDBACK / 3 / EFFECTIVENESS	D4.1	R4.3
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD/SOFT

Effectiveness: the saving measure effectively relates device usage with energy consumption.

The saving/consumption measure provided to the energy consumer must be reliable enough to be considered realistic. For example if the user requests energy consumption information of the oven and s/he expects a value like “10KW/h”, we can say that the measure does not effectively relates device usage with energy consumption if the information provided present a value like “100KW/h”.

This means that the storing of data into the system, the calculation for consumption retrieval and the visualization on the user screen must be performed correctly.

This can be measured in two ways:

- Basing on the perception of the user when s/he analyzes feedback provided by the system (SOFT). For this purpose the Consortium should provide the user with a list of appliances power classes reporting consumption values, so that he can be able to compare the consumption provided by the system with the one that is typical for that device.
- Statistically basing on data stored in the system, that have been gathered from sensors (HARD).

RESPONSIBLE PARTNER: BASEN/TKK/ENG

5.4.4 Metric number 4

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
FEEDBACK/ 4 / TIMELINESS	D4.1	R4.4
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Timeliness: The user must know if the action on the device has been registered by the sensor even before the network provides the updated saving value.

Each time the user performs an action on a device he must be immediately alerted through an advice on the iPhone/iPod Touch (no messages, only a popup appearing somewhere in the screen containing a text that explain the action just taken). Each other information (like the new saving value) that is updated as a consequence of the action, must be shown **after** the system has generated the advice. See also metric nr.1 (User should be notified of what is going on on the system).

5.4.5 Metric number 5

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
FEEDBACK/ 5 /	D4.1	R4.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

The feedback is tailored to the user's actions and household.

5.4.6 Metric number 6

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
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FEEDBACK / 6 / GOAL	D4.1	R4.6
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

The feedback is connected to a goal in order to be meaningful; the goal is pre-defined (15% saving)

Each feedback related to saving information should be able to provide the information on the current status of the energy saving with an indicator that shows how much the current status is far from the goal (pre-defined 15%).

Example: The saving information on the main window of Energy Life must provide a percentage indicating the current saving status (e.g. 3%) and something else indicating how much this status is far from the goal. In this case a graphic level indicator must be used to show the distance from the goal.

RESPONSIBLE PARTNER: TKK/ENG

5.5 Awareness feedback

5.5.1 Metric number 1

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 1 / TIPS READ, AWARENESS SCORE INCREASE	D4.1	R5.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

The system increases the users' awareness through tips on the way in which electric devices can be used.

The system must be able to increase the user's awareness score basing on the number of tips read (opened) out of those generated.

This requirement can be verified by ensuring that the awareness score shown in Energy Life increases everywhen the user read a tip.

The system must be able to increase the user's awareness score basing on the number of quiz's succesfully answered.

This requirement can be verified by ensuring that the awareness score shown in Energy Life increases whenever the user gives the right answer to a quiz.

RESPONSIBLE PARTNER: TKK/ENG

5.5.2 Metric number 2

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 2 / TIPS, USER OPINION	D4.1	R5.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

The system increases the users' awareness through tips on the way in which electric devices can be used.

This requirement can be tested by checking an increase in the users' knowledge, as an improvement in the quiz score.

RESPONSIBLE PARTNER: TKK

5.5.3 Metric number 3

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 3 / TIPS, USER OPINION	D4.1	R5.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

The system increases the users' awareness through tips on the way in which electric devices can be used.

in order to improve user awareness, the user should receive the information about the energy consumption for a "operating cycle of the device".

In other words the system should provide information such as:

"For cooking your food you have consumed XXXX equivalent energy"....or "In the last month, you have used for 3 times the microwave oven and consumed...."

"For washing your clothes you have consumed YYYY equivalent energy"....or....

"For washing your dishes you have consumed ZZZZ equivalent energy".....or...

The association of "operating cycle of the device" (which is a complete task and provides a "concrete and observable result") with its "energy consumption" can improve the energy awareness and make sense for the end user.

This will not be tested in first trial since it is a new feature to the service to be tested in the subsequent trials.

5.5.4 Metric number 4

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
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AWARENESS FEEDBACK / 4 / QUIZ FUNCTIONALITY	D4.1	R5.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Quiz. The system can measure the users' awareness level through quiz, in order to increase the household's awareness score.

