Implementation of iWIDGET system with historical data

iWIDGET Milestone MS33

Paula Vieira (LNEC), José Barateiro (LNEC), Dália Loureiro (LNEC), Panagiotis Kossieris (NTUA), Enrico Creaco (UNEXE), Lydia Vamvakeridou-Lyroudia (UNEXE), Hans Thies (SAP), Nicole Taheri (IBM) Ernesto Arandia (IBM), João Coelho (LNEC), Christine Grimm(SAP), Zoran Kapelan (UNEXE)

Smart meters
Smart water
Smart societies

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Author (s): Paula Vieira (LNEC), José Barateiro (LNEC), Dália Loureiro (LNEC), Panagiotis Kossieris (NTUA), Enrico Creaco (UNEXE), Lydia Vamvakeridou-Lyroudia (UNEXE), Hans Thies (SAP) Nicole Taheri (IBM) Ernesto Arandia (IBM), João Coelho (LNEC), Christine Grimm (SAP), Zoran Kapelan (UNEXE)

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1.1	PV, JB, DL (LNEC)	Draft	29-03-14	Off line testing methodology internal document including contributions from SAP and NTUA
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1.3	PV, DL, JB (LNEC)	Draft	27-06-14	Chapter 8 and 9 related with the execution of the off-line tests (timeline, results registry, work distribution, etc)
1.4	PV, JC (LNEC), CG (SAP), PK (NTUA), NT, EA (IBM),	Draft	29-07-14	Definition of new test cases for recently developed widgets in chapters 5,6 and 7
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1.6	PK (NTUA)	Draft	19-9-2014	Update of NTUA test cases in chapters 6,7
1.7	JPC (LNEC)	Draft	14-10-2014	Inclusion of test cases for newly developed widgets in chapters 5, 6,7

	PK (NTUA)			Description of data used for household analytics testing
1.8	EC (UNEXE)	Draft	17-10-2014	Inclusion of test cases for UNEXE widgets in chapters 5, 6, 7; inclusion of results from preliminary tests in an annex
1.9	PV, JB (LNEC)	Draft	31-10-2014	Results from tests in section 9.1

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1 Introduction

1.1 The iWIDGET Project

iWIDGET is a European Commission FP7 collaborative project aimed at improved water efficiencies through the use of novel ICT technologies for integrated supply-demand side management. iWIDGET's focus is a more integrated approach to water resources management and the project will contribute to delivering a sustainable, low-carbon society, helping progress towards the Europe 2020 targets on Climate and Energy.

The aim of iWIDGET is to advance knowledge and understanding about smart metering technologies in order to develop novel, robust, practical and cost-effective methodologies and tools to manage urban water demand in households across Europe, by reducing wastage, improving utility understanding of end-user demand and reducing customer water and energy costs.

The main scientific challenges for iWIDGET are the management and extraction of useful information from vast amounts of high-resolution consumption data, the development of customised intervention and awareness campaigns to influence behavioural change, and the integration of iWIDGET concepts into a set of decision-support tools for water utilities and consumers, applicable in differing local conditions. In order to meet these aims and challenges, iWIDGET investigates: (i) how best to provide the dynamic accurate measurement and data transfer of useful information about end-user water consumption, (ii) how best to use consumption data to improve the operation of utilities and influence end-users to modify their behaviour, (iii) how to arrive at the best business model to convert a promising technology into a useful and cost-effective product, and (iv) how to demonstrate and validate the new methodologies on three case studies in the UK, Portugal and Athens.

1.2 Objective of this document

This report is part of Work Package 3 (WP3), entitled "Implementation and validation of the iWIDGET systems", and , more specifically, of Task 3.2: Design the off-line testing and validation of the iWIDGET systems and Task 3.3: iWIDGET off-line tests and validation

The aim of this WP is to design and carry out real life full scale testing of the iWIDGET systems (prototype developed in WP2) in close collaboration with households and utility stakeholders.

In Task 3.2 a standardized methodology for performing a comprehensive off-line testing of the prototype iWIDGET system was developed. Task 3.3 consisted in the application of the previously developed methodology, which included collecting historical data from Barcelos case study (Portugal), feeding this data to the prototype, analysing the results and evaluating performance indicators in order to identify improvements.

1.3 Structure of the document

After this introduction, the report includes the following chapters:

- Chapter 2 details the methodology used in iWIDGET for off-line testing of the widgets developed in WP2.
- Chapter 3 sets the main objectives for off-line tests as well as the level of testing that was carried out in WP3.
- Chapter 4 specifies the type of tests carried out, including functional and non-functional tests.
- Chapter 5 defines the test scenarios where the components of the iWIDGET system will be tested.
- Chapter 6 describes the test cases corresponding to each scenario previously defined in chapter 5.
- Chapter 7 presents the success criteria and performance indicators for the test cases previously defined in chapter 6.
- Chapter 8 describes the general setup and procedures for the off-linetests.
- Chapter 9 presents and analysis the results from off-line tests.
- Chapter 10 summarizes the main conclusions of Tasks 3.2 and 3.3.

2 General methodology for off-line testing

The methodology for off-line testing within WP3 (Figure 1) is based on a test scenarios/test case approach and comprises three main phases: i) preparatory work, ii) off-line tests using historical data and iii) evaluation of the performance of the iWIDGET system during the tests. Phase i) and part of phase iii) were carried out in Task 3.2. Phase ii) and part of phase iii) were carried out in task 3.3.

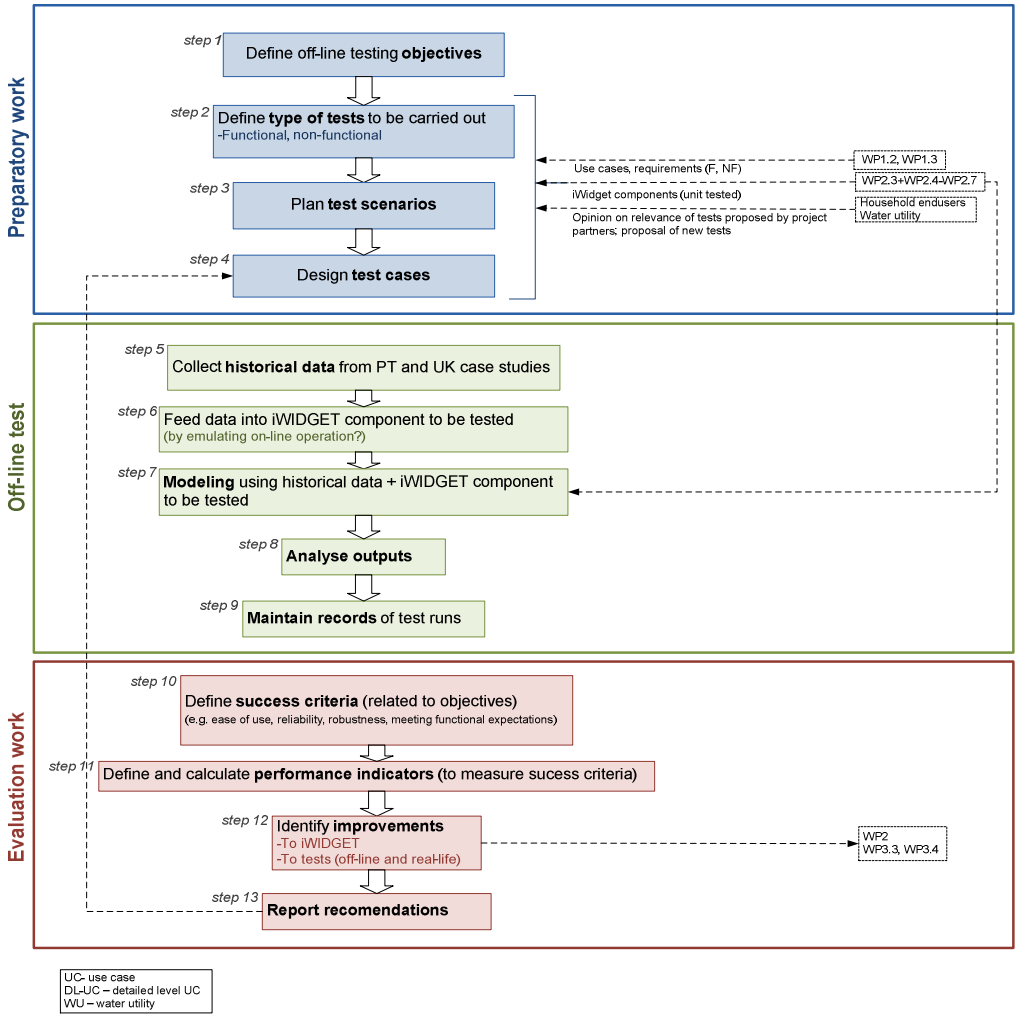

Figure 1 – Methodology for off-line testing in WP3

In preparatory work, objectives for off-line testing are set and the type of tests to be carried out is defined. For each use case to be tested, the test scenarios where the components will be tested are defined. Finally, the test cases corresponding to each scenario are specifically designed and described.

During the off-line test, historical data is collected from the project case studies, fed into the iWIDGET prototype and results are recorded and analysed according to the evaluation criteria established in step iii).

Evaluation work consists in the definition of success criteria related to the objectives. In order to assess the achievement of the success criteria key performance indicators were developed and calculated. This performance assessment allows identifying faults and potential improvements of the iWIDGET systems, which are reported as recommendations to WP2.

Off-line testing in WP3 assumes that the following **pre-conditions** are fulfilled:

- A set of consolidated and harmonized of use cases and corresponding functional and non-functional requirements exists. [related with Tasks 1.2 and 1.3]
- Individual components (data management and the analytical components) are ready in prototype version and integrated in the prototype for off-line testing. [related with WP2]
- Individual components have already passed unit testing. [related with WP2]
- Historical data has migrated into the off-line testing prototype database. Data used for off-line testing is a static dataset.
- Training materials are ready (assuming that off-line testing will also test training materials).

3 Definition of off-line testing objectives

The **main objective of off-line testing** is the evaluation of the **operational readiness** of the iWIDGET system with **historical data**, previously migrated to the off-line testing prototype database. Specific objectives are the following:

- **Test the system in meeting the requirements** of each detailed level use case of WP1 (T1.2 and T1.3).
- **Evaluate the resources required to run** the iWIDGET system to meet those requirements.

Two levels of testing are considered within the iWIDGET project:

1) **Unit testing** - testing of individual iWIDGET software components (developed in Tasks 2.4 to 2.7) and of the data management component (developed in Task 2.3). **This type of testing was done during software development in WP2**, prior to testing in WP3. Historical data or simulated data was used for individual component testing during component development in WP2.

2) **Integration and system testing** - concerned with the behaviour of the system as a whole. Involves making sure that all unit-tested components in the system work together as intended. Specifically, one must test the interactions among units and find discrepancies between the system and its external specifications.

To achieve the above mentioned objectives **WP3 focussed on level 2 tests** and tested the software **after integration** (all analytical components and data management component linked), using **migrated historical and static data**, as much as possible.

4 Definition of the type of tests to be carried out

Following the objectives set in step 1, WP3 performed **black box tests** on a system level considering the following definition:

- **Black box tests** – tests that examine the functionality of the application (what the software does) without peering into its internal structures or algorithms. The tester is only aware of what the software is supposed to do, not how it does it. The tester does not have a visibility into the source code.

In opposition to black box testing methods, **white box tests** allow an internal perspective of the system, as well as of the programming skills. These tests are designed to exercise paths through the code and testers are generally the developers who have access to the source code. The white box tests are out of WP3 scope because white-box testing methods are more appropriate for lower levels of testing, specially unit testing for validation and/or debugging purposes, but are not adequate for testing on a system level by end-users.

In WP3 two main types of tests were performed:

A) Functional tests (F) – Tests to verify if functional requirements are met (**if the software does what it is supposed to do**). Functions are tested by feeding them input and examining the output; internal program structure is rarely considered.

B) Non-functional tests (NF) - Tests to verify if non-functional requirements are met. Basically, they test the quality of the software (**if the software does what it is supposed to do in an adequate way**). In the IT domain, several NF tests are ususally carried out, depending on the pre-defined non-functional requirements. Examples of common non-functional tests include:

- **Performance testing** – to evaluate the response time (application loading, screen opening, refresh times, output graphics display, etc.) and processing times (functions, calculations, imports, exports) of the system.

- **Load testing** - to evaluate the system's behaviour under both normal and anticipated peak load conditions. It helps to identify the maximum operating capacity of an application as well as any bottlenecks, and determine which element is causing degradation. When the load placed on the system is raised beyond normal usage patterns it is known as **stress testing**.

- **Stress testing** – see load testing.
- **Scalability testing** – to evaluate the ability of the system to increase total throughput under an increased load when resources (typically hardware) are added.
- **Security testing** - to determine if the system protects data and maintains functionality as intended. Evaluates several dimensions of information security, such as, confidentiality, integrity, authentication and authorization.
- **Usability testing** – to evaluate the look and feel standards (screen element density, layout and flow, colours, UI metaphors).
- **Availability testing** – to evaluate when and where the system is available (e.g. hours of operation/maintenance, location of operation).
- **Documentation testing** – to evaluate the quality of the documentation (e.g. training material) accompanying the software; testing training material alongside the system is important to ensure readiness for the online testing, by ensuring iWIDGET "ease of use"
- **Compatibility testing** - to evaluate the application's compatibility with the computing environment (compatibility with other applications – what other systems does it need interoperate, compatibility with different operating systems, compatibility with different hardware platforms).
- **Others** such as endurance testing, reliability testing, recovery testing, resilience testing, etc.

Note that NF tests can be done in an isolated way, but are usually combined to test multiple dimensions of software quality (multiple non-functional requirements). On the other hand, they can also be combined with functional tests in order to evaluate if the system behaves as it is supposed to (compliance with functional requirements), with an adequate level of quality (compliance with NF requirements).

In some domains software testing corresponds to an extensive work, while in others a not so complex check may be sufficient. As iWIDGET is a research project, the first 9 items of the above list ensure that the basics are covered and also that the aspects important for a successful online testing of NF requirements. NF tests carried out in Task 3.3 are presented in section 5.3 and 7.3.

The final list of F tests to be made in Task 3.3 was based on the final list of F requirements from Task 1.3 reported by Ozcan and Grimm (2013). This type of tests is presented in sections 5.1, 5.2, 6.1 and 6.2.

In a research project such as iWIDGET, F tests were given a higher importance than NF tests.

5 Planning of test scenarios

The current state-of-the art in requirements engineering recommends that tests are generated from requirements/use cases in an earlier stage of system development, as opposed to generation from later specifications and models of code. That fact makes it possible to base the test on system specifications, instead of having a biased testing, focused on the developed solutions that might not be aligned with the system specifications.

Testing in WP3 was done through scenario evaluation based on WP1 use cases and system requirements, considering the following definitions:

- A **test scenario** specifies what is to be tested, **what** is the functionality of the system that is to be tested. A **test case** specifies **how** is to be tested in detail.
- A test scenario is composed by a set of test cases (independent or sequential) with test cases being derived from test scenarios;
- A test case describes the sequence of steps to be executed by the tester in detail

In the iWIDGET project, the following has been assumed:

- **Non-functional tests** were derived from requirements, i.e., to evaluate **non-functional requirements,** tests were directly driven by and checked against requirements in the form of scenarios (requirements-based testing); NF tests were done using selected use cases (e.g. more complex UC in terms of data processing).
- **Functional tests** were derived from use cases and aimed to test the main functionalities of each use case, i.e., to evaluate **functional requirements,** tests were based on scenarios defined for each detailed level use case. Test cases were associated with UCs, because:
    - Each UC's main flow (and alternative flow, if existing), represents the interactions between actors and iWidget, and thus corresponds to the sequence of steps that must be tested;
    - The **tester** (person who executes the sequence of steps following a written script) must have an adequate profile (profiles of iWidget testers were: consumer, water utility - billing and customers management staff, water utility

- maintenance staff, water utility - network operation staff, water utility - public relations and communication staff, water utility –strategic, tactical and operational planning staff). Each profile tested one (or more) UC according to the actors identified in the UC description (Task 1.2).

When testing a UC, associated F requirements were tested but also the applicable NF requirements (the ones that needed to be evaluated specifically for each UC).

- **Performance indicators** (metrics to assess the achievement of success criteria) **were always linked to the requirements**.

The following sections present the test scenarios for functional testing, both for the consumer domain and for the water utility domain. Test scenarios for non-functional testing are also presented.

5.1Test scenarios for functional testing – consumer domain

Table 1 presents the test scenarios for functional testing in the consumer domain.