The system must provide quiz functionality on the Energy Life screen. In particular:

1. it must provide the quiz list, so that the user can choose the quiz
2. it must provide the list of questions available for the quiz
3. it must provide the list of possible answers for the question
4. it must give the possibility to check the correct answer
5. it must give the possibility for the user to get the quiz history and the correct answers with the related score

This requirement is passed if these functionalities are provided.

RESPONSIBLE PARTNER: TKK/ENG

5.5.5 Metric number 5

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 5 / QUIZ, RIGHT ANSWERS, SCORE INCREASE	D4.1	R5.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Quiz. The system can measure the users' awareness level through quiz, in order to increase the household's awareness score.

The system must be able to increase the user's awareness score (in the main menu) basing on the number of correct answers given in the quiz out of all those given. It should consider the number of right answers over the total number of answered questions.

This requirement is considered satisfied if:

1. the user see the awareness score being increased every time he correctly answer a question
2. the user see the awareness score being decreased every time he wrongly answer a question

This will not be tested in first trial . This will be tested when the community-part will be ready and the awareness score has more importance.

RESPONSIBLE PARTNER: TKK/ENG

5.5.6 Metric number 6

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 6 / SUGGESTIVE QUIZ	D4.1	R5.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Quiz. The system can measure the users' awareness level through quiz, in order to increase the household's awareness score.

- *Quiz is formulated so as not to be suggestive*

The quiz must not address the user to the correct answer. This requirements can be measured in two ways:

1. through the user perception in reading questions. It is satisfied if the user has the impression that quizzes are not suggestive.
2. By analyzing answers of novice users. If the majority of novice users have responded correctly this indicates that the quiz is suggestive.

RESPONSIBLE PARTNER: ?

5.5.7 Metric number 7

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 7 / AWARENESS SCOPE	D4.1	R5.3
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Awareness scope: Tips and quiz focus on both general knowledge and knowledge related to the specific electric device sensed in the household.

Quizzes and tips must target either general practises to save electricity or practises related to specific devices, and must be categorized accordingly.

RESPONSIBLE PARTNER: TKK/ENG

5.5.8 Metric number 8

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK/ 8 / TIPS TAILORING	D4.1	R5.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC

REQUIRED	DIRECT	SOFT
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Tailoring. Tips focus on user's specific situation and on the sensed electric device.

Each time the user is alerted with a tip he/she must have the possibility to understand both which is the electrical device that caused the tip generation and the reason why the tip has been generated (consumption out of target, etc.).

This requirement is satisfied if each tip is tailored to both the specific situation and the device.

RESPONSIBLE PARTNER: TKK

5.5.9 Metric number 9

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 9 / TIPS, TIMELINESS	D4.1	R5.6
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Timeliness: advises are provided timely.

System should be able to provide information timely. Advices are generated when saving for a specific device (or for the whole household) is below the intended target. A rule will be defined to regulate the advises selection and sending behaviour. This function will be available for Phase 2.

5.5.10 Metric number 10

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK/ 10 / REWARD	D4.1	R5.7
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Reward. Reward messages are sent when behavior is good.

At the end of each day during which the user consumption behaviour on the whole household has been good (over the 15% saving score), the system send a message to the user to inform him/her about the good behaviour.

RESPONSIBLE PARTNER: TKK/ENG

5.5.11 Metric number 11

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 11 / TIPS, SIGNALLING	D4.1	R5.8
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Tip's arrival must be signalled.

Each tip generated by the system must be signalled to the user.

For example when a tip is shown in the mobile phone a visual effect may be used (category device icon dimming in the case of consumption not on target).

This requirement is satisfied if the above event can be observed during the use of the system.

RESPONSIBLE PARTNER: TKK

5.5.12 Metric number 12

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 12 / TIP READ	D4.1	R5.9
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Tip read: If a tip has been read, it appears to the user as already read, but does not disappear.

The system must be able to distinguish tips read from tips that have not yet been read. The idea is to have two different lists with all tips that have been read and with the ones unread.

When the user requests the tip list, the system must be able to provide both read and unread messages.

The requirements is satisfied if, once the user reads a tip, the tip is still visible and ticked off.