Table 1 – Test scenarios for functional testing (consumer domain)

Use Case	Test scenario	Historical data needed	Leading partner
C_UC01.1 Obtain total water consumption and costs using real-time data	#1 Obtain information on the 15-minutes total water consumption for a specific day	Consumer water consumption	NTUA
	#2 Obtain information on the hourly total water consumption for a specific week	Consumer water consumption	
	#3 Obtain information on the cumulative water consumption for a specific month	Consumer water consumption	
	#4 Obtain information on the daily total water consumption for a specific week	Consumer water consumption	
	#5 Obtain information on the per capita daily total water consumption for a specific month	Consumer water consumption	
	#6 Obtain information on the monthly total water consumption for a specific year	Consumer water consumption	
	#7 Obtain information on the monthly total cost related to water consumption for a specific year	Consumer water consumption, pricing scheme	
	#8 Obtain the allocation of the total water consumption into night and day for a specific day	Consumer water consumption	
	#9 Obtain the allocation of the total water consumption into summer and winter period for a specific month	Consumer water consumption	

Use Case C_UC01.2: Obtain per appliance water consumption and costs (total water consumption breakdown) using real-time data from smart meters	#1 Obtain per appliance water consumption for a specific month	Consumer water consumption	NTUA
Use Case C_UC02.1: Obtain total energy consumption and costs associated with water consumption using real-time data from smart meters	#1 Obtain information on the 15-minutes total energy consumption for a specific day	Consumer energy consumption	NTUA
	#2 Obtain amount of energy consumption associated with water uses for a specific month	Consumer energy consumption	NTUA
Use Case C_UC02.2: Obtain per appliance energy consumption and costs associated with water consumption using real-time data from smart meters	#1 Obtain per appliance energy consumption for a specific month	Consumer energy consumption	NTUA

Use Case C_UC02.3: Display carbon emissions related to water consumption (carbon footprint for water)	#1 Obtain amount of carbon emissions for water and non-water related uses for a specific month	Consumer energy consumption	NTUA
C_UC03.1 Compare current water use pattern with historical consumption data of the same household	#1 Obtain comparative overview information of current water consumption against consumption of previous periods	Consumer water consumption	NTUA
	#2 Obtain comparative information on the total water consumption of last 7 days	Consumer water consumption	NTUA
	#3 Obtain comparative information on the total monthly water consumption of last 12 months	Consumer water consumption	NTUA
	#4 Obtain comparative information on the daily and nightly water consumption of last month days	Consumer water consumption	NTUA
	#5 Obtain comparative information on the total daily water consumption of two different time periods	Consumer water consumption	NTUA
C_UC03.2 : Compare water consumption with other consumers (e.g. neighbour, in the same building or street)	#1 Compare the daily per capita water consumption with the relevant average consumption of the DMA for a specific day	Consumer water consumption, DMA water consumptions	UNEXE
C_UC03.3 : Compare water consumption with standard profiles	#1 Compare the daily per capita water consumption with users with similar characteristics in the DMA	Consumer water consumption, DMA water consumptions	UNEXE
C_UC03.4 : Compare household water consumption with most efficient users	#1 Compare the daily per capita water consumption with low consumption users in the DMA	Consumer water consumption, DMA water consumptions	UNEXE

C_UC03.5: Obtain information on inefficient water uses	#1 Obtain information on inefficient water uses through direct comparison of current consumption pattern with water-efficient values	-	NTUA
Use Case C_UC03.6: Receive warnings about faults (leakages, bursts) and unusual water consumptions	#1 Receive information on unusual water consumption events (leakages or bursts)	Consumer water consumption	NTUA
C_UC04.1:&5.4: Compare energy pattern associated with water use in the same household; Forecast the component of next energy bill associated with water consumption	#1 Compare the water related energy consumptions associated with different periods and forecast of the part of the next energy bill associated with water	Consumer water consumption and energy consumption if available	UNEXE
C_UC05.1 Receive customised suggestions (practices and interventions) on how to reduce water consumption	#1 Obtain general conservation tips and suggestions on household water efficiency	-	NTUA
	#2 Develop scenarios and obtain information on how to reduce household water efficiency by using BATNEEC technologies and distributed infrastructures.	-	NTUA
C_UC05.2 Receive information on specific and alternatives pricing schemes	#1 Analyse the extent to which a change in the water tariffs affects the consumer's bill for prefixed consumption	Consumer water consumption	UNEXE

C_UC05.3 Forecast the next water bill	#1 Forecast the next bill on the basis of the bills and consumptions recorded in the past	Consumer water consumption	UNEXE
C_UC6.1-6.2: Direct control and scheduling of water appliances	# 1 Control remotely smart plugs connected to water appliances	-	NTUA

5.2 Test scenarios for functional testing – water utility domain

Table 2 presents the test scenarios for functional testing in the water utility domain.

Table 2 – Test scenarios for functional testing (water utility domain)

Use Case	Test scenario	Historical data needed	Leading partner
WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data	#1 Obtain the water consumption in all the network sectors for a period of one year per month	Water utility data on consumption	SAP
	#2 Obtain the water consumption in all the network sectors for a period of one year per year quarter	Water utility data on consumption	
	#3 Obtain the daily water flow for a specific water meter (MC6) for a series of months	Water utility data on inflow and outflow	
	#4 Obtain the hourly water flow for all meters during one day	Water utility data on inflow and outflow	
	#5 Obtain the monthly water consumption for a specific DMA for one year	Water utility data on inflow and outflow	
	#6 Obtain the daily water inflow for a specific DMA (DMA 1) for three weeks	Water utility data on inflow	
	#7 Obtain the hourly consumption for a specific DMA (DMA 2) for two days	Water utility data on consumption	
	#8 Obtain the monthly inflow/consumption for all the DMAs for one year	Water utility data on inflow and outflow	
WU_UC01.2 Obtain water consumption data per category of consumer using real-time data	#1 Obtain the water consumption for a specific consumption category (e.g. Household consumption category) in a specific DMA (DMA 2) for a period of three months	Water utility data on consumption	SAP
	#2 Obtain the water consumption per hour of all consumption categories in all the DMAs for a specific time period	Water utility data on consumption	
	#3 Obtain the monthly water consumption of all the network sectors for one year	Water utility data on consumption	

Use Case	Test scenario	Historical data needed	Leading partner
WU_UC02.1 Obtain real-time water balance	#1 Obtain the system input, the authorised consumption, the water losses, the real losses and the apparent losses in a specific DMA for one month	Water utility data on inflow, outflow, consumption	SAP
	#2 Obtain the system input, the authorised consumption, the water losses, the real losses and the apparent losses of all the DMAs for one day	Water utility data on inflow, outflow, consumption	
	#3 Obtain billed metered consumption and the unbilled metered consumption for a year	Water utility data on inflow, outflow, consumption	
WU_UC02.2: Benchmark water losses against reference values	#1Obtain comparative information: Benchmark water losses against reference values	Reference value for water losses components from the water utility, the water regulator or from existing studies	SAP
WU_UC02.3: Obtain information on consumption profiling	#1Obtain information on consumption profiling	Adequate consumption data (at least 3 months), socio-demographic data from census or non-domestic consumer characteristics and meter characteristics	SAP
WU_UC02.4: Obtain detailed information on operational inefficiency	#1Obtain detailed information on operational inefficiency	Adequate data about consumption and influential factors	SAP
WU_UC03.1: Obtain information on energy consumption associated with pumping	#1 Obtain energy consumption for a selection of: any chosen day, a price per day of €0.10, a pumping schedule of (1, 1, 1, 0), and DMA1	Consumer water consumption, Network information	IBM
	#2 Obtain energy consumption for a selection of: any chosen day, a tariff price of (€0.05, €0.11, €0,09, €0.05), a pump schedule of (0, 0, 0, 0), and DMA2	Consumer water consumption, Network information	
	#3 Obtain energy consumption for a selection of: any chosen day, a price per day of €0.05, a pump schedule of (0, 1, 0, 0), and DMA3	Consumer water consumption, Network information	
	#4 Obtain energy consumption for a selection of: any chosen day, a tariff price of (€0.07, €0.09, €0.09, €0.10) and the	Consumer water consumption, Network	

Use Case	Test scenario	Historical data needed	Leading partner
	pump schedule (0, 1, 0, 0), and DMA1	information	
WU_UC04.1: Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network	#1Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network	Integration between different information systems (operation, maintenance and customers)	SAP
WU_UC04.2: Receive warnings about the status and sizing adequacy of water meters	#1Receive warnings about the status and sizing adequacy of water meters	Integration between different information systems (operation, maintenance and customers)	SAP
WU_UC04.3: Obtain information on the effect of pressure control on leakage components and on consumption	#1 Obtain information about the effect of pressure control on leakage components and on consumption – "Pressure Control" tab #2 Obtain information about the effect of pressure control on leakage components and on consumption – "DMA Analysis" tab #3 Obtain information about the effect of pressure control on leakage components and on consumption – "Campaigns" tab	Water utility data on inflow and consumption. Water losses (from WU_UC01). Water utility pressure data.	LNEC
sed suggesti ons about pressur e	#1 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 20, 6 periods per day, deterministic analytics and DMA1	Consumer water consumption, Network information	IBM

Use Case	Test scenario	Historical data needed	Leading partner
	#2 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 24, 4 periods per day, robust analytics with confidence interval of 90% and DMA2	Consumer water consumption, Network information	
	#3 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 22, 2 periods per day, deterministic analytics and DMA3	Consumer water consumption, Network information	
	#4 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 20, 1 period per day, robust analytics with confidence interval of 70% and DMA2	Consumer water consumption, Network information	
WU_UC04.5: Receive customised suggestions about pumping schedules	#1 Receive optimal pumping schedules for a selection of: any chosen day, price per day of €0.10 and DMA1	Consumer water consumption, Network information	IBM
	#2 Receive optimal pumping schedules for a selection of: any chosen day, tariff price of (€0.05, €0.14, €0.09, €0.05) and DMA2	Consumer water consumption, Network information	
	#3 Receive optimal pumping schedules for a selection of: any chosen day, price per day of €0.07 and DMA3	Consumer water consumption, Network information	
WU_UC05.1: Receive information to make billing more accurate and flexible	#1 Obtain billing information for a selection of: any chosen smart meter device ID, a flat-rate water price per cubic meter of €2.05, any chosen date range, and each of the four display methods.	Consumer water consumption	IBM
	#2 Obtain billing information for a selection of: any chosen smart meter device ID, a tariff price of (€2.05, €2.55, €2,75, €2.40), any chosen date range, and each of the four available display methods.	Consumer water consumption	
WU_UC05.2 Receive information to improve the management of complaints	#1 Receive information to improve the management of complaints	Consumer water consumption, Network information	LNEC
WU_UC05.3 Receive information to provide warnings to consumers	#1 Receive information to provide warnings for a given network sector, time interval and tolerance	Consumer water consumption, Network information	LNEC

Use Case	Test scenario	Historical data needed	Leading partner
WU_UC06.1: Receive customised suggestions about dynamic pricing schemes	#1 Receive dynamic pricing suggestions for a selection of: the residential category, the Time of Use billing program, any chosen date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.	Consumer water consumption	IBM
	#2 Receive dynamic pricing suggestions for a selection of: the residential category, the Peak Time Rebate billing program, any chosen date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.	Consumer water consumption	
	#3 Receive dynamic pricing suggestions for a selection of: the residential category, the Seasonal Use billing program, any chosen date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.	Consumer water consumption	
WU_UC06.2 Receive customised suggestions about awareness campaigns	#1 Obtain comparative information: comparative data and statistics concerning the percentage of total water aware households	Water utility data on: number of households and household number increase rate (if available), distribution of at least one socio-demographic characteristics of households (i.e. income level, age level) and percentage of households that already conserve water	NTUA
WU_UC07.2 Get support to decision-making on water network expansions	#1 Get support to decision-making on water network expansions	Consumer water consumption, Network information	LNEC
Obtain information to support optimal equipment replacement scheduling	#1 Receive a suggested replacement time for a smart meter for a selection of: any chosen residential smart meter ID, a meter age in years between 1 and 15, a linear deterioration rate, a marginal cost of non-revenue water between €1 and €10, an annual growth rate of the marginal cost between 1% and 3%, and the cost of capital between 5% and 10%.	Consumer water consumption, Network information	IBM

Use Case	Test scenario	Historical data needed	Leading partner
	#2 Receive a suggested replacement time for a smart meter for a selection of: any chosen residential smart meter ID, a meter age in years between 1 and 15, a sigmoid deterioration rate, a marginal cost of non-revenue water between €1 and €10, an annual growth rate of the marginal cost between 1% and 3%, and the cost of capital between 5% and 10%.	Consumer water consumption, Network information	
	#3 Receive a suggested replacement time for a pump for a selection of: any selected start date, DMA 1, 2 or 3, a tariff price of (0.11, 0.21, 0.27, 0.18), an on-off pump schedule of (on, on, off, on), an available deterioration curve, an electricity cost growth between 1 and 5%, and the yearly capital cost of a new pump.	Consumer water consumption, Network information	
WU_UC07.4: Determine optimal placement of valves and flow meters on pipes in the network	#1 Receive optimal valve placement for a selection of: any chosen day, time of day 08:00, minimum pressure 20, 2 valves, deterministic analytics, and DMA1	Consumer water consumption, Network information	IBM
	#2 Receive optimal valve placement for a selection of: any chosen day, time of day 12:00, minimum pressure 22, 2 valves, robust analytics with confidence interval of 80%, and DMA2	Consumer water consumption, Network information	
	#3 Receive optimal valve placement for a selection of: any chosen day, time of day 16:00, minimum pressure 20, 3 valves, deterministic analytics and DMA3	Consumer water consumption, Network information	
	#4 Receive optimal valve placement for a selection of: any chosen day, time of day 20:00, minimum pressure 22, 1 valve, robust analytics with confidence interval of 50%, and DMA1	Consumer water consumption, Network information	

5.3 Test scenarios for non-functional testing

Table 3 presents the test scenarios for non-functional testing.

Table 3 – Test scenarios for non-functional testing

Requirement	Test scenario
Load	#1 Test the iWIDGET system with 5 users at the same time
	#2 Test the iWIDGET system with 20 users at the same time
Performance	#1 Test the iWIDGET system with data from one month of 1 DMA
	#2 Test the iWIDGET system with data from all the period of x DMA (x is the maximum number available in case studies)

Compatibility	#1 Test the iWIDGET system with 3 different browsers
	#2 Test the iWIDGET system from a mobile device
Scalability	#1 Test the iWIDGET system with extended memory
	#2 Test the iWIDGET system with multiple processors
Security	#1 Test the iWIDGET system accessing a direct link, without previous login
	#2 Test the iWIDGET accessing a functionality not allowed for the logged user
	#3 Test the iWIDGET against SQL injection
Usability	#1 Test the iWIDGET system with test objective (without defining the detailed script)
Documentation	#1 Test the existence of documentation
	#2 Test the execution of UCs with users that used that documentation materials, against users without any training
Availability	#1 Test the iWidget availability after forced errors (e.g., power failure)

6 Design of test cases

Test cases are the instructions for testers on how they should carry out the test. Usually, a **test script** is written for this purpose. A test case is a set of step-by-step instructions (corresponding to the sequence of steps that the tester has to execute) that will be performed on the system under test to test that the system functions as expected, i.e., that all the functional requirements are met.

The following sections present the test cases for the consumer domain and for the water utility domain. Each test case is characterized with the following information:

- test case ID
- corresponding test scenario
- test case description
- sequence of steps
- related requirements that have to be met
- tester profile required

6.1Test cases for functional testing – consumer domain

Table 4 to Table 18 present the test cases corresponding to the test scenarios defined in section 5.1 for the consumer domain.

Table 4 – Test cases for use case C_UC01.1 Obtain total water consumption and costs using real-time data

Test scenario #1 Obtain information on the 15-minutes total water consumption for a specific day	
Test case ID	**#1.1**
Test case description	Obtain information on the 15-minutes total water consumption for a specific day. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day from calendar (7 January 2009) • Select 15-minutes resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile	Householder

required	
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain information on the hourly total water consumption for a specific week	
Test case ID	**#2.1**
Test case description	Obtain information on the hourly total water consumption for a specific week. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the week under investigation (7 January 2009 for January 2009) • Select hourly resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #3 Obtain information on the cumulative water consumption for a specific month	
Test case ID	**#3.1**
Test case description	Obtain information on the cumulative water consumption for a specific month. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the month under investigation (7 January 2009 for January 2009) • Select monthly resolution from the time resolution list • Select "monthly water consumption" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Select units (Fn. 011) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #4 Obtain information on the daily total water consumption for a specific week	
Test case ID	**#4.1**
Test case description	Obtain information on the daily total water consumption for a specific week. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the week under investigation (7 January 2009) • Select daily resolution from the time resolution list • Select "daily water consumption" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result

	• iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Select units (Fn. 011) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #5 Obtain information on the per capita daily total water consumption for a specific week	
Test case ID	**#5.1**
Test case description	Obtain information on the per capita daily total water consumption for a specific week. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the week under investigation (7 January 2009) • Select daily resolution from the time resolution list • Select “daily water consumption per capita” as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Select units (Fn. 011) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005)

	• Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #6 Obtain information on the monthly total water consumption for a specific year	
Test case ID	**#6.1**
Test case description	Obtain information on the monthly total water consumption for a specific year. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the year under investigation (7 January 2009 for year 2009) • Select monthly resolution from the time resolution list • Select "monthly water consumption" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Select units (Fn. 011) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #7 Obtain information on the monthly total cost related to water consumption for a specific year	
Test case ID	**#7.1**
Test case description	Obtain information on the monthly total cost related to water consumption for a specific year. The system displays the time series graphs and statistics of consumption data.

Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the year under investigation (7 January 2009 for year 2009) • Select monthly resolution from the time resolution list • Select "monthly water cost" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Select units (Fn. 011) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #8 Obtain the allocation of the total water consumption into night and day for a specific day	
Test case ID	**#8.1**
Test case description	Obtain the allocation of the total water consumption into night and day for a specific day. The system displays a pie chart with the allocation.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day from calendar (7 January 2009) • Select hourly resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents the allocation in the form of pie chart and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder

Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Select consumption scenario (Fn. 004) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security • Performance • Response time • Data resolution

Test scenario #9 Obtain the allocation of the total water consumption into summer and winter period for a specific month	
Test case ID	**#9.1**
Test case description	Obtain the allocation of the total water consumption into summer and winter period for a specific month. The system displays a pie chart with the allocation.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of water consumption details • Select a day that belongs to the month under investigation (7 January 2009 for month January) • Select monthly resolution from the time resolution list • Select "monthly water consumption" as units of presented information • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents the allocation in the form of pie chart and a report with the main statistics and information • Print the report • Download data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn. 001) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Select consumption scenario (Fn. 004) • Select units (Fn. 011) • Obtain data (Fn. 003) • Execute calculations (Fn. 002) • Display information (Fn. 005) • Print (Fn. 010) • Download information (Fn. 006) • Security

	• Performance • Response time • Data resolution

Table 5 – Test cases for use case C_UC1.2: Obtain per appliance water consumption and costs (total water consumption breakdown) using real-time data from smart meters

Test scenario #1 #1 Obtain per appliance water consumption for a specific month	
Test case ID	**#1.1**
Test case description	Obtain information on the breakdown of total monthly water consumption into various water uses.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the information on per appliance water consumption • Select the month and the year under investigation • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the breakdown into uses in the form of pie chart and summary report • Print report
Tester profile required	• Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Execute calculations (Fn. 002) • Obtain data (Fn. 003) • Select consumption scenario (Fn. 004) • Display information (Fn. 005) • Download information (Fn. 006) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Store calculations (Fn. 009) • Print (Fn. 010) • Select units (Fn. 011) • Request breakdown information (Fn. 012) • Obtain technical characteristics (Fn. 013) • Select type of analysis (Fn. 014) • Select appliance (Fn. 015) • Security • Performance • Response time • Data resolution

Table 6 – Test cases for use case C_UC2.1: Obtain total energy consumption and costs associated with water consumption using real-time data from smart meters

Test scenario #1 Obtain information on the 15-minutes total energy consumption for a specific day	
Test case ID	**#1.1**
Test case description	Obtain information on the 15-minutes total energy consumption for a specific day. The system displays the time series graphs and statistics of consumption data.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of energy consumption details • Select a day from calendar (7 January 2009) • Select 15-minutes resolution from the time resolution list • iWIDGET obtains data from database • iWIDGET calculates the result • iWIDGET presents time series graphs and a report with the main statistics and information • Print the report • Download data
Tester profile required	• Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Execute calculations (Fn. 002) • Obtain data (Fn. 003) • Select consumption scenario (Fn. 004) • Display information (Fn. 005) • Download information (Fn. 006) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Store calculations (Fn. 009) • Print (Fn. 010) • Obtain technical characteristics (Fn. 013) • Request info on energy consumption (Fn. 016) • Select units (Fn. 017) • Obtain energy data (Fn. 018) • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain amount of energy consumption associated with water uses for a specific month	
Test case ID	**#2.1**
Test case description	Obtain information on the monthly energy consumption related to water uses and appliances. The platform presents the results in the form of pie chart and summary report.
Test case sequence of	• Log on to iWIDGET using a password • Select the option related to the information on energy consumption associated with

steps	water • Select the month and the year under investigation • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the amount of energy consumption related to water in the form of pie chart and summary report • Print report
Tester profile required	• Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Execute calculations (Fn. 002) • Obtain data (Fn. 003) • Select consumption scenario (Fn. 004) • Display information (Fn. 005) • Download information (Fn. 006) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Store calculations (Fn. 009) • Print (Fn. 010) • Obtain technical characteristics (Fn. 013) • Request info on energy consumption (Fn. 016) • Select units (Fn. 017) • Obtain energy data (Fn. 018) • Security • Performance • Response time • Data resolution

Table 7 – Test cases for use case C_UC2.2: Obtain per appliance energy consumption and costs associated with water consumption using real-time data from smart meters

Test scenario #1 #1 Obtain per appliance energy consumption for a specific month	
Test case ID	**#1.1**
Test case description	Obtain information on the breakdown of total monthly energy consumption into various energy uses and appliances. The platform presents the results in the form of pie chart and summary report.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the information on per appliance energy consumption • Select the month and the year under investigation • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the breakdown into uses in the form of pie chart and summary report • Print report
Tester profile	• Householder

required	
Related requirements that have to be met (F and NF) (as in T1.3)	• Execute calculations (Fn. 002) • Obtain data (Fn. 003) • Select consumption scenario (Fn. 004) • Display information (Fn. 005) • Download information (Fn. 006) • Select time period (Fn. 007) • Select temporal resolution (Fn. 008) • Store calculations (Fn. 009) • Print (Fn. 010) • Select units (Fn. 011) • Obtain technical characteristics (Fn. 013) • Select type of analysis (Fn. 014) • Select appliance (Fn. 015) • Request info on breakdown of energy consumption (Fn. 019) • Security • Performance • Response time • Data resolution

Table 8 – Test cases for use case C_UC2.3: Display carbon emissions related to water consumption (carbon footprint for water)

Test scenario #1 Obtain amount of carbon emissions for water and non-water related uses for a specific month	
Test case ID	**#1.1**
Test case description	Obtain information on the monthly carbon emissions related to water and energy appliances. The platform presents the results in the form of pie chart and summary report.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the information on carbon emissions of the household • Select the month and the year under investigation • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the carbon emissions related to energy and water uses • Print report
Tester profile required	• Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Execute calculations (Fn. 002) • Obtain data (Fn. 003) • Select consumption scenario (Fn. 004) • Display information (Fn. 005) • Download information (Fn. 006) • Select time period (Fn. 007)

	• Select temporal resolution (Fn. 008) • Store calculations (Fn. 009) • Print (Fn. 010) • Select units (Fn. 011) • Obtain technical characteristics (Fn. 013) • Select type of analysis (Fn. 014) • Select appliance (Fn. 015) • Request info on breakdown of energy consumption (Fn. 019) • Security • Performance • Response time • Data resolution

Table 9 – Test cases for use case C_UC03.1 Compare current water use pattern with historical consumption data of the same household

Test scenario #1 Obtain comparative overview information of current water consumption against consumption of previous periods	
Test case ID	**#1.1**
Test case description	Compare the water consumption of last full measured periods (daily, weekly, monthly, yearly) with previous periods of the same length.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status ("homepage" of the platform) • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents the comparison of the current consumption with the relevant consumption of the same period of previous years • Print report
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request comparative data (Fn. 024) • Obtain consumer data (Fn. 021) • Calculate comparative data (Fn. 025) • Display comparative data (Fn. 022) • Print (Fn. 010) • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain comparative information on the total water consumption of last 7 days

Test case ID	#2.1
Test case description	Compare the daily water consumptions of last full measured 7 days.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of comparison of water consumptions • Select daily data resolution • Select last 7 days as time-period under investigation • Select "total" as data resolution • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents comparative graphs and reports • Print report
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request comparative data (Fn. 024) • Select time-period of consumer data (Fn. 020) • Select resolution of consumer data (Fn. 023) • Obtain consumer data (Fn. 021) • Calculate comparative data (Fn. 025) • Display comparative data (Fn. 022) • Print (Fn. 010) • Security • Performance • Response time • Data resolution

Test scenario #3 Obtain comparative information on the total monthly water consumption of last 12 months	
Test case ID	**#3.1**
Test case description	Compare the monthly water consumption of last full measured 12 months.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of comparison of water consumptions • Select monthly data resolution • Select last 12 months as time-period under investigation • Select "total" as data resolution • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents comparative graphs and reports • Print report
Tester profile required	Householder
Related requirements that have to be	• Request comparative data (Fn. 024) • Select time-period of consumer data (Fn. 020) • Select resolution of consumer data (Fn. 023)

met (F and NF) (as in T1.3)	• Obtain consumer data (Fn. 021) • Calculate comparative data (Fn. 025) • Display comparative data (Fn. 022) • Print (Fn. 010) • Security • Performance • Response time • Data resolution

Test scenario #4 Obtain comparative information on the daily and nightly water consumption of last month days	
Test case ID	**#4.1**
Test case description	Compare the daily and nightly water consumption of last full measured month on daily resolution.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of comparison of water consumptions • Select daily data resolution • Select last month as time-period under investigation • Select “day/night” as data resolution • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents comparative graphs and reports • Print report
Tester profile required	• householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request comparative data (Fn. 024) • Select time-period of consumer data (Fn. 020) • Select resolution of consumer data (Fn. 023) • Obtain consumer data (Fn. 021) • Calculate comparative data (Fn. 025) • Display comparative data (Fn. 022) • Print (Fn. 010) • Security • Performance • Response time • Data resolution

Test scenario #5 Obtain comparative information on the total daily water consumption of two different time periods	
Test case ID	**#5.1**
Test case description	Compare the total water consumption of two different time periods.
Test case	• Log on to iWIDGET using a password

sequence of steps	• Select the option related to the visualization of comparison of water consumptions • Select daily data resolution • Select the two different time-periods under investigation • Select "total" as data resolution • iWIDGET obtains data • iWIDGET calculates the result • iWIDGET presents comparative graphs and reports • Print report
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request comparative data (Fn. 024) • Select time-period of consumer data (Fn. 020) • Select resolution of consumer data (Fn. 023) • Obtain consumer data (Fn. 021) • Calculate comparative data (Fn. 025) • Display comparative data (Fn. 022) • Print (Fn. 010) • Security • Performance • Response time • Data resolution

Table 10 – Test cases for use case C_UC03.2 Compare water consumption with other consumers (e.g. neighbour, in the same building or street)

Test scenario #1 Compare the daily per capita water consumption with the relevant average consumption of the DMA for a specific day	
Test case ID	**#1.1**
Test case description	Compare the daily per capita water consumption with the relevant average consumption of the DMA for a specific day. The system displays the time series graphs with comparative information.
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status • iWIDGET calculates the result • iWIDGET presents time series graphs and a report • iWIDGET presents time series graphs and a report • iWIDGET presents time series graphs and a report • Print the report • Save data
Tester profile required	Householder
Related requirements that have to be	• Request information (Fn.024) • Calculate comparative data (Fn.025) • Display comparative data (Fn.026)

met (F and NF) (as in T1.3)	• Comparison with a group and computation of relative performance (Fn.027) • Display of injunctive norm feedback to the consumer (Fn.028) • Print • Download • Security • Performance • Response time • Data resolution

Table 11 – Test cases for use case C_UC03.3 Compare water consumption with standard profiles

Test scenario #1 Compare the daily per capita water consumption with users with similar characteristics in the DMA	
Test case ID	**#1.1**
Test case description	Compare water consumption with standard profiles
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status • iWIDGET calculates the result • iWIDGET presents time series graphs and a report • iWIDGET presents time series graphs and a report • iWIDGET presents time series graphs and a report • Print the report • Save data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn.024) • Calculate comparative data (Fn.025) • Display comparative data (Fn.026) • Comparison with a group and computation of relative performance (Fn.027) • Display of injunctive norm feedback to the consumer (Fn.028) • Print • Download • Security • Performance • Response time • Data resolution

Table 12 – Test cases for use case C_UC03.4 Compare household water consumption with most efficient users

Test scenario #1 Compare the daily per capita water consumption with low consumption users in the DMA	
Test case ID	**#1.1**

Test case description	Compare household water consumption with most efficient users
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the visualization of the current status • iWIDGET calculates the result • iWIDGET presents time series graphs and a report • iWIDGET presents time series graphs and a report • iWIDGET presents time series graphs and a report • Print the report • Save data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information (Fn.024) • Calculate comparative data (Fn.025) • Display comparative data (Fn.026) • Comparison with a group and computation of relative performance (Fn.027) • Display of injunctive norm feedback to the consumer (Fn.028) • Print • Download • Security • Performance • Response time • Data resolution

Table 13 – Test cases for use case C_UC03.5 Obtain information on inefficient water uses

Test scenario #1 Obtain information on inefficient water uses	
Test case ID	**#1.1**
Test case description	Obtain information on inefficient water uses. The information is displayed through the iWIDGET eLearning platform.
Test case sequence of steps	• Log on to iWIDGET platform using authentication credentials (username and password) • iWIDGET displays a hyperlink to iWIDGET eLearning platform named "Be Smart with Water in the House" • Access the on-line course that is displayed via a new tab in the browser • Log on to eLearning platform using a password and username • Select the tool "Water Calculator" for the analysis of total consumption into various uses and comparison with water-efficient values • Give the required information • iWIDGET platform analyses data and calculates the results • iWIDGET platform retrieves warnings • iWIDGET eLearning platform displays the results and possible warnings
Tester profile required	Householder
Related	• Obtain data (Fn. 029)

requirements that have to be met (F and NF) (as in T1.3)	• Retrieve warnings (Fn. 030) • Display warnings (Fn. 031) • Analyse data (Fn. 032) • Send notification (Fn. 033) • Allow cancelation of warning (Fn. 034) • Security • Performance • Response time

Table 14 – Test cases for use case C_UC 3.6 Receive warnings about faults (leakages, bursts) and unusual water consumptions

Test scenario #1 Receive information on unusual water consumption events (leakages or bursts)	
Test case ID	**#1.1**
Test case description	Obtain warnings about possible unusual water consumption events (leakages and bursts). The platform presents the details about the events (day, time, consumption).
Test case sequence of steps	• Log on to iWIDGET platform using authentication credentials (username and password) • Select the option related to information on unusual water consumption events • iWIDGET platform analyses data and calculates the results • iWIDGET platform retrieves warnings • iWIDGET displays the detected unusual events and provide warnings
Tester profile required	• Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Obtain data (Fn. 029) • Analyse data (Fn. 032) • Send notification (Fn. 033) • Allow cancelation of warning (Fn. 034) • Retrieve warnings (unusual consumption) (Fn. 035) • Display warnings (fault and unusual consumption) (Fn. 036) • Security • Performance • Response time

Table 15 – Test cases for use case C_UC04.1&5.4 Compare energy pattern associated with water use in the same household; Forecast the component of next energy bill associated with water consumption

Test scenario #1 Compare the water related energy consumptions associated with different periods and forecast of the part of the next energy bill associated with water	
Test case ID	**#1.1**

Test case description	Compare energy pattern associated with water use in the same household; Forecast the component of next energy bill associated with water consumption
Test case sequence of steps	• Log on to iWIDGET using a password • Select time-period of consumer data (energy use) • iWIDGET displays consumer data and energy consumption • Input energy tariff information • Select forecast time-period • iWIDGET presents time series graphs and a report on energy cost • iWIDGET presents time series graphs and a report on water cost • Print the report • Save data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information • Display data • Request information • Request information • Display data • Display data • Print • Download • Security • Performance • Response time • Data resolution

Table 16 – Test cases for use case C_UC05.1 Receive customised suggestions (practices and interventions) on how to reduce water consumption

Test scenario #1 Obtain general conservation tips and suggestions on household water efficiency	
Test case ID	**#1.1**
Test case description	Obtain general conservation tips and advices for improving household water efficiency. The information is displayed through the iWIDGET eLearning platform.
Test case sequence of steps	• Log on to iWIDGET platform using authentication credentials (username and password) • iWIDGET displays a hyperlink to iWIDGET eLearning platform named “Be Smart with Water in the House” • Access the on-line course that will be displayed via a new tab in the browser • Log on to eLearning platform using a password and username • Select the application “Tips and Practices through virtual application” • iWIDGET retrieves the suggestions from the library • Select either general suggestions or specific for a water use • iWIDGET eLearning platform displays the various tips
Tester profile required	Householder

Related requirements that have to be met (F and NF) (as in T1.3)	• Request general suggestions (Fn. 039) • Request specific suggestions (Fn. 040) • Retrieve suggestions (Fn. 044) • Display suggestions (Fn. 045) • Security • Performance • Response time

Test scenario #2 Develop scenarios and obtain information on how to reduce household water efficiency by using BATNEEC technologies and distributed infrastructures.	
Test case ID	**#2.1**
Test case description	Develop scenarios and obtain information on how to reduce household water efficiency by using BATNEEC technologies and distributed infrastructures. The information is displayed through the iWIDGET eLearning platform.
Test case sequence of steps	• Log on to iWIDGET platform using authentication credentials (username and password) • iWIDGET displays a hyperlink to iWIDGET eLearning platform named "Be Smart with Water in the House" • Access the on-line course that will be displayed via a new tab in the browser • Log on to eLearning platform using a password and username • Select the application "Water Planner" • Select water appliances configuration (develop scenarios) • Specify the household characteristics and climate information (obtain data) • iWIDGET runs scenarios and calculates the results • iWIDGET eLearning platform displays the results
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request specific suggestions (Fn. 040) • Develop scenarios (Fn. 041) • Run scenarios (Fn. 047) • Obtain data (Fn. 043) • Obtain weather data (Fn. 046) • Retrieve suggestions (Fn. 044) • Display suggestions (Fn. 045) • Security • Performance • Response time