RESPONSIBLE PARTNER: TKK

5.5.13 Metric number 13

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 13 / TIPS, ASSOCIATION WITH DEVICES	D4.1	R5.9

REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Tip read: Tips are accessible by electric device, to avoid having to browse long lists of tips.

Tips focus on knowledge related to the specific electric device sensed in the household. They must be accessible from the device menu by selecting a specific device. The system must not provide any functionality that permit to access either tips related to a specific device category or tips related to all categories, because this would mean to have a long list of tips.

This requirement is satisfied if the system behaves as describes above.

RESPONSIBLE PARTNER: TKK

5.5.14 Metric number 14

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 14 / SOLICITATIONS	D4.1	R5.10
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Solicitations are provided once in a while about BeAware functionalities that are available but have never been used.

The system must be able to identify BeAware functionalities (i.e. Quiz, energy consumption requests, etc) that have never been used. Different cases have to be distinguished:

- Level 1: if the user is on the level 1 of the level schema, solicitations (received in the form of messages) are provided on the mobile phone to inform/remember the user about the available functionality (one message per functionality), starting from one week after the end of the Baselevel.
- Level 2: When the user advances to Level 2 new functionalities become available,

and related solicitations (received in the form of messages) are provided on the mobile phone to inform/remember the user about the available functionality (one message per functionality) , starting from one week after the user has advanced to Level 2.

- Level 3: When the user advances to Level 3 new functionalities become available, and related solicitations (received in the form of messages) are provided on the mobile phone to inform/remember the user about the available functionality (one message per functionality) , starting from one week after the user has advanced to Level 3.

In any case the system must generate solicitations of the same type once a week, until the user accesses the functionality. General solicitations (i.e. About functionalities not related to levels, like energy consumption requests) must be provided periodically regardless of the current level. Once the user accesses a functionality, no more solicitations related to that functionality must arrive.

The requirement is satisfied if the system behaviour is the one described above.

RESPONSIBLE PARTNER: TKK/ENG

5.5.15 Metric number 15

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 15 / TIPS, LOGGING	D4.1	R5.11
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Logging: User's access to tips is tracked to be logged

The system must be able to detect user's access to tips. Each time a tip is accessed the event must be logged into a database. This requirement can be verified by analyzing the database and ensuring that each access to tips has been logged. The log should contain at least information about the tip accessed, the user that performed the action (and

related household), and the datetime of the event. Access to this information is regulated to avoid privacy infringements.

RESPONSIBLE PARTNER: TKK/ENG

5.5.16 Metric number 16

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 16 / AWARENESS SCORE, INCREASE/DECREASE CRITERIA	D4.1	R5.12
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Awareness score.

The user must be able to see the awareness score in the Energy Life, within the range [-1, 1]. The score (not the score range) must change according to the following considerations and cases:

Level 1:

- Case 1: the score increases if the user correctly answers a question of a quiz and decrease if wrongly answers a question. In general the score is calculated by taking into account the number of correct answers given in the quiz out of all those given.
- Case 2: The score is calculated by taking into account the number of tips read (opened) out of those generated. The score should decrease each time a tip arrives and increase each time a tip is read.
- Case 3: The score is calculated by taking into account the relation between sent and received messages in the BeAware chat. This must not weight too much in the final value of the score with respect to Case 1 and Case 2. If the weight of the score in case 1 is x, the same score in case 3 must weight x/3.

Level2: The score must increase basing on the number of awareness scores visualized belonging to the other households. Also in this case the score must be calculated basing on the number of score visualized with respect to the total number of households. On level 2 also the score calculation based on case 1, 2, 3 described above must be taken into account.

Level 3: At this stage also the communication with the user team is important, so the system must be able to monitor messages the user exchanges with his own team, increasing the score accordingly. On level 3 also the score calculation based on case 1, 2, 3 described above must be taken into account.

This requirement is satisfied if the awareness score changes according to the above cases.

This will not be tested in first trial.

RESPONSIBLE PARTNER: TKK/ENG

5.5.17 Metric number 17

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
AWARENESS FEEDBACK / 17 / SAVING ACTIONS	D4.1	R5.13
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Actions: The household can add the actions they have taken to save energy. They are not counted in the awareness/saving score.