Table 17 – Test cases for use case C_UC05.2 Receive information on specific and alternatives pricing schemes

Test scenario #1 Analyse the extent to which a change in the water tariffs affects the consumer's bill for prefixed consumption	
Test case ID	**#1.1**

Test case description	Receive information on specific and alternatives pricing schemes
Test case sequence of steps	• Log on to iWIDGET using a password • Select water pricing tariff • iWIDGET displays pricing tariff • iWIDGET displays water cost • iWIDGET displays comparative tariff costs • iWIDGET identifies best tariff cost • iWIDGET yields ease of interpreting water cost • iWIDGET yields ease of interpretation • Print the report • Save data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information • Display data • Print • Download • Security • Performance • Response time • Data resolution

Table 18 – Test cases for use case C_UC05.3 Forecast the next water bill

Test scenario #1 Forecast the next bill on the basis of the bills and consumptions recorded in the past	
Test case ID	**#1.1**
Test case description	Forecast the next water bill
Test case sequence of steps	• Log on to iWIDGET using a password • Select forecast time-period • iWIDGET calculates water use • iWIDGET displays future water bill • iWIDGET displays alternative future bills • Print the report • Save data
Tester profile required	Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request information • calculate results • Display data • Print • Download • Security

	• Performance • Response time • Data resolution

Table 19 – Test cases for use case C_UC 6.1-6.2 Direct control and scheduling of water appliances

Test scenario #1 Control remotely smart plugs connected to water appliances	
Test case ID	**#1.1**
Test case description	Remote control of plugs connected to water appliances (e.g. dishwasher and washing machine)
Test case sequence of steps	• Log on to iWIDGET platform using authentication credentials (username and password) • Select the option related to device control • iWIDGET platform presents the available smart devices and their status (sleep mode, on mode, off mode) • Change the status of desirable appliance (turn on, turn off) • iWIDGET system communicates with smart plugs • iWIDGET goes updated and presents the current new status
Tester profile required	• Householder
Related requirements that have to be met (F and NF) (as in T1.3)	• Request Scheduling (Fn.064) • Select appliance (Fn.065) • Select time period (Fn.066) • Obtain data (Fn.067) • Display time schedule (Fn.068) • Remote control (Fn.069) • Confirm/Cancel operation (Fn.070) • Print (Fn.071) • Download (time schedule) (Fn.072) • Security • Performance • Response time

6.2 Test cases for functional testing – water utility domain

Table 20 to Table 39 present the test cases corresponding to the test scenarios defined in section 5.2 for the water utility domain.

Table 20 – Test cases for use case WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data

Test scenario #1 Obtain the water consumption in all the network sectors for a period of one year per month	
Test case ID	**#1.1**
Test case description	Obtain the monthly water consumption in all the network sectors during the period of one year (01/01/09 until 31/12/09). Overall water consumption components to be calculated are consumption per DMA and consumption per consumption category. The widget presents the bar chart and the time series graph
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select temporal resolution (last 12 months) • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: temporal resolution • Graphic type selection: time series charts, bar charts • Overall water consumption data filtered by time interval • Overall water consumption data aggregated by temporal resolution • Calculate overall water consumption components • Graphics: Overall water consumption bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain the water consumption in all the network sectors for a period of one year per year quarter	
Test case ID	**#2.1**
Test case description	Obtain the quarterly water consumption in all the network sectors during the period of one year (01/01/09 until 31/12/09). Overall water consumption components to be calculated are consumption per DMA and consumption per consumption category. The widget presents the bar chart and the time series graph
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select temporal resolution (last 4 quarters) • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be	• Parameter selection: temporal resolution • Graphic type selection: time series charts, bar charts • Overall water consumption data filtered by time interval

met (F and NF) (as in T1.3)	• Overall water consumption data aggregated by temporal resolution • Calculate overall water consumption components • Graphics: Overall water consumption bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #3 Obtain the daily water flow for MC6 for a series of months	
Test case ID	**#3.1**
Test case description	Obtain the daily water flow for MC6 of Barcelos supply system for the time period between 01/01/09 until 31/03/09. Water overview components to be calculated are inflow and outflow. The widget presents the bar chart and the time series graph

Test case sequence of steps	• Log on to iWIDGET
	• Select data processing options
	  ➢ select meter
	  ➢ select time period
	  ➢ select temporal resolution
	• Visualize data
	• Exit the application

Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and meter selection • Graphic type selection: time series charts, bar charts • Meter overview data filtered by time interval • Meter overview data aggregated by temporal resolution • Calculate meter overview components • Graphics: Meter overview bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #4 Obtain the hourly water flow for all meters during one day	
Test case ID	**#4.1**
Test case description	Obtain the water flow per hour for all meters of Barcelos supply system, for the time period between 1 July 2009 00:00 and 1 July 2009 23:59. Water overview components to be calculated are inflow and outflow. The widget presents the bar chart and the time series graph.

Test case sequence of steps	• Log on to iWIDGET
	• Select data processing options
	  ➢ select meter
	  ➢ select time period
	  ➢ select temporal resolution

	• Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and meter selection • Graphic type selection: time series charts, bar charts • Meter overview data filtered by time interval • Meter overview data aggregated by temporal resolution • Calculate water overview components • Graphics: Water overview bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #5 Obtain the monthly water consumption for a specific DMA for one year	
Test case ID	**#5.1**
Test case description	Obtain the monthly water flow of DMA 3 of Barcelos supply system, for the time period between 01/01/09 and 31/12/09. Water overview components to be calculated are inflow and outflow. The widget presents the bar chart and the time series graph.

Test case sequence of steps	• Log on to iWIDGET
	• Select data processing options
	  ➢ select meter
	  ➢ select time period
	  ➢ select temporal resolution
	• Visualize data
	• Exit the application

Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and meter selection • Graphic type selection: time series charts, bar charts • Meter overview data filtered by time interval • Meter overview data aggregated by temporal resolution • Calculate water overview components • Graphics: Water overview bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #6 Obtain the daily water inflow for DMA 1 for three weeks	
Test case ID	**#6.1**
Test case description	Obtain the daily water inflow and consumption of DMA 1 of Barcelos supply system, for the time period between 01/07/09 and 21/07/09. Water overview components to be

	calculated are inflow and consumption. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • DMA water inflow and consumption data filtered by time interval • DMA water inflow and consumption data aggregated by temporal resolution • Calculate DMA water inflow and consumption components • Graphics: Water DMA inflow and consumption bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #7 Obtain the hourly consumption for DMA 2 for two days	
Test case ID	**#7.1**
Test case description	Obtain the hourly water inflow and consumption of DMA 2 of Barcelos supply system, for the time period between 01/07/09 and 02/07/09. Water overview components to be calculated are inflow and consumption. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • DMA water inflow and consumption data filtered by time interval • DMA water inflow and consumption data aggregated by temporal resolution • Calculate DMA water inflow and consumption components • Graphics: Water DMA inflow and consumption bar chart, time series chart • Security

	• Performance • Response time • Data resolution

Test scenario #8 Obtain the monthly inflow/consumption for all the DMAs for one year	
Test case ID	**#8.1**
Test case description	Obtain the monthly water inflow and consumption of all network sectors of Barcelos supply system, for the time period between 01/01/09 and 31/12/09. Water overview components to be calculated are inflow and consumption. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • DMA water inflow and consumption data filtered by time interval • DMA water inflow and consumption data aggregated by temporal resolution • Calculate DMA water inflow and consumption components • Graphics: Water DMA inflow and consumption bar chart, time series chart • Security • Performance • Response time • Data resolution

Table 21 – Test cases for use case WU_UC01.2 Obtain water consumption data per category of consumer using real-time data

Test scenario #1 Obtain the water consumption for a specific consumption category (e.g. Household consumption category) in DMA 2 for a period of three months	
Test case ID	**#1.1**
Test case description	Obtain the daily water consumption from one consumption category (household category) of the DMA 2 network sector of Barcelos supply system, for the time period between 01/01/09 and 31/03/09. The component to be calculated is the consumption per category. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period

	➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • Consumption per category data filtered by time interval • Consumption per category data aggregated by temporal resolution • Calculate consumption per category components • Graphics: Consumption per category bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain the water consumption per hour of all consumption categories in all the DMAs for specific days	
Test case ID	**#2.1**
Test case description	Obtain the hourly water consumption of all the consumption categories out of all the network sectors of Barcelos supply system, for the time period between 01/07/09 and 03/07/09. The component to be calculated is the consumption per category. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • Consumption per category data filtered by time interval • Consumption per category data aggregated by temporal resolution • Calculate consumption per category components • Graphics: Consumption per category bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #3 Obtain the monthly water consumption of all the network sectors for one year	
Test case ID	**#3.1**
Test case description	Obtain the monthly water consumption of all the consumption categories out of all the network sectors of Barcelos supply system, for the time period between 01/01/09 and 31/12/09. The component to be calculated is the consumption per category. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • Consumption per category data filtered by time interval • Consumption per category data aggregated by temporal resolution • Calculate consumption per category components • Graphics: Consumption per category bar chart, time series chart • Security • Performance • Response time • Data resolution

Table 22 – Test cases for use case WU_UC02.1 Obtain real-time water balance

Test scenario #1 Obtain the system input, the authorised consumption, the water losses, the real losses and the apparent losses in a specific DMA for one month	
Test case ID	**#1.1**
Test case description	Obtain the daily water balance of DMA 1 from Barcelos supply system, for the time period between 01/06/09 and 08/06/09. The components to be calculated are the system input, the authorised consumption, the water losses, the real losses and the apparent losses. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related	• Parameter selection: time interval, temporal resolution and network sector

requirements that have to be met (F and NF) (as in T1.3)	• Graphic type selection: time series charts, bar charts • Water balance data filtered by time interval • Water balance data aggregated by temporal resolution • Calculate Water balance components • Graphics: Water balance bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain the system input, the authorised consumption, the water losses, the real losses and the apparent losses of all the DMAs for one day	
Test case ID	**#2.1**
Test case description	Obtain the hourly water balance of all the network sectors from Barcelos supply system, for the time period between 01/06/09 00:00 and 01/06/09 23:59. The components to be calculated are the system input, the authorised consumption, the water losses, the real losses and the apparent losses. The widget presents the bar chart and the time series graph.
Test case sequence of steps	• Log on to iWIDGET • Select data processing options ➢ select network sector ➢ select time period ➢ select temporal resolution • Visualize data • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • Water balance data filtered by time interval • Water balance data aggregated by temporal resolution • Calculate Water balance components • Graphics: Water balance bar chart, time series chart • Security • Performance • Response time • Data resolution

Test scenario #3 Obtain billed metered consumption and the unbilled metered consumption for a year	
Test case ID	**#3.1**
Test case description	Obtain the monthly water balance of all the network sectors from Barcelos supply system, for the time period between 01/01/09 00:00 and 31/12/09 23:59. The components to be calculated are the billed metered consumption and the unbilled metered consumption. The widget presents the bar chart and the time series graph.

Test case sequence of steps	• Log on to iWIDGET
	• Select data processing options
	  ➢ select network sector
	  ➢ select time period
	  ➢ select temporal resolution
	• Visualize data
	• Exit the application

Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Parameter selection: time interval, temporal resolution and network sector • Graphic type selection: time series charts, bar charts • Water balance data filtered by time interval • Water balance data aggregated by temporal resolution • Calculate Water balance components • Graphics: Water balance bar chart, time series chart • Security • Performance • Response time • Data resolution

Table 23 – Test cases for use case WU_UC02.2 Benchmark water losses against reference values

Test scenario #1 Obtain comparative information: Benchmark water losses against reference values	
Test case ID	**# 1.1**
Test case description	Perceive information on water losses through benchmarking
Test case sequence of steps	• Log on to iWIDGET using a password • Go to Water Analysis Tab • Select the option Water Balance • Select Network Sector • Select Temporal Resolution • Annual Billed • Select time interval • Press calculate • Check screen displayed • Print information • Exit
Tester profile required	Utility staff
Related requirements that have to be met (F and NF)	• Data about infrastructure shall be available for every DMA • External reference data shall be available for comparison • The system shall have selection menu for reference data • The system shall allow comparison to reference data

(as in T1.3)	• The system shall display tabular view of important KPIs (according to IWA) • The system shall display different KPIs in comparison (e.g. two DMAs etc.) in table form • The system shall display KPIs in bar charts • The system shall highlight KPIs according to reference values (e.g. better: green; similar: yellow; worse: red) • The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Table 24 – Test cases for use case WU_UC02.3 Obtain information on consumption profiling

Test scenario #1 Obtain information on consumption profiling	
Test case ID	**#1.1**
Test case description	Obtain information on consumption profiling and improve understanding about water demand
Test case sequence of steps	• Login the iWidget system • Go to Water Analysis Tab • Select Consumption Profiling • Select Network • Select Meter • Select Consumer ID • Select Time Series • Select Consumption Category • Select Scenario (weekday) • Select Co-variables • Select Time interval • Press calculate • Check the information displayed in the graph • Print the report, • Save data • Escape the application
Tester profile required	Network operation or utility strategic, tactical and operational planning staff
Related requirements that have to be met (F and NF) (as in T1.3)	• The system shall illustrate consumption patterns in time series • The system shall display characteristic variables (e.g. peak factors) • The system shall have selection menu for consumption scenario (e.g. night, work days, winter) • The system shall have selection menu for type of analysis (e.g. pattern, variable) • The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Table 25 – Test cases for use case WU_UC02.4 Obtain detailed information on operational inefficiency

Test scenario #1 Obtain detailed information on operational inefficiency	
Test case ID	**#1.1**
Test case description	Obtain detailed information on operational inefficiency to improve understanding about water losses components (real losses and apparent losses)
Test case sequence of steps	• Logon to iWidget • Go to Water Analysis • select Operational Inefficiency option • Select Network Sector • Select Time Series • Select Weekday Scenario • Select Time Interval • Press calculate • Check the information displayed for accuracy • Print the information • Save the information • Escape the application
Tester profile required	Network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• The system shall display characteristic variables (IWA) for water losses • The system shall display time series about water losses: real losses and apparent losses • The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Table 26 – Test cases for use case WU_UC03.1 Obtain information on energy consumption associated with pumping

Test scenario #1 Obtain energy consumption for a selection of: any chosen day, a price per day of €0.10, a pumping schedule of (1, 1, 1, 0) and DMA1	
Test case ID	**#1.1**
Test case description	Obtain the energy consumption for a given day, with a single price per day of €0.10, and the pump on in the first 18 hours of the day, for DMA1. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.

Test case sequence of steps	• Log on to iWIDGET
	• Select IBM Widget: 3.1
	• Select options:
	  ➢ **Day:** Any day
	  ➢ **DMA:** DMA1
	  ➢ **Energy Price:** Price per day of €0.10
	  ➢ **Pumps and Hours:** Pumping schedule of (1, 1, 1, 0)
	• Submit query
	• Visualize Results
	  ➢ Daily Energy Cost (in Euros)
	  ➢ Daily Power Consumption (in kWh)
	  ➢ Line Plot of Tank Levels

	• Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and pump details • Data describing the network can be stored in database • Data is processed and analysed to output information on energy consumption due to pumping • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain energy consumption for a selection of: any chosen day, a tariff price of (€0.05, €0.11, €0,09, €0.05), a pump schedule of (0, 0, 0, 0), and DMA2	
Test case ID	**#2.1**
Test case description	Obtain the energy consumption for a given day, with a tariff price of (€0.05, €0.11, €0,09, €0.05), and a pump schedule of (0, 0, 0, 0), for DMA2. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.