The system should provide a functionality that allow the user to keep track of the actions he has taken to save energy. For example if the user wants to remember that, in order to save energy, he should not keep the stove switched on for not more than 2 hours, he must have the possibility to access this functionality available on the household profile section and specify the action.

Other actions are for instance: " today I bought a refrigerator with higher saving potential; " or "today I had my house checked for energy saving" or "today I bought fluorescence electricity bulbs" or "today I have read electricity saving info on a website" or "today I have joined wwf".

The actions that the user specifies in the household profile section must be a mixture of free text and predefined actions, so the user can have a hint of what kind of actions he/she can enter.

Obviously these actions must not have any impact on the awareness/saving score.

This will not be tested in initial trial but has to be considered and added to the graphic interface, and has to be tested in later phases.

RESPONSIBLE PARTNER: TKK/ENG

5.6 Saving feedback

5.6.1 Metric number 1

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK/ 1 / SAVING	D4.1	R6.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Saving. The system provides feedback on electricity saving through an index related to energy consumption, limited to those electric devices sensed in the household.

The system must be able to provide information about the current electricity saving, by taking into account the energy consumption related to all sensed devices in the household.

The system must provide information about the target saving needed to reach the next level, the time the user has to keep the actual reached saving and the gap between the actual target and the next level. In this perspective, the system has to provide:

- The list of target information;
- The possibility to update target information.

This requirement is passed if these functionalities are provided

5.6.2 Metric number 2

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK / 2 / HOUSEHOLD SPECIFICITY	D4.1	R6.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Tailoring. The saving considers the specificity of the household

5.6.3 Metric number 3

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK / 3 / GOAL SETTING	D4.1	R6.3
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Goal setting. The feedback is related to a goal, which is to diminish to 15% the level of consumption in the household.

The goal on saving energy is to diminish to 15% the level of consumption in the household. The reduction to 15% must be calculated with respect to the energy consumption of the baseline period.

The feedback must be related to this goal.

The requirement is satisfied if the above considerations are followed.

RESPONSIBLE PARTNER: TKK/ENG

5.6.4 Metric number 4

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK / 4 / SAVING PERSONALIZATION	D4.1	R6.4
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Personalization. The saving can be measured in several units (green, CO2, ...) according to the users' preferences and in secondary navigation levels of the interface.

A default measure is defined, which is the starting one that everybody will visualize without browsing the Interface

The default measure used to express energy saving is a percentage (es. 3%). It is always displayed on the main window. The application must also give the possibility to choose a unit measure the user will visualize on secondary navigation levels. For this purpose there should be an appropriate section that permit the user to choose between the following values: CO2, KW/h, percentage, money.

The test is passed if the system provide and follows the above functionality.

RESPONSIBLE PARTNER: TKK

5.6.5 Metric number 5

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK / 5 / BASELINE, HAWTHORNE EFFECT	D4.1	R6.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Baseline: the baseline of the single household is defined as the electricity consumption of during the first month of the trial, where the sensing system is active but the feedback system is not;

occurrence of an Hawthorne effect is checked by comparing the general household consumption during the first 2 weeks of trial without feedback with the same period in the previous year; if the difference is significant, then there is a suspect of an Hawthorne effect;

if there is an Hawthorne effect after two weeks of observation, then the baseline starts once the Hawthorne effect disappears or stabilizes for the subsequent 2 weeks

During the first month of the trial the system must be able to store the household energy consumption, called baseline, without any feedback active. The baseline can start only if there is no Hawthorne effect. To establish if there is an Hawthorne effect the consumption of the first two weeks of the trial must be compared to the two weeks in the same period of the previous year. If there is too much difference the same operation must be repeated during the next two weeks, until no Hawthorne effect is observed.

This requirement can be verified during the first trial. The test is passed if the above consideration and “rules” are taken into account.

5.6.6 Metric number 6

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK / 6 / BASELINE, PACE OF CALCULATION	D4.1	R6.6

REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Pace of calculation: Feedback must be sensible to each energy consumption behavior, so it has to be updated very frequently (e.g. each minute) and contain decimals.

The feedback must be next to real time. For this purpose the system must be able to update feedback with a frequency of 1 minute. The Base Station must talk continuously, meaning every minute, with the BeAware Platform.

Lets suppose that the user is visualizing the feedback when there are three appliances turned on, and immediately he turn off them. The updated feedback must be shown after about 1 minute.

In order to be sensible to small consumption variations, the feedback must contains decimals.

Improvement:

The Base Station should be able to contact the Platform when triggered by some urgent event.

This means that, in the case user requests (wants to interact with ambient interface), the Base Station could start contacting of BeAware Platform more frequent than 1 time per minute (like e.g. 10 times a minute). When this interaction is not needed, the Base Station continues to contact BeAware Platform less frequent.

Example: when out of house, people do not need that fast reaction time from the system. (Does coffee machine close in 5 seconds or in 1 minute seems the same, when the user is in the bus). In the case people are interacting with the system at home and want to interact with ambient interface or BeAware, the Base Station should contact Platform more frequent.

This requirement can be verified by ensuring that the system behaves as described above.

RESPONSIBLE PARTNER: TKK

5.6.7 Metric number 7

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK / 7 / GOAL MANTAINANCE	D4.1	R6.7
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Goal mantainance: It is necessary to define the minimal time interval with respect to which saving has to be maintained (e.g. seven days)

At each level the system set the time interval to be maintained for 7 days to save and keep the preset target of 15%.

RESPONSIBLE PARTNER: TKK

5.6.8 Metric number 8

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
SAVING FEEDBACK / 8 / SAVING SCORE.	D4.1	R6.8
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Saving score:

Level 1. The saving score expresses in percentage, CO₂, KW/h, percentage, money.

Level 2. Same as level 1, except that there are more electric devices active.

Level 3. Same as level 2 plus saving at the team level.

This requirement is satisfied if the saving score is calculated and visualized taking into account the above suggestions.

RESPONSIBLE PARTNER: TKK/ENG

5.7 Visualization

5.7.1 Metric number 1

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION / 1 / SCORE VISUALIZATION, LEVEL 1	D4.1	R7.1
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Visualization of scores level 1.

1. *First layer of navigation: awareness score; saving score per device and total;*
2. *Secondary layer of navigation: score maintenance; saving expressed in units other than kWh, all in the same page; single device status (on-off) and relative contribution to saving; history of saving and awareness scores achieved by electric device and total since start of feedback provision at different levels of granularity (month-week-day);*

The test is passed if scores in level 1 are visualized in such a way

5.7.2 Metric number 2

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION / 2 / SCORE VISUALIZATION, LEVEL 2	D4.1	R7.2
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Visualization of scores level 2.

1. *first layer of navigation: awareness score; saving score per device and total; position with respect to other households per device and total;*
2. *second layer of navigation: score maintenance; saving expressed in units other than kWh, all in the same page; single device status (on-off) and relative contribution to saving; history of saving and awareness scores achieved by electric device and total since start of feedback provision at different levels of granularity (month-week-day); history of position with respect to other households at different levels of granularity (month-week-day);*

The test is passed if scores in level 2 are visualized in such a way

5.7.3 Metric number 3

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION / 3 / SCORE VISUALIZATION, LEVEL 3	D4.1	R7.3
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Visualization of scores level 3.

1. *first layer of navigation: awareness score; saving score per device and total, in the household and in the team; position with respect to other households per device and total;*
3. *second layer of navigation: score maintenance; saving expressed in units other than kWh, all in the same page; single device status (on-off) and relative contribution to other teams score compared to own; history of saving and awareness scores achieved by electric device and total since start of feedback provision at different levels of granularity (month-week-day); history of position with respect to other households at different levels of granularity (month-week-day);*

The test is passed if scores in level 3 are visualized in such a way

5.7.4 Metric number 4

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION/ 4 / VISIBILITY, CLEAR SCREEN	D4.1	R7.4
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Visibility: Each screen contains just a little information, with big and clear alphabetic characters.

Each screen must contain a little information, just the essential one, so as to not appear confusing. Moreover, big and clear alphabetic characters must be used to represent relevant textual information, like the saving /awareness score and menu items.

This requirements can be verified according to the user perception.

RESPONSIBLE PARTNER: TKK

5.7.5 Metric number 5

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION/ 5 / VISIBILITY, DIRECT ACCESS	D4.1	R7.4
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Visibility: Awareness score, saving score, game level, electric device are always immediately visible.