Test case sequence of steps	• Log on to iWIDGET
	• Select IBM Widget: 3.1
	• Select options:
	  ➢ **Day:** Any day
	  ➢ **DMA:** DMA2
	  ➢ **Energy Price:** Tariff price of (€0.05, €0.11, €0,09, €0.05)
	  ➢ **Pumps and Hours:** Pumping schedule of (0, 0, 0, 0)
	• Submit query
	• Visualize Results
	  ➢ Daily Energy Cost (in Euros)
	  ➢ Daily Power Consumption (in kWh)
	  ➢ Line Plot of Tank Levels
	• Exit the application

Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and pump details • Data describing the network can be stored in database • Data is processed and analysed to output information on energy consumption due to pumping • Security • Performance • Response time • Data resolution

Test scenario #3 Obtain energy consumption for a selection of: any chosen day, a price per day of €0.05, a

pump schedule of (0, 1, 0, 0), and DMA3	
Test case ID	**#3.1**
Test case description	Obtain the energy consumption for a given day, with a single price per day of €0.05, and the pump on in the first 9 hours of the day, for DMA3. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 3.1 • Select options: ➢ **Day:** Any day ➢ **DMA:** DMA3 ➢ **Energy Price:** Price per day of €0.05 ➢ **Pumps and Hours:** Pumping schedule of (0, 1, 0, 0) • Submit query • Visualize Results ➢ Daily Energy Cost (in Euros) ➢ Daily Power Consumption (in kWh) ➢ Line Plot of Tank Levels • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and pump details • Data describing the network can be stored in database • Data is processed and analysed to output information on energy consumption due to pumping • Security • Performance • Response time • Data resolution

Test scenario #4 Obtain energy consumption for a selection of: any chosen day, a tariff price of (€0.07, €0.09, €0.09, €0.10) and the pump schedule (0, 1, 0, 0), and DMA1	
Test case ID	**#4.1**
Test case description	Obtain the energy consumption for a given day, with a tariff price of (€0.07, €0.09, €0.09, €0.10), and pump schedule of (0, 1, 0, 0), for DMA1. Overall energy consumption and price is computed and the tank levels over the day are shown in a line plot.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 3.1 • Select options: ➢ **Day:** Any day ➢ **DMA:** DMA1 ➢ **Energy Price:** Tariff price of (€0.07, €0.09, €0.09, €0.10) ➢ **Pumps and Hours:** Pumping schedule of (0, 1, 0, 0) • Submit query • Visualize Results

	➢ Daily Energy Cost (in Euros) ➢ Daily Power Consumption (in kWh) ➢ Line Plot of Tank Levels • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and pump details • Data describing the network can be stored in database • Data is processed and analysed to output information on energy consumption due to pumping • Security • Performance • Response time • Data resolution

Table 27 – Test cases for use case WU_UC04.1 Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network

Test scenario #1 Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network	
Test case ID	**#1.1**
Test case description	Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network to improve the water utility response to network faults and unusual water consumptions
Test case sequence of steps	• Logon to iWidget • Go to Performance tab • Select Network Sector • Select Time Series • Select Meter Selection • Select Flow range • Select Consumer ID • Select meter type • Select Time Interval • Press calculate • Check the information displayed • Print the information • Save the information • Escape the application
Tester profile required	Network operation staff
Related requirements that have to be met (F and NF)	• The system shall forecast consumption • The system shall provide estimation of important KPIs (e.g. mean consumption) • The system shall detect anomalies (e.g. leakage) • The system shall display anomalies (e.g. leakage)

(as in T1.3)	• The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Table 28 – Test cases for use case WU_UC04.2 Receive warnings about the status and sizing adequacy of water meters

Test scenario #1 Receive warnings about the status and sizing adequacy of water meters	
Test case ID	**#1.1**
Test case description	Receive warnings about the status and sizing adequacy of water meters to improve water meter management and water utility response to meter faults
Test case sequence of steps	• Logon to iWidget • Go to Performance tab • Select Network Sector • Select Time Series • Select Meter Selection • Select Flow range • Select Consumer ID • Select meter type • Select Time Interval • Press calculate • Check the information displayed • Print the information • Save the information • Escape the application
Tester profile required	Network operation staff, network maintenance staff, customers
Related requirements that have to be met (F and NF) (as in T1.3)	• The system shall detect anomalies (e.g. leakage) • The system shall display anomalies (e.g. leakage) • The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Table 29 – Test cases for use case WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption

Test scenario #1 Obtain information on the effect of pressure control on leakage components and on consumption – Pressure Control tab	
Test case ID	**#1.1, #1.2, #1.3, #1.4, #1.5, #1.6, #1.7, #1.8**
Test case description	Obtain information on the effect of pressure control on leakage components and on consumption – Pressure Control
Test case sequence of steps	• Logon to iWidget • Go to Pressure Control • Select Network Sector • Select Time Series • Select Time Interval

	• Press calculate • Check the information displayed for accuracy • Escape the application
Tester profile required	Network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Fn.074-1: Select quantity to display as time series • Fn.073: Select parameter location • Fn.072: Select parameter temporal resolution • Fn.071: Select parameter time interval • Fn.074: Display as time series • Fn.111-1: Display pressure data for analysis • Fn.115: Output results in user interface • The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Test scenario #2 Obtain information on the effect of pressure control on leakage components and on consumption – DMA Analysis tab	
Test case ID	**#2.1, #2.2, #2.3, #2.4, #2.5, #2.6**
Test case description	Obtain information on the effect of pressure control on leakage components and on consumption – DMA Analysis
Test case sequence of steps	• Logon to iWidget • Go to DMA Analysis • Select Network Sector • Select Time Series • Select Time Interval • Press calculate • Check the information displayed for accuracy • Escape the application
Tester profile required	Network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Fn.074-1: Select quantity to display as time series • Fn.073: Select parameter location • Fn.072: Select parameter temporal resolution • Fn.071: Select parameter time interval • Fn110: Process pressure data • Fn.074: Display as time series • Fn.111-1: Display pressure data for analysis • Fn.115: Output results in user interface • The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Test scenario #3 Obtain information on the effect of pressure control on leakage components and on consumption – Campaigns tab

Test case ID	#3.1, #3.2, #3.3, #3.4
Test case description	Obtain information on the effect of pressure control on leakage components and on consumption – Campaigns
Test case sequence of steps	• Logon to iWidget • Go to Campaigns • Select Network Sector • Select Time Series • Select Time Interval • Select number of monitoring campaigns • Select start and end time for all campaigns • Press calculate • Check the information displayed for accuracy • Escape the application
Tester profile required	Network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Fn.074-1: Select quantity to display as time series • Fn.073: Select parameter location • Fn.072: Select parameter temporal resolution • Fn.109-2: Select number of monitoring campaigns to analyze • Fn109-1: Select data during monitoring campaigns • Fn107-1: Analyze monitoring campaign • Fn110: Process pressure data • Fn.074: Display as time series • Fn.111-1: Display pressure data for analysis • Fn.115: Output results in user interface • The system shall be responsive in displaying graphics • All data shall be available in a resolution of 15 minutes or better

Table 30 – Test cases for use case UC_WU04.4 Receive customized suggestions about pressure reducing valve (PRVs) settings

Test scenario #1 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 20, 6 periods per day, deterministic analytics, and DMA1	
Test case ID	**#1.1**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 20, 6 periods per day, and deterministic analytics, for DMA1.Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:** 20

	➢ **Periods Per day:** 6 ➢ **Analytics:** deterministic ➢ **DMA:** DMA1 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes ➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options • Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV settings • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #2 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 24, 4 periods per day, robust analytics with confidence interval of 90%, and DMA2	
Test case ID	**#2.1**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 24, 4 periods per day, and robust analytics with confidence interval 50%, for DMA2. Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:** 24 ➢ **Periods Per day:** 4 ➢ **Analytics:** robust, with confidence interval 50% ➢ **DMA:** DMA2 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes

	➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options • Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV settings • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #3 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 22, 2 periods per day, deterministic analytics and DMA3	
Test case ID	**#3.1**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 22, 2 periods per day, and deterministic analytics, for DMA3. Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:** 22 ➢ **Periods Per day:** 2 ➢ **Analytics:** deterministic ➢ **DMA:** DMA3 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes ➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF)	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options • Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV

(as in T1.3)	settings • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #4 Receive optimal pressure reducing valve settings for a selection of: any chosen day, minimum pressure of 20, 1 period per day, robust analytics with confidence interval of 70%, and DMA2	
Test case ID	**#4.4.4**
Test case description	Receive optimal pressure reducing valve settings for a given day, minimum pressure of 20, 1 period per day, and robust analytics with confidence interval 70%, for DMA2. Total pressure is calculated, optimal pressure setting of each pressure reducing valve is output, a line plot of the minimum pressure for each period of the day is shown, and a plot of the network with the valves is displayed.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Day:** Any day ➢ **Minimum Pressure:** 20 ➢ **Periods Per day:** 1 ➢ **Analytics:** robust, with confidence interval 70% ➢ **DMA:** DMA2 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Pressure settings for the PRVs over the day ➢ Line plot of minimum pressure over all nodes ➢ Drawing of the network with valves • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options • Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV settings • Utility presented with solution • Security • Performance • Response time • Data resolution

Table 31 – Test cases for use case UC_WU04.5 Receive customized suggestions about pumping scheduling

Test scenario #1 Receive optimal pumping schedules for a selection of: any chosen day, price per day of €0.10, and DMA1	
Test case ID	**#1.1**
Test case description	Receive optimal pumping schedules for a given day, price per day €0.10, for DMA1. Optimal pump schedule is output as a table and a line plot, and a line plot of the tank levels is shown.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.5 • Select options: ➢ **Day:** Any day ➢ **Energy Price:** Price per day of €0.10 ➢ **DMA:** DMA1 • Submit query • Visualize Results ➢ Table of pump schedule ➢ Line plot of tank levels ➢ Line plot of pump schedules • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and pump details • Utility uses GUI to allow them to select appropriate data and options • Utility requests pumping schedule is optimized • Input sent to optimization software and formulation and determine the optimal pumping schedule • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #2 Receive optimal pumping schedules for a selection of: any chosen day, tariff price of (€0.05, €0.14, €0.09, €0.05) and DMA2	
Test case ID	**#2.1**
Test case description	Receive optimal pumping schedules for a given day, tariff price of (€0.05, €0.14, €0.09, €0.05), for DMA2. Optimal pump schedule is output as a table and a line plot, and a line plot of the tank levels is shown.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.5 • Select options: ➢ **Day:** Any day

	➢ **Energy Price:** Tariff price of (€0.05, €0.14, €0.09, €0.05) ➢ **DMA:** DMA2 • Submit query • Visualize Results ➢ Table of pump schedule ➢ Line plot of tank levels ➢ Line plot of pump schedules • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and pump details • Utility uses GUI to allow them to select appropriate data and options • Utility requests pumping schedule is optimized • Input sent to optimization software and formulation and determine the optimal pumping schedule • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #3 Receive optimal pumping schedules for a selection of: any chosen day, price per day of €0.07 and DMA3	
Test case ID	**#3.1**
Test case description	Receive optimal pumping schedules for a given day, price per day €0.07, for DMA3. Optimal pump schedule is output as a table and a line plot, and a line plot of the tank levels is shown.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.5 • Select options: ➢ **Day:** Any day ➢ **Energy Price:** Price per day of €0.07 ➢ **DMA:** DMA3 • Submit query • Visualize Results ➢ Table of pump schedule ➢ Line plot of tank levels ➢ Line plot of pump schedules • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be	• Utility can provide input data on network and pump details • Utility uses GUI to allow them to select appropriate data and options • Utility requests pumping schedule is optimized

met (F and NF) (as in T1.3)	• Input sent to optimization software and formulation and determine the optimal pumping schedule • Utility presented with solution • Security • Performance • Response time • Data resolution

Table 32 – Test cases for use case use case WU_UC5.1 Receive information to make billing more accurate and flexible

Test scenario #1 Obtain billing information for a selection of: any chosen smart meter device ID, a flat-rate water price per cubic meter of €2.05, any chosen date range, and each of the four available display methods	
Test case ID	**#1.1**
Test case description	Obtain water consumption and billing information about a smart meter device with a flat-rate water price of €2.05 per cubic meter, any chosen date range, and each of the available display methods.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 5.1 • Select options: ➢ **Device:** Any available device ➢ **Price Information:** Flat-rate price of €2.05 per cubic meter ➢ **Date Range:** Any date range ➢ **Display Results:** Volume time series • Visualize Results ➢ Time series of cumulative volume used in cubic meters ➢ Minimum volume reading, maximum volume reading, total volume consumed in the selected date range, and total price. • Change options: ➢ **Display Results:** Flow time series • Visualize Results ➢ Time series of water usage flow rates in cubic meters per second. ➢ Summary table including the total price of water per time period. • Change options: ➢ **Display Results:** Pie chart: volume • Visualize Results ➢ Pie chart of water prices. ➢ Minimum volume reading, maximum volume reading, total volume consumed in the selected date range, and total price. ➢ Summary table with the total price of water per time period. • Change options: ➢ **Display Results:** Summary table • Visualize Results ➢ Minimum volume reading, maximum volume reading, total volume

	consumed in the selected date range, and total price. ➢ Summary table including the total price of water per time period. • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Data is processed and analysed to output information on pricing. • Security • Performance • Response time • Data resolution

Test scenario #2 Obtain billing information for a selection of: any chosen smart meter device ID, a tariff price of (€2.05, €2.55, €2,75, €2.40), any chosen date range, and each of the four available display methods.	
Test case ID	**#2.1**
Test case description	Obtain the billing information for a given smart meter with a variable tariff price of (€2.05, €2.55, €2,75, €2.40) per cubic meter, a range of dates and each of the available display methods.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 5.1 • Select options: ➢ **Device:** Any available device ➢ **Price Information:** Tariff price of (€2.05, €2.55, €2.75, €3.40) per cubic meter ➢ **Date Range:** Any date range ➢ **Display Results:** Volume time series • Visualize Results ➢ Time series of cumulative volume used in cubic meters ➢ Minimum volume reading, maximum volume reading, total volume consumed in the selected date range, and total price. • Change options: ➢ **Display Results:** Flow time series • Visualize Results ➢ Time series of water usage flow rates in cubic meters per second. ➢ Summary table including the total price of water per time period. • Change options: ➢ **Display Results:** Pie chart: volume • Visualize Results ➢ Pie chart of water prices. ➢ Minimum volume reading, maximum volume reading, total volume consumed in the selected date range, and total price. ➢ Summary table with the total price of water per time period. • Change options: ➢ **Display Results:** Summary table

	• Visualize Results ➢ Minimum volume reading, maximum volume reading, total volume consumed in the selected date range, and total price. ➢ Summary table including the total price of water per time period. • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Data is processed and analysed to output information on pricing. • Security • Performance • Response time • Data resolution

Table 33 – Test cases for use case WU_UC05.2 Receive information to improve the management of complaints

Test scenario #1 Receive information to improve the management of complaints	
Test case ID	**#1.1, #1.2**
Test case description	For a specific client, receive information about active problems in the network on a given date that it might be being affected by.
Test case sequence of steps	• Log on to iWIDGET • Select LNEC widgets • Go to tab "WU_UC05.2 Complaints" • Select options: ➢ **Client ID** ➢ **Date** • Press the "calculate" button • Visualize Results ➢ Message of with active newtork issues that might be affecting the client • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Dfn.012: Water consumption data • Dfn.013: Network data • Nfn.008: Billing data • Fn.141: Send request for repair • Fn.143: Send complaint-relevant data • Fn.145: Diagnose complaint cause • Swiftness • Data accountability

Table 34 – Test cases for use case WU_UC05.3 Receive information to provide warnings to consumers

Test scenario #1 Receive information to provide warnings for a given network sector, time interval and tolerance	
Test case ID	**#1.1, #1.2**
Test case description	Receive a list of active warnings of possibly leaking devices for a given network sector and time interval, within a fixed tolerance value.
Test case sequence of steps	• Log on to iWIDGET • Select LNEC widgets • Go to tab "WU_UC05.3 Warnings" • Select options: ➢ **Network sector** ➢ **Tolerance** ➢ **Time interval** • Press the "calculate" button • Visualize Results ➢ Table of possibly leaking devices and associated information • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Dfn.014: Water consumption data • Dfn.015: Reference values database • Dfn.017 Analyze consumption data • Fn.147 Identify abnormal consumption patterns • Reliability • Response time • Data resolution

Table 35 – Test cases for use case WU_UC06.1 Receive customized suggestions about adaptive pricing schemes

Test scenario #1 Receive dynamic pricing suggestions for a selection of: the residential category, the Time of Use billing program, any chosen date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.	
Test case ID	**#1.1**
Test case description	Receive dynamic pricing suggestions for the time of use billing program, any chose date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 6.1 • Select options: ➢ **Consumption Category:** Residential ➢ **Billing Program:** Time of use ➢ **Time Period:** Any start and end dates ➢ **Select Devices:** Any selection of devices from DMAs 1, 2 or 3 ➢ **Current Unit Price:** A price per cubic meter for water in the weekdays

	(€2.35) and in the weekends (€2.1). • Submit query • Visualize Results ➢ Demand averages in cubic meters per second (chart) ➢ Pricing schedule in EUR (chart) ➢ Peak consumption information (table) • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Data is processed and analysed to output information on dynamic pricing. • Security • Performance • Response time • Data resolution

Test scenario #2 Receive dynamic pricing suggestions for a selection of: the residential category, the Peak Time Rebate billing program, any chosen date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.	
Test case ID	**#2.1**
Test case description	Receive dynamic pricing suggestions for the peak time rebate billing program, any chose date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 6.1 • Select options: ➢ **Consumption Category:** Residential ➢ **Billing Program:** Peak time rebate ➢ **Time Period:** Any start and end dates ➢ **Select Devices:** Any selection of devices from DMAs 1, 2 or 3 ➢ **Current Unit Price:** A price per cubic meter for water in the weekdays (€2.35) and in the weekends (€2.1). • Submit query • Visualize Results ➢ Monthly consumption chart, including peak-time, total, and forecasts. ➢ Rebate and consumption information table. • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Data is processed and analysed to output information on dynamic pricing. • Security • Performance • Response time • Data resolution

Test scenario #3 Receive dynamic pricing suggestions for a selection of: the residential category, the Seasonal Use billing program, any chosen date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.	
Test case ID	**#3.1**
Test case description	Receive dynamic pricing suggestions for the seasonal use billing program, any chose date range, any selection of devices from DMAs 1, 2 or 3, a weekend water unit price of €2.1, and a weekday water unit price of €2.35.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 6.1 • Select options: ➢ **Consumption Category:** Residential ➢ **Billing Program:** Seasonal use ➢ **Time Period:** Any start and end dates ➢ **Select Devices:** Any selection of devices from DMAs 1, 2 or 3 ➢ **Current Unit Price:** A price per cubic meter for water in the weekdays (€2.35) and in the weekends (€2.1). • Submit query • Visualize Results ➢ Quarterly water usage volumes chart ➢ Seasonal information and pricing suggestion (table) • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Data is processed and analysed to output information on dynamic pricing. • Security • Performance • Response time • Data resolution

Table 36 – Test cases for use case WU_UC06.2 Receive customized suggestions about awareness campaigns

Test scenario #1 Obtain comparative information: comparative data and statistics concerning the percentage of total water aware households	
Test case ID	**#1.1**
Test case description	Obtain comparative data and statistics concerning the percentage of total water aware households
Test case sequence of steps	• Log on to iWIDGET using a password • Select the option related to the effects of awareness raising campaigns (Fn. 125) • Select the type of the awareness raising campaign (low, medium, high effect) (Fn. 128) • Select the time of initiation of the campaign and its running period (Fn. 129) • Select the time of price changes (Fn. 130) • Select the type of price changes (Fn. 130)

	• iWIDGET calculates the results (run scenarios) (Fn. 131) • iWIDGET displays the results of different scenarios (Fn. 132) • Print Information
Tester profile required	Utility public relations and communication staff, consumers
Related requirements that have to be met (F and NF) (as in T1.3)	• Request scheduling • Select time period • Develop scenarios • Run scenarios • Print • Security • Performance • Response time

Table 37 – Test cases for use case WU_UC07.2 Get support to decision-making on water network expansions

Test scenario #1 Get support to decision-making on water network expansions	
Test case ID	**#1.1, #1.2, #1.3**
Test case description	Get support to decision-making on water network expansions for different custom-built scenarios
Test case sequence of steps	• Log on to iWIDGET • Go to LNEC widgets and choose tab "WU-UC07.2 – Network Expansions" • Browe and upload .inp file with network information • Define consumption scenarios by selecting "Change demand" value or specifying a range of demand change values • Select values for scenario evaluation parameters minimum pressure, maximum pressure and reference velocity • Browse and upload .pat file with consumption pattern obtained from previous UC • Calculate scenarios • Visualize output • Exit the application
Tester profile required	Water utility network staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Allow data input • Select scenarios • Calculate network alternatives • Report alternatives • Response time • Data resolution

Table 38 – Test cases for use case WU_UC07.3 Obtain information to support optimal equipment replacement scheduling

Test scenario #1 Receive a suggested replacement time for a smart meter for a selection of: any chosen residential smart meter ID, a meter age in years between 1 and 15, a linear deterioration rate, a marginal cost of non-revenue water between €1 and €10, an annual growth rate of the marginal cost between 1% and 3%, and the cost of capital between 5% and 10%.	
Test case ID	**#1.1**
Test case description	Receive a suggested replacement time for a selected smart meter with a certain age in years between 1 and 15, a linear deterioration rate, a marginal cost of non-revenue water between €1 and €10, an annual growth rate of the marginal cost between 1% and 3%, and the cost of capital between 5% and 10%.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.3 • Select options: ➢ **Residential Meter:** Any meter ➢ **Meter's Age in Years:** A value between 1 and 15 ➢ **Deterioration Rate:** Linear ➢ **Marginal Cost of Non-Revenue Water (€/m3):** Value between 1 and 10 ➢ **Annual Growth Rate Marginal Cost:** Value between 1 and 3% ➢ **Cost of Capital:** Value between 5 and 10%. • Submit query • Visualize Results ➢ Suggested time of replacement in years • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on equipment deterioration • Utility uses GUI to allow them to select appropriate data and options • Utility requests time of replacement • Input sent to analytical software to perform calculations • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #2 Receive a suggested replacement time for a smart meter for a selection of: any chosen residential smart meter ID, a meter age in years between 1 and 15, a sigmoid deterioration rate, a marginal cost of non-revenue water between €1 and €10, an annual growth rate of the marginal cost between 1% and 3%, and the cost of capital between 5% and 10%.	
Test case ID	**#2.1**
Test case description	Receive a suggested replacement time for a selected smart meter with a certain age in years between 1 and 15, a sigmoid deterioration rate, a marginal cost of non-revenue water between €1 and €10, an annual growth rate of the marginal cost between 1% and 3%, and the cost of capital between 5% and 10%.
Test case	• Log on to iWIDGET

sequence of steps	• Select IBM Widget: 7.3 • Select options: ➢ **Residential Meter:** Any meter ➢ **Meter's Age in Years:** A value between 1 and 15 ➢ **Deterioration Rate:** Sigmoid ➢ **Marginal Cost of Non-Revenue Water (€/m3):** Value between 1 and 10 ➢ **Annual Growth Rate Marginal Cost:** Value between 1 and 3% ➢ **Cost of Capital:** Value between 5 and 10%. • Submit query • Visualize Results ➢ Suggested time of replacement in years. • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on equipment deterioration • Utility uses GUI to allow them to select appropriate data and options • Utility requests time of replacement • Input sent to analytical software to perform calculations • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #3 Receive a suggested replacement time for a pump for a selection of: any selected start date, DMA 1, 2 or 3, a tariff price of (0.11, 0.21, 0.27, 0.18), an on-off pump schedule of (1, 1, 0, 1), an available deterioration curve, an electricity cost growth between 1 and 5%, and a yearly capital cost of €4,200.	
Test case ID	**#3.1**
Test case description	Receive a suggested replacement time for a selected pump for a given start date and a selection of DMA 1, 2 or 3, a tariff price of (0.11, 0.21, 0.27, 0.18), an on-off pump schedule of (on, on, off, on), an available deterioration curve, an electricity cost growth between 1 and 5%, and a yearly capital cost of €4,200.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 4.4 • Select options: ➢ **Start Date:** Any date ➢ **DMA:** DMA 1, 2 or 3 ➢ **Energy Price:** Set the tariff price equal to (0.11, 0.21, 0.27, 0.18) ➢ **Times Where the Pump is On and Off:** Set to (1, 1, 0, 1) ➢ **Pump Efficiency Deterioration Curve:** Select PumpDeterioration ➢ **Annual Percent Rise of Electricity Cost:** Value between 1 and 5% ➢ **Capital Cost:** Value of €4,200 • Submit query • Visualize Results

	➢ Suggested replacement time in years. • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on equipment deterioration • Utility uses GUI to allow them to select appropriate data and options • Utility requests time of replacement • Input sent to analytical software to perform calculations • Utility presented with solution • Security • Performance • Response time • Data resolution

Table 39 Test cases for use case UC_WU07.4 Determine optimal placement of valves and flow meters on pipes in the network

Test scenario #1 Receive optimal valve placement for a selection of: any chosen day, time of day 08:00, minimum pressure 20, 2 valves, deterministic analytics, and DMA1	
Test case ID	**#1.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 20, 2 valves, and deterministic analytics, for DMA1. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 08:00-09:00 ➢ **Minimum Pressure:** 20 ➢ **Number of valves:** 2 ➢ **Analytics:** deterministic ➢ **DMA:** DMA1 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options

met (F and NF) (as in T1.3)	• Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV settings • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #2 Receive optimal valve placement for a selection of: any chosen day, time of day 12:00, minimum pressure 22, 2 valves, robust analytics with confidence interval of 80%, and DMA2	
Test case ID	**#2.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 22, 2 valves, and robust analytics with confidence interval of 80%, for DMA2. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 12:00-13:00 ➢ **Minimum Pressure:** 22 ➢ **Number of valves:** 2 ➢ **Analytics:** robust, with confidence interval 80% ➢ **DMA:** DMA2 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options • Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV settings • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #3 Receive optimal valve placement for a selection of: any chosen day, time of day 16:00, minimum pressure 20, 3 valves, deterministic analytics, and DMA3	
Test case ID	**#3.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 20, 3 valves, and deterministic analytics, for DMA3. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.
Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 16:00-17:00 ➢ **Minimum Pressure:** 20 ➢ **Number of valves:** 3 ➢ **Analytics:** deterministic ➢ **DMA:** DMA3 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options • Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV settings • Utility presented with solution • Security • Performance • Response time • Data resolution

Test scenario #4 Receive optimal valve placement for a selection of: any chosen day, time of day 20:00, minimum pressure 22, 1 valve, robust analytics with confidence interval of 50%, and DMA1	
Test case ID	**#4.1**
Test case description	Receive optimal pressure reducing valve placement for a given day, minimum pressure of 22, 1 valves, and robust analytics with confidence interval of 50%, for DMA1. Total pressure is calculated, optimal placement of each pressure reducing valve is output, and a line plot of the pressure vs. elevation at each node is shown,.

Test case sequence of steps	• Log on to iWIDGET • Select IBM Widget: 7.4 • Select options: ➢ **Day:** Any day ➢ **Time of day:** 20:00-21:00 ➢ **Minimum Pressure:** 22 ➢ **Number of valves:** 1 ➢ **Analytics:** robust, with confidence interval of 50% ➢ **DMA:** DMA1 • Submit query • Visualize Results ➢ Total Pressure over all demand nodes ➢ Optimal placement of PRVs ➢ Line plot of pressure vs. elevation of all demand nodes ➢ Drawing of the network with valve placements • Exit the application
Tester profile required	• Water utility network operation staff
Related requirements that have to be met (F and NF) (as in T1.3)	• Utility can provide input data on network and valve details • Utility uses GUI to allow them to select appropriate data and options • Utility requests PRV settings are optimized • Input sent to optimization software and formulation and determine the optimal PRV settings • Utility presented with solution • Security • Performance • Response time • Data resolution

7 Definition of success criteria and performance indicators

Success criteria are criteria defined for determining whether an observed behaviour of the product is or is not correct. For each requirement, one success criteria was defined.

Key performance indicators (KPI) are metrics to assess the achievement of success criteria. Quantifiable KPI are more used for non-functional requirements than for functional requirements. For functional requirements, success was evaluated with a qualitative classification: pass/fail. In addition, sometimes it was not only a matter of pass/fail and testers provided qualitative feedback about their testing session.

Sections 7.1, 7.2 and 7.3 present success criteria and performance indicators for the test cases previously defined. Success criteria, performance indicators and targets are related to requirements (Task 1.3).

7.1 Success criteria and performance indicators for functional testing – consumer domain

Table 40 to Table 74 present the success criteria and performance indicators associated with test cases for the water utility domain.

Table 40 – Success criteria and performance indicators for use case C_UC01.1 Obtain total water consumption and costs using real-time data

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption	(FR) Request information (Fn. 001)	Successful request of information	Pass/fail
			3. Select a day from a calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of time period	Pass/fail
			4. Select 15-minutes resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of temporal resolution	Pass/fail
			5. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			6. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			7. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail

			8. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			9. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select hourly resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			6. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			7. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			8. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			9. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select monthly resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. Select "monthly water consumption" from unit list	(FR) Select units (Fn. 011)	Successful selection of units	Pass/Fail
			6. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			7. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail

			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			10. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#4	#4.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select "daily" resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. Select "daily water consumption" from unit list	(FR) Select units (Fn. 011)	Successful selection of units	Pass/Fail
			6. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			7. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			10. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#5	#5.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select "daily" resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. Select "daily water consumption per capita" from unit list	(FR) Select units (Fn. 011)	Successful selection of units	Pass/Fail
			6. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			7. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail

			8. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			10. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#6	#6.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from a calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select "monthly" resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. Select "monthly water consumption" from unit list	(FR) Select units (Fn. 011)	Successful selection of units	Pass/Fail
			6. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			7. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			10. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#7	#7.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from a calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select "monthly" resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. Select "monthly cost" from unit list	(FR) Select units (Fn. 011)	Successful selection of units	Pass/Fail
			6. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			7. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail

			8. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			10. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#8	#8.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from a calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select "hourly" resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			6. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			7. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			8. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			9. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC01.1 Obtain total water consumption and costs using real-time data	#9	#9.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of water consumption details	(FR) Request information (Fn. 001)	Successful selection of information	Pass/fail
			3. Select a day from a calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of option	Pass/fail
			4. Select "monthly" resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of option	Pass/fail
			5. Select "monthly water consumption" from unit list	(FR) Select units (Fn. 011)	Successful selection of units	Pass/Fail
			6. iWIDGET platform obtains data from the database	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/Fail
			7. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail

			8. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			10. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Table 41 – Success criteria and performance indicators for use case C_UC1.2 Obtain per appliance water consumption and costs (total water consumption breakdown) using real-time data from smart meters

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
Use Case C_UC01.2: Obtain per appliance water consumption and costs (total water consumption breakdown) using real-time data from smart meters	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the information on per appliance water consumption	(FR) Request breakdown information (Fn. 012)	Successful request	Pass/fail
			3. Select a month and a year from the calendar (October 2014)	(FR) Select time period (Fn. 007)	Successful selection of period	Pass/fail
			4. iWIDGET obtains data	(FR) Obtain data (Fn. 003)	Successful data retrieve	Pass/fail
			5. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			6. iWIDGET presents the results	(FR) Display information (Fn. 005)	Successful display of time series	Pass/fail
			7. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Table 42 – Success criteria and performance indicators for use case C_UC2.1: Obtain total energy consumption and costs associated with water consumption using real-time data from smart meters

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
Use Case C_UC02.1: Obtain total energy consumption and costs associated with water consumption using real-time data from smart meters	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of energy consumption	(FR) Request info on energy consumption (Fn. 016)	Successful request of information	Pass/fail
			3. Select a day from a calendar (7 January 2009)	(FR) Select time period (Fn. 007)	Successful selection of time period	Pass/fail
			4. Select 15-minutes resolution from a options list	(FR) Select temporal resolution (Fn. 008)	Successful selection of temporal resolution	Pass/fail
			5. iWIDGET platform obtains data from the database	(FR) Obtain energy data (Fn. 018)	Successful data retrieve	Pass/Fail
			6. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			7. iWIDGET presents a time series graph and a report	(FR) Display information (Fn. 005)	Correct display of results	Pass/fail
			8. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail
			9. Download data	(FR) Download information (Fn. 006)	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
Use Case C_UC02.1: Obtain total energy consumption and costs associated with water consumption using real-time data from smart meters	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of energy consumption	(FR) Request info on energy consumption (Fn. 016)	Successful request	Pass/fail
			3. Select a month and a year from the calendar (October 2014)	(FR) Select time period (Fn. 007)	Successful selection of period	Pass/fail
			3. iWIDGET obtains data	(FR) Obtain energy data (Fn. 018)	Successful data retrieve	Pass/fail
			4. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			5. iWIDGET presents the amount of energy consumption related to water in the form of pie chart and summary report	(FR) Display information (Fn. 005)	Successful display of information	Pass/fail
			6. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Table 43 – Success criteria and performance indicators for use case C_UC2.2: Obtain per appliance energy consumption and costs associated with water consumption using real-time data from smart meters

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
Use Case C_UC02.2: Obtain per appliance energy consumption and costs associated with water consumption using real-time data from smart meters	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the information on per appliance energy consumption	(FR) Request info on breakdown of energy consumption (Fn. 019)	Successful request	Pass/fail
			3. Select a month and a year from the calendar (October 2014)	(FR) Select time period (Fn. 007)	Successful selection of period	Pass/fail
			4. iWIDGET obtains data	(FR) Obtain energy data (Fn. 018)	Successful data retrieve	Pass/fail
			5. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			6. iWIDGET presents the results	(FR) Display information (Fn.	Successful display of time series	Pass/fail

				005)		
			7. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Table 44 – Success criteria and performance indicators for use case C_UC2.3: Display carbon emissions related to water consumption (carbon footprint for water)

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
Use Case C_UC02.3: Display carbon emissions related to water consumption (carbon footprint for water)	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the information on carbon emissions related to water and energy uses	(FR) Request info on energy consumption (Fn. 016)	Successful request	Pass/fail
			3. iWIDGET obtains data	(FR) Obtain consumer data (Fn. 021)	Successful data retrieve	Pass/fail
			4. iWIDGET calculates the result	(FR) Execute calculations (Fn. 002)	Correct result is calculated	Pass/fail
			5. iWIDGET presents the results	(FR) Display information (Fn. 005)	Successful display of time series	Pass/fail
			6. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Table 45 – Success criteria and performance indicators for use case C_UC03.1 Compare current water use pattern with historical consumption data of the same household

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.1 Compare current water use pattern with historical consumption data of the same household	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status ("homepage of the platform)	(FR) Request comparative information (Fn. 024)	Successful request	Pass/fail
			3. iWIDGET obtains data	(FR) Obtain consumer data (Fn. 021)	Successful data retrieve	Pass/fail
			4. iWIDGET calculates the result	(FR) Calculate comparative data (Fn. 025)	Correct result is calculated	Pass/fail
			5. iWIDGET presents time series graphs and a report	(FR) Display comparative data (Fn. 022)	Successful display of time series	Pass/fail

			6. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.1 Compare current water use pattern with historical consumption data of the same household	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status ("homepage of the platform)	(FR) Request comparative information (Fn. 024)	Successful request	Pass/fail
			3. Select daily data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time resolution	Pass/Fail
			4. Select last 7 days as time-period	(FR) Select time-period of consumer data (Fn. 020)	Successful selection of time period	Pass/Fail
			5. Select "total" as data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time period	Pass/Fail
			6. iWIDGET obtains data	(FR) Obtain consumer data (Fn. 021)	Successful data retrieve	Pass/fail
			7. iWIDGET calculates the result	(FR) Calculate comparative data (Fn. 025)	Correct result is calculated	Pass/fail
			8. iWIDGET presents time series graphs and a report	(FR) Display comparative data (Fn. 022)	Successful display of time series	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.1 Compare current water use pattern with historical consumption data of the same household	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status ("homepage of the platform)	(FR) Request comparative information (Fn. 024)	Successful request	Pass/fail
			3. Select monthly data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time resolution	Pass/Fail
			4. Select last 12 months as time-period	(FR) Select time-period of consumer data (Fn. 020)	Successful selection of time period	Pass/Fail
			5. Select "total" as data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time period	Pass/Fail
			6. iWIDGET obtains data	(FR) Obtain consumer data (Fn. 021)	Successful data retrieve	Pass/fail
			7. iWIDGET calculates the result	(FR) Calculate comparative data (Fn. 025)	Correct result is calculated	Pass/fail
			8. iWIDGET presents time series graphs and a report	(FR) Display comparative data (Fn. 022)	Successful display of time series	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.1 Compare current water use pattern with historical consumption data of the same household	#4	#4.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status ("homepage of the platform)	(FR) Request comparative information (Fn. 024)	Successful request	Pass/fail
			3. Select daily data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time resolution	Pass/Fail
			4. Select last month as time-period	(FR) Select time-period of consumer data (Fn. 020)	Successful selection of time period	Pass/Fail
			5. Select "day/night" as data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time period	Pass/Fail
			6. iWIDGET obtains data	(FR) Obtain consumer data (Fn. 021)	Successful data retrieve	Pass/fail
			7. iWIDGET calculates the result	(FR) Calculate comparative data (Fn. 025)	Correct result is calculated	Pass/fail
			8. iWIDGET presents time series graphs and a report	(FR) Display comparative data (Fn. 022)	Successful display of time series	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.1 Compare current water use pattern with historical consumption data of the same household	#5	#5.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status ("homepage of the platform)	(FR) Request comparative information (Fn. 024)	Successful request	Pass/fail
			3. Select daily data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time resolution	Pass/Fail
			4. Select two different time periods	(FR) Select time-period of consumer data (Fn. 020)	Successful selection of time period	Pass/Fail
			5. Select "day/night" as data resolution	(FR) Select resolution of consumer data (Fn. 023)	Successful selection of time period	Pass/Fail
			6. iWIDGET obtains data	(FR) Obtain consumer data (Fn. 021)	Successful data retrieve	Pass/fail
			7. iWIDGET calculates the result	(FR) Calculate comparative data (Fn. 025)	Correct result is calculated	Pass/fail
			8. iWIDGET presents time series graphs and a report	(FR) Display comparative data (Fn. 022)	Successful display of time series	Pass/fail
			9. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Table 46 – Success criteria and performance indicators for use case C_UC03.2 Compare water consumption with other consumers (e.g. neighbour, in the same building or street)

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.2 Compare water consumption with other consumers (e.g. neighbour, in the same building or street)	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status	(FR) Request information	Successful selection of information	Pass/fail
			3. iWIDGET calculates the result	(FR) Calculate comparative data	Correct result is calculated	Pass/fail
			4. iWIDGET presents time series graphs and a report	(FR) Display comparative data	Correct display of results	Pass/fail
			5. iWIDGET presents time series graphs and a report	(FR) Comparison with a group and computation of relative performance	Correct display of results	Pass/fail
			6. iWIDGET presents time series graphs and a report	(FR) Display of injunctive norm feedback to the consumer	Correct display of results	Pass/fail
			7. Print the report	(FR) Print	Successful print of report	Pass/fail
			8. Save data	(FR) Download	Successful data saving	Pass/fail

Table 47 – Success criteria and performance indicators for use case C_UC03.3 Compare water consumption with standard profiles

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.3Compare water consumption with standard profiles	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status	(FR) Request information	Successful selection of information	Pass/fail
			3. iWIDGET calculates the result	(FR) Calculate comparative data	Correct result is calculated	Pass/fail
			4. iWIDGET presents time series graphs and a report	(FR) Display comparative data	Correct display of results	Pass/fail
			5. iWIDGET presents time series graphs and a report	(FR) Comparison with a group and computation of relative performance	Correct display of results	Pass/fail
			6. iWIDGET presents time series graphs and a report	(FR) Display of injunctive norm feedback to the	Correct display of results	Pass/fail

				consumer		
			7. Print the report	(FR) Print	Successful print of report	Pass/fail
			8. Save data	(FR) Download	Successful data saving	Pass/fail

Table 48 – Success criteria and performance indicators for use case C_UC03.4 Compare household water consumption with most efficient users

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.4: Compare household water consumption with most efficient users	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the visualization of the current status	(FR) Request information	Successful selection of information	Pass/fail
			3. iWIDGET calculates the result	(FR) Calculate comparative data	Correct result is calculated	Pass/fail
			4. iWIDGET presents time series graphs and a report	(FR) Display comparative data	Correct display of results	Pass/fail
			5. iWIDGET presents time series graphs and a report	(FR) Comparison with a group and computation of relative performance	Correct display of results	Pass/fail
			6. iWIDGET presents time series graphs and a report	(FR) Display of injunctive norm feedback to the consumer	Correct display of results	Pass/fail
			7. Print the report	(FR) Print	Successful print of report	Pass/fail
			8. Save data	(FR) Download	Successful data saving	Pass/fail

Table 49 – Success criteria and performance indicators for use case C_UC03.5 Obtain information on inefficient water uses

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC03.5 Obtain information on inefficient water uses	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. iWIDGET presents a hyperlink to the iWIDGET eLearning platform named "Be smart with water in the house"	(FR) Display hyperlink (not defined in the initial list of system requirements)	Successful display of hyperlink	Pass/fail
			3. Request access to the eLearning platform	(FR) Request access (not defined in the initial list of system requirements)	Successful request	Pass/fail
			4. iWIDGET opens a new tab with the eLearning platform	(FR) Display the eLearning platform (not defined in the initial list of system requirements)	Successful display	Pass/fail
			5. Log on to iWIDGET eLearning platform	(FR) Logon (not defined in the initial list of system requirements)	Successful logon without errors	Pass/fail
			6. Request information on inefficient water uses through Water Calculator	(FR) Request suggestions (not defined in the initial list of system requirements)	Successful request	Pass/fail
			7. Specify input parameters	(FR) Obtain data (Fn. 029)	Successful parameter specification	Pass/Fail
			8. iWIDGET eLearning platform analyses data and retrieves warnings	(FR) Analyse data (Fn. 032 – Fn. 030)	Successful analysis of data	Pass/Fail
			9. iWIDGET eLearning platform displays results and warnings	(FR) Display warnings (Fn. 031)	Successful display	Pass/fail

Table 50 – Success criteria and performance indicators for use case C_UC 3.6 Receive warnings about faults (leakages, bursts) and unusual water consumptions

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
Use Case C_UC03.6: Receive warnings about faults (leakages, bursts) and unusual water consumptions	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to information on unusual water consumption events	(FR) Request information (not defined in the initial list of system requirements)	Successful request	Pass/fail
			3. iWIDGET obtains data	(FR) Obtain data (Fn. 029)	Successful data retrieve	Pass/fail
			4. iWIDGET calculates the result	(FR) Analyse data (Fn. 032)	Correct result is calculated	Pass/fail
			5. iWIDGET retrieves warnings	(FR) Retrieve warnings (unusual consumption) (Fn. 035)	Successful retrieve of warnings	Pass/fail
			6. iWIDGET displays warnings	(FR) Display warnings (fault and unusual consumption) (Fn. 036)	Successful display of warnings	Pass/Fail
			7. Delete warning	(FR) Allow cancelation of warnings (Fn. 034)	Successful cancelation of warnings	Pass/Fail
			8. Print the report	(FR) Print (Fn. 010)	Successful print of report	Pass/fail

Table 51 – Success criteria and performance indicators for use case C_UC0 4.1&5.4 Compare energy pattern associated with water use in the same household; Forecast the component of next energy bill associated with water consumption

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC 4.1 Compare energy pattern; C_UC 5.4 Forecast the component of next energy bill	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select time-period of consumer data (energy use)	(FR) Request information	Successful selection of information	Pass/fail
			3. iWIDGET displays consumer data and energy consumption	(FR) Display data	Correct display of results	Pass/fail
			4. Input energy tariff information	(FR) Request information	Correct input of data	Pass/fail
			5. Select forecast time-period	(FR) Request information	Successful selection of information	Pass/fail
			6. iWIDGET presents time series graphs and a report on energy cost	(FR) Display data	Correct display of results	Pass/fail
			7. iWIDGET presents time series graphs and a report on water cost	(FR) Display data	Correct display of results	Pass/fail
			8. Print the report	(FR) Print	Successful print of report	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Table 52 – Success criteria and performance indicators for use case C_UC05.1 Receive customised suggestions (practices and interventions) on how to reduce water consumption

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC05.1 Receive customised suggestions (practices and interventions) on how to reduce water consumption	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. iWIDGET presents a hyperlink to the iWIDGET eLearning platform named "Be smart with water in the house"	(FR) Display hyperlink (not defined in the initial list of system requirements)	Successful display	Pass/fail
			3. Request access to the eLearning platform	(FR) Request access (not defined in the initial list of system requirements)	Successful request	Pass/fail
			4. iWIDGET opens a new tab with the eLearning platform	(FR) Display the eLearning platform (not defined in the initial list of system requirements)	Successful display	Pass/fail
			5. Log on to iWIDGET eLearning platform	(FR) Logon (not defined in the initial list of system requirements)	Successful logon without errors	Pass/fail
			6. Request general information on improving water efficiency using "Tips and Practices through virtual application" application	(FR) Request general suggestions (Fn. 039)	Successful request	Pass/fail
			7. Request information about how to improve the water efficiency of washing machine using "Tips and Practices through virtual application" application	(FR) Request specific suggestions (Fn. 040)	Successful request	Pass/Fail
			8. iWIDGET eLearning platform retrieves the various tips and suggestions	(FR) Retrieve suggestions (Fn. 044)	Successful uploading of application	Pass/Fail
			9. iWIDGET eLearning platform displays the various tips and suggestions	(FR) Display suggestions (Fn. 045)	Successful display	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC05.1 Receive customised suggestions (practices and interventions) on how to reduce water consumption	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. iWIDGET presents a hyperlink to the iWIDGET eLearning platform named "Be smart with water in the house"	(FR) Display hyperlink (not defined in the initial list of system requirements)	Successful display	Pass/fail
			3. Request access to the eLearning platform	(FR) Request access (not defined in the initial list of system requirements)	Successful request	Pass/fail
			4. iWIDGET opens a new tab with the eLearning platform	(FR) Display the eLearning platform (not defined in the initial list of system requirements)	Successful display	Pass/fail
			5. Log on to iWIDGET eLearning platform	(FR) Logon (not defined in the initial list of system requirements)	Successful logon without errors	Pass/fail
			6. Request information on improving water efficiency using "Water Planner" application	(FR) Request specific suggestions (Fn. 040)	Successful request	Pass/fail
			7. Select water appliances configuration (save more water)	(FR) Develop scenarios (Fn. 041)	Successful scenario development	Pass/Fail
			8. Specify household characteristics	(FR) Obtain data (Fn. 043)	Successful parameter specification	Pass/Fail
			9. Specify climatic conditions	(FR) Obtain weather data (Fn. 043)	Successful parameter specification	Pass/Fail
			10. iWIDGET eLearning platform runs scenarios and calculates results	(FR) Run scenarios (Fn. 047)	Successful run of application	Pass/Fail
			11. iWIDGET eLearning platform displays the results	(FR) Display suggestions (Fn. 045)	Successful display	Pass/fail

Table 53 – Success criteria and performance indicators for use case C_UC 5.2 Receive information on specific and alternatives pricing schemes

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC 5.2 Receive information on specific and alternatives pricing schemes	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/Fail
			2. Select water pricing tariff	(FR) Request information	Successful selection of information	Pass/Fail
			3. iWIDGET displays pricing tariff	(FR) Display data	Correct display of results	Pass/Fail
			4. iWIDGET displays water cost	(FR) Display data	Correct display of results	Pass/Fail
			5. iWIDGET displays comparative tariff costs	(FR) Display data	Correct display of results	Pass/Fail
			6. iWIDGET identifies best tariff cost	(FR) Display data	Correct display of results	Pass/Fail
			7. iWIDGET yields ease of interpreting water cost	(FR) Display data	Correct display of results	Pass/Fail
			8. iWIDGET yields ease of interpretation	(FR) Display data	Correct display of results	Pass/Fail
			9. Print the report	(FR) Print	Successful print of report	Pass/Fail
			10. Save data	(FR) Download	Successful data saving	Pass/Fail

Table 54 – Success criteria and performance indicators for use case C_UC 5.3 Forecast the next water bill

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC05.3 Forecast the next water bill	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select forecast time-period	(FR) Request information	Successful selection of information	Pass/fail
			3. iWIDGET calculates water use	(FR) calculate results	Correct result is calculated	Pass/fail
			4. iWIDGET displays future water bill	(FR) Display data	Correct display of results	Pass/fail
			5. iWIDGET displays alternative future bills	(FR) Display data	Correct display of results	Pass/fail
			6. Print the report	(FR) Print	Successful print of report	Pass/fail

			7. Save data	(FR) Download	Successful data saving	Pass/fail

Table 55 – Success criteria and performance indicators for use case C_UC6.1-6.2 Direct control and scheduling of water appliances.

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
C_UC 6.1: Direct control and scheduling of water appliances	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to device control	(FR) Request (Fn.064)	Successful display	Pass/fail
			3. Request access to the eLearning platform	(FR) Request access (not defined in the initial list of system requirements)	Successful request	Pass/fail
			4. iWIDGET presents the available smart devices and their status	(FR) Display the list of appliances (not defined in the initial list of system requirements)	Successful display	Pass/fail
			5. Select the smart device	(FR) Select appliance (Fn. 065)	Successful logon without errors	Pass/fail
			6. Change the status of smart device	(FR) Remote control (Fn. 069)	Successful request	Pass/fail
			7. iWIDGET communicates with smart device	(FR) Remote control (Fn. 069)	Successful scenario development	Pass/Fail
			8. iWIDGET presents the new status	(FR) Display the status of new device (not defined in initial list of system requirements)	Successful parameter specification	Pass/Fail

7.2Success criteria and performance indicators for functional testing – water utility domain

Table 56 to Table 74 present the success criteria and performance indicators associated with test cases for the water utility domain.

Table 56 – Success criteria and performance indicators for use case WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "utility overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.select temporal resolution "monthly"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			4. Deselect and select all network sectors, e.g., DMA1, DMA2, and DMA3	(FR) Network sector selection	Successful selection of option	Pass/fail
			5. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			6. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "utility overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.select temporal resolution "quarterly"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			4. Deselect and select all network sectors, e.g., DMA1, DMA2, and DMA3	(FR) Network sector selection	Successful selection of option	Pass/fail
			5. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			6. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
and total water consumption per network	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "consumption overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "meter overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.01.2009 00:00 hours to 31.03.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select temporal resolution "daily"	(FR) Selection of	Successful	Pass/fail

				temporal resolution	selection of option	
			6. Deselect and select meters, MC6, 8 , 9, 10	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data	#4	#4.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab “consumption overview”	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab “meter overview”	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.07.2009, 00:00 hours to 01.07.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select minimum temporal resolution, “15 minutes”	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Deselect and select meters, MC6, 8 , 9, 10	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data	#5	#5.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab “consumption overview”	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab “meter overview”	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.01.2009 00:00 hours to 31.12.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select temporal resolution “monthly”	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Deselect and select meters, MC6, 8 , 9, 10	(FR) Meter selection	Successful selection of option	Pass/fail

			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.1 Obtain inflow and total water consumption per network sector using real-time data	#6	#6.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "consumption overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "DMA inflow/ consumption"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.07.2009 00:00 hours to 21.07.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select temporal resolution "daily"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Select Network Sector "DMA 1"	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.1 Obtain inflow and total water consumption per network	#7	#7.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "consumption overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "DMA inflow/ consumption"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.07.2009 00:00 hours to 02.07.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select minimum temporal resolution "15 minutes"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Select Network Sector "DMA 2"	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.1 Obtain inflow and total water consumption per network	#8	#8.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "consumption overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "DMA inflow/ consumption"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.01.2009 00:00 hours to 31.12.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select temporal resolution "monthly"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Select Network Sector "all DMAs"	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Table 57 – Success criteria and performance indicators for use case WU_UC01.2 Obtain water consumption data per category of consumer using real-time data

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.12Obtain water consumption data per category of consumer using real-time data	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "consumption overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "Consumption categories"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.01.2009 00:00 hours to 31.03.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select temporal resolution "daily"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Select DMA 2	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.12Obtain water consumption data per category of consumer using real-time data	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "consumption overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "Consumption categories"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.07.2009 00:00 hours to 03.07.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select minimum temporal resolution "15 minutes"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Select Network Sector "all DMAs"	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC01.12Obtain water consumption data per category of consumer using real-time data	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "consumption overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "Consumption categories"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.01.2009 00:00 hours to 31.12.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5.Select temporal resolution "monthly"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Select Network Sector "all DMAs"	(FR) Meter selection	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a bar chart	(FR) Display information	Correct display of results	Pass/fail

Table 58 – Success criteria and performance indicators for use case WU_UC02.1 Obtain real-time water balance

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC02.1 Obtain real-time water balance	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "Water balance"	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab "Water balance overview"	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.06.2009 00:00 hours to 08.06.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5. Select Network Sector " DMA 1"	(FR) Meter selection	Successful selection of option	Pass/fail
			6. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			7. iWIDGET presents a bar chart and a water balance table	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC02.1 Obtain real-time water balance	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab “Water balance”	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab “Water balance overview”	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.06.2009 00:00 hours to 01.06.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5. Select Network Sector “all DMAs"	(FR) Meter selection	Successful selection of option	Pass/fail
			6. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			7. iWIDGET presents a bar chart and a water balance table	(FR) Display information	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC02.1 Obtain real-time water balance	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab “Water balance”	(FR) Widget selection	Successful selection of option	Pass/fail
			3.Go to sub-tab “Water balance overview”	(FR) Widget selection	Successful selection of option	Pass/fail
			4.Select time period: 01.01.2009 00:00 hours to 31.12.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			5. Select Network Sector “all DMAs”	(FR) Meter selection	Successful selection of option	Pass/fail
			6. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			7. iWIDGET presents a bar chart and a water balance table	(FR) Display information	Correct display of results	Pass/fail

Table 59 – Success criteria and performance indicators for use case WU_UC02.2 Benchmark water losses against reference values

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC02.2: Benchmark water losses against reference values	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to "Water Analysis" Tab	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select the option "Water Balance"	(FR) Widget selection	Successful selection of option	Pass/fail
			4. Select Network Sector "all DMA"	(FR) Select parameter location	Successful selection of option	Pass/fail
			5. Select Temporal Resolution "Daily"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			6. Annual Billed 0.0/Annual Unbilled 0.1	(FR) Select parameter reference data	Successful selection of option	Pass/fail
			7. Select time interval: 30.08.2009 00:00 hours to 01.12.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			8. Press calculate	(FR) Execute calculations	Correct result is calculated	Pass/fail
			9. Check screen displayed	(FR) Display information	Correct result is displayed	Pass/fail
			10. Print information	(FR) Print Information	Result is printed	Pass/fail
			11. Exit	(FR) Logoff	Logoff	Pass/fail

Table 60 – Success criteria and performance indicators for use case WU_UC02.3 Obtain information on consumption profiling

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC02.3: Obtain information on consumption profiling	#1	#1.1	1. Login the iWidget system	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to "Water Analysis" Tab	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select "Consumption Profiling"	(FR) Widget selection	Successful selection of option	Pass/fail
			4. Select Network Sector "DMA1"	(FR) Select parameter location	Successful selection of option	Pass/fail
			5. Select Meter "all Diameters"	(FR) Meter selection	Successful selection of option	Pass/fail
			6. Select Consumer ID "00062382"	(FR) Consumer type	Successful selection of option	Pass/fail
			7. Select Time Series "Average consumption"	(FR) Selection of time period	Successful selection of option	Pass/fail
			8. Select Consumption Category "public"	(FR) Select parameter consumption scenario	Successful selection of option	Pass/fail
			9. Select Scenario (weekday) "Weekends"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			10. Select Co-variables "Economic Mobility"	-	Successful selection of option	Pass/fail
			11. Select Time interval 16.07.2009 00:00 hours to 29.11.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			12. Press calculate	(FR) Execute calculations	Correct result is calculated	Pass/fail
			13. Check the information displayed in the graph	(FR) Display information	Correct result is displayed	Pass/fail
			14. Print the report,	(FR) Print Information	Result is printed	Pass/fail
			15. Save	(FR) Download	Successful data saving	Pass/fail
			16. Escape the application	(FR) Logoff	Successful log off	Pass/fail

Table 61 – Success criteria and performance indicators for use case WU_UC02.4 Obtain detailed information on operational inefficiency

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC02.4: Obtain detailed information on operational inefficiency	#1	#1.1	1. Logon to IWidget	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to "Water Analysis"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select "Operational Inefficiency option"	(FR) Widget selection	Successful selection of option	Pass/fail
			4. Select Network Sector "all DMA"	(FR) Select parameter location	Successful selection of option	Pass/fail
			5. Select Time Series "Apparent losses"	(FR) Selection of time period	Successful selection of option	Pass/fail
			6. Select Weekday Scenario "all days"	(FR) Selection of temporal resolution	Successful selection of option	Pass/fail
			7. Select Time Interval 15.03.2009 00:00 hours to 26.09.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			8. Press calculate	(FR) Execute calculations	Correct result is calculated	Pass/fail
			9. Check the information displayed for accuracy	(FR) Display information	Correct result is displayed	Pass/fail
			10. Print the information	(FR) Print Information	Result is printed	Pass/fail
			11. Save the information	(FR) Download	Successful data saving	Pass/fail
			12. Escape the application	(FR) Logoff	Successful log off	Pass/fail

Table 62 Success criteria and performance indicators for use case WU_UC03.1 Obtain information on energy consumption associated with pumping

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC03.1 Obtain information on energy consumption associated with pumping	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 3.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select DMA1 from the drop-down list	(FR) Network description	Successful selection of option	Pass/fail
			5. Enter chosen energy price: price per day of €0.10	(FR) Price selection	Successful selection of option	Pass/fail
			6. Enter pump schedule (1, 1, 1, 0)	(FR) Pump specifications	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC03.1 Obtain information on energy consumption associated with pumping	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 3.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select DMA2 from the drop-down list	(FR) Temporal resolution selection	Successful selection of option	Pass/fail
			5. Enter chosen energy price: Tariff price of (€0.05, €0.11, €0,09, €0.05)	(FR) Time period display selection	Successful selection of option	Pass/fail
			6. Enter pump schedule (0, 0, 0, 0)	(FR) Execute calculations	Correct result is calculated	Pass/fail
			7. iWIDGET calculates the result	(FR) Display information	Correct display of results	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Print	Successful print of report	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC03.1 Obtain information on energy consumption associated with pumping	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 3.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select DMA3 from the drop-down list	(FR) Network description	Successful selection of option	Pass/fail
			5. Enter chosen energy price: price per day of €0.05	(FR) Price selection	Successful selection of option	Pass/fail
			6. Enter pump schedule (0,1,0,0)	(FR) Pump specifications	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC03.1 Obtain information on energy consumption associated with pumping	#4	#4.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 3.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select DMA1 from the drop-down list	(FR) Network description	Successful selection of option	Pass/fail
			5. Enter chosen energy price: Tariff price of (€0.07, €0.09, €0.09, €0.10)	(FR) Price selection	Successful selection of option	Pass/fail
			6. Enter pump schedule (0,1,0,0)	(FR) Pump specifications	Successful selection of option	Pass/fail
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Table 63 – Success criteria and performance indicators for use case WU_UC04.1 Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.1: Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network	#1	#1.1	1. Logon to IWidget	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to "Performance" tab	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select Network Sector "DMA 2"	(FR) Select parameter location	Successful selection of option	Pass/fail
			4. Select Time Series "weekly"	(FR) Selection of time period	Successful selection of option	Pass/fail
			5. Select Meter Selection "MC10"	(FR) Meter selection	Successful selection of option	Pass/fail
			6. Select Flow range "50 days"	-		Pass/fail
			7. Select Consumer ID "00062700"	(FR) Consumer type	Successful selection of option	Pass/fail
			8. Select meter type "Gladiator EU"	(FR) Select Meter	Successful selection of option	Pass/fail
			9. Select Time Interval 09.04.2009 00:00 hours to 01.05.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			10. Press calculate	(FR) Execute calculations	Correct result is calculated	Pass/fail
			11. Check the information displayed	(FR) Display information	Correct result is displayed	Pass/fail
			12. Print the information	(FR) Save report	Result is printed	Pass/fail
			13. Save the information	(FR) Download	Successful data saving	Pass/fail
			14. Escape the application	(FR) Logoff	Successful log off	Pass/fail

Table 64 – Success criteria and performance indicators for use case WU_UC04.2 Receive warnings about the status and sizing adequacy of water meters

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.2: Receive warnings about the status and sizing adequacy of water meters	#1	#1.1	1. Logon to IWidget	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to "Performance" tab	(FR) Widget selection	Successful navigation to widget	Pass/fail
			3. Select Network Sector "all DMA"	(FR) Select parameter location	Successful selection of option	Pass/fail
			4. Select Time Series "Daily"	(FR) Selection of Time Series	Successful selection of option	Pass/fail
			5. Select Meter Selection "MC 6"	(FR) Meter selection	Successful selection of option	Pass/fail
			6. Select Flow range "10 days"	-	Successful selection of option	Pass/fail
			7. Select Consumer ID "00062648"	(FR) Consumer type	Successful selection of option	Pass/fail
			8. Select meter type "Gladiator EU"	(FR) Display option meter	Successful selection of option	Pass/fail
			9. Select Time Interval 31.07.2009 00:00 hours to 31.09.2009 23:59 hours	(FR) Selection of time period	Successful selection of option	Pass/fail
			10. Press calculate	(FR) Execute calculations	Correct result is calculated	Pass/fail
			11. Check the information displayed	(FR) Display information	Correct result is displayed	Pass/fail
			12. Print the information	(FR) Print Information	Result is printed	Pass/fail
			13. Save the information	(FR) Download	Successful data saving	Pass/fail
			14. Escape the application	(FR) Logoff	Successful log off	Pass/fail

Table 65 – Success criteria and performance indicators for use case WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Pressure Control"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Leakage"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 1"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Daily"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-04-15" to "2009-04-22"	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#1	#1.2	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Pressure Control"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Leakage"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 2"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Hourly"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-04-15" to "2009-04-22"	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage	#1	#1.3	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Pressure Control"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Pipe-Burst"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 3"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Hourly"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-04-	Fn.071: Select	Successful selection	Pass/fail

			15" to "2009-05-15"	parameter time interval	of option	
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#1	#1.4	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Pressure Control"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Pipe-Burst"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 2"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Daily"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-06-15" to "2009-07-15"	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#1	#1.5	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Pressure Control"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Real-Loss"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 1"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Hourly"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-07-15" to "2009-07-22"	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components	#1	#1.6	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Pressure Control"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Real-Loss"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 3"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Daily"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-07-15" to "2009-07-22"	Fn.071: Select parameter time	Successful selection of option	Pass/fail

				interval		
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#1	#1.7	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab “Pressure Control”	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series “Inflow”	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector DMA 1”	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period “Hourly”	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval “2009-08-01” to “2009-10-01”	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#1	#1.8	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Pressure Control"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Inflow"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "All DMAs"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Daily"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-08-01" to "2009-10-01"	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "DMA Analysis"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Inflow"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 1"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Hourly"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail

			6. Select time interval “2009-03-15” to “2009-03-22”	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET calculates pressure variation	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#2	#2.2	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab “DMA Analysis”	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series “Inflow”	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector “DMA 2”	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period “Daily”	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval “2009-03-15” to “2009-03-22”	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET calculates pressure variation	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#2	#2.3	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "DMA Analysis"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Pipe Burst"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "All DMAs"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Hourly"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-06-15" to "2009-06-22"	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET calculates pressure variation	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#2	#2.4	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "DMA Analysis"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Pipe Burst"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 1"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Daily"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval "2009-06-15" to "2009-06-22"	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET calculates pressure variation	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of	#2	#2.5	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "DMA Analysis"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Leakage"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 2"	Fn.073: Select parameter location	Successful selection of option	Pass/fail

			5. Select time period “Hourly”	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval “2009-02-15” to “2009-02-20”	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET calculates pressure variation	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#2	#2.6	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab “DMA Analysis”	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series “Leakage”	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector “DMA 3”	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period “Daily”	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Select time interval “2009-02-15” to “2009-02-20”	Fn.071: Select parameter time interval	Successful selection of option	Pass/fail
			7. iWIDGET calculates pressure variation	Fn110: Process pressure data	Correct result is calculated	Pass/fail

			8. iWIDGET presents a time series graph and a pressure graph	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "Campaigns"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Inflow"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "All DMAs"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Hourly"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Enter number of monitoring campaigns "2"	Fn.109-2: Select number of monitoring campaigns to analyze	Successful selection of option	Pass/fail
			7. Select start time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			8. Select end time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			9. iWIDGET calculates time-series variation	Fn107-1: Analyze monitoring campaign	Correct result is calculated	Pass/fail
			10. iWIDGET calculates average pressure value	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			11. iWIDGET displays the campaign time-series values and the associated pressure value	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#3	#3.2	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "Campaigns"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Inflow"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 3"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Daily"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Enter number of monitoring campaigns "3"	Fn.109-2: Select number of monitoring campaigns to analyze	Successful selection of option	Pass/fail
			7. Select start time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			8. Select end time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			9. iWIDGET calculates time-series variation	Fn107-1: Analyze monitoring campaign	Correct result is calculated	Pass/fail
			10. iWIDGET calculates average pressure value	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			11. iWIDGET displays the campaign time-series values and the associated pressure value	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#3	#3.3	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "Campaigns"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Leakage"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 2"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Hourly"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Enter number of monitoring campaigns "5"	Fn.109-2: Select number of monitoring campaigns to analyze	Successful selection of option	Pass/fail
			7. Select start time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			8. Select end time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			9. iWIDGET calculates time-series variation	Fn107-1: Analyze monitoring campaign	Correct result is calculated	Pass/fail
			10. iWIDGET calculates average pressure value	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			11. iWIDGET displays the campaign time-series values and the associated pressure value	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.3 Obtain information on the effect of pressure control on leakage components and on consumption	#3	#3.4	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2.Go to tab "Campaigns"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select time-series "Leakage"	Fn.074-1: Select quantity to display as time series	Successful selection of option	Pass/fail
			4. Select network sector "DMA 1"	Fn.073: Select parameter location	Successful selection of option	Pass/fail
			5. Select time period "Daily"	Fn.072: Select parameter temporal resolution	Successful selection of option	Pass/fail
			6. Enter number of monitoring campaigns "1"	Fn.109-2: Select number of monitoring campaigns to analyze	Successful selection of option	Pass/fail
			7. Select start time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			8. Select end time for all campaigns (see MS32, p.36)	Fn109-1: Select data during monitoring campaigns	Successful selection of option	Pass/fail
			9. iWIDGET calculates time-series variation	Fn107-1: Analyze monitoring campaign	Correct result is calculated	Pass/fail
			10. iWIDGET calculates average pressure value	Fn110: Process pressure data	Correct result is calculated	Pass/fail
			11. iWIDGET displays the campaign time-series values and the associated pressure value	Fn.074: Display as time series Fn.111-1: Display pressure data for analysis Fn.115: Output results in user interface	Correct display of results	Pass/fail

Table 66 – Success criteria and performance indicators for use case WU_UC04.4 Receive customized suggestions about pressure reducing valve (PRVs) settings

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.4 Receive customized suggestions about pressure reducing valve (PRVs) settings	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 4.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Enter minimum pressure: 20	(FR) Data input	Successful selection of option	Pass/fail
			5. Select number of periods per day: 6	(FR) Time period selection	Successful selection of option	Pass/fail
			6. Choose analytics type: deterministic	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA1 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.4 Receive customized suggestions about pressure reducing valve (PRVs) settings	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 4.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Enter minimum pressure: 24	(FR) Data input	Successful selection of option	Pass/fail
			5. Select number of periods per day: 4	(FR) Time period selection	Successful selection of option	Pass/fail
			6. Choose analytics type: robust, with confidence interval of 50%	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA2 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail

			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.4 Receive customized suggestions about pressure reducing valve (PRVs) settings	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 4.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Enter minimum pressure: 22	(FR) Data input	Successful selection of option	Pass/fail
			5. Select number of periods per day: 2	(FR) Time period selection	Successful selection of option	Pass/fail
			6. Choose analytics type: deterministic	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA3 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC04.4 Receive customized suggestions about pressure reducing valve (PRVs) settings	#4	#4.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 4.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Enter minimum pressure: 20	(FR) Data input	Successful selection of option	Pass/fail
			5. Select number of periods per day: 1	(FR) Time period selection	Successful selection of option	Pass/fail
			6. Choose analytics type: robust, with confidence interval of 70%	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA2 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail

			9. Save data	(FR) Download	Successful data saving	Pass/fail

Table 67 – Success criteria and performance indicators for use case WU_UC05.1 Receive information to make billing more accurate and flexible

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC05.1 Receive information to make billing