When using Energy Life, the user must be able to quickly access the information that are relevant for him, i.e. saving /awareness score, the game level and electrical devices. In particular the saving score, awareness score and game level must be always visible on

the mobile phone, that is they should be run as fixed elements of each page of the application, regardless of the function the user is currently accessing.

This requirement is satisfied if the above information are always visible on the screen.

In the first trial awareness score is removed because of ‘expert reviews’, but can be added later when the community is tested.

RESPONSIBLE PARTNER: TKK

5.7.6 Metric number 6

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION/ 6 / INTERPRETATION, SCORE RANGE	D4.1	R7.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Interpretation: when visualizing the score range, the value of the extremes must be clear.

Each time the awareness score is visualized also the score range must appear, with smaller character than the score ones. The score range must indicate which is the minimum value and which is the maximum value. This is important for the user to be aware of how much he is far from the maximum level of awareness. For example, if he visualizes a score of 0,9 he must also be provided with the score range [-1, 1] so that he can learn that he is reaching the maximum awareness score.

The score range can also be shown graphically, for instance a rectangle 50% full clearly shows what is the current household position with respect to maximum and minimim without adding extreme value in text.

This requirement is satisfied if the score is shown by using one of the techniques described above.

This will not be tested in the first trial, but in subsequent trials when awareness score is introduced and the community is tested

RESPONSIBLE PARTNER: TKK

5.7.7 Metric number 7

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION/ 7 / INTERPRETATION, PARTICIPANT POSITION	D4.1	R7.5
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Interpretation: the participant's position must be clearly identified with respect to relevant targets.

Each time the user makes a consumption request the participant's position with respect to the target must be provided. For example, let's suppose that the target is energy conservation of 15% and the user consumption visualized is 100KW. The user cannot be able to understand if the energy saving attempt is going well or not if he see only the consumption value and the target. There should be a level indicator showing the current status with respect to the target, so that the user can decide to take an action accordingly.

RESPONSIBLE PARTNER: TKK

5.7.8 Metric number 8

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION/ 8 / DEVICE, PICTURE	D4.1	R7.5

REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	HARD

Interpretation: Each device is associated to a picture for easier comprehension.

The user must be able, for each predefined Device Category visible, to take a photograph of the device he/she wants to have in the category and attach a sensor. In this way, when visualizing devices, the user can immediately and easily individuate the device s/he is interested in.

The requirement can be verified by checking that the interface is able to show these pictures once the user has done picture/device association.

In the first trial the photographs will have to be added manually.

RESPONSIBLE PARTNER: TKK/ENG

5.7.9 Metric number 9

METRIC TYPE/NUMBER/TAG	COMING FROM DOCUMENT	DOCUMENT REFERENCE
VISUALIZATION/ 9 / SIGNALLING, NEW MESSAGE	D4.1	R7.6
REQUIRED/BENEFICIAL	DIRECT/INDIRECT	HARD/SOFT METRIC
REQUIRED	DIRECT	SOFT

Signalling: Information sent to the user must flash or be anyhow easily spotted as 'new'.

Case 1: Each time the user receives a message from a member of the community, the community section on the bottom of the main window must signal the arrival with an icon flashing or by showing a number indicating the number of unread messages (number that increases each time a new message arrives).

Case 2: The tip on the iPhone/iPod Touch generated when the consumption is not on target must consist in the device category icon dimming (the one that is off target).

The requirement can be verified by ensuring that the system behaviour is the one specified in the above cases.

RESPONSIBLE PARTNER: TKK

6 Conclusions

The BeAware system will be extensively tested according to verification scenarios (section 2) during Phase 0. In this phase the deployment team will check time needed for installation, the consortium end user partners will check system reliability and will give the OK to the kick-off of Phase 1. In Phase 1 the system, that is supposed to work perfectly, will be installed with the features foreseen according to the BeAware Implementation Plan (<http://wiki.hiit.fi/display/BeAware/SWImplementationPlan>). At the end of Phase 1 the Metrics described in Section 4 will be checked and validation reports will be prepared. These feedback will help in refine functionalities the system will provide in Phase 2 and correct malfunctions of behaviours not in line with end user expectations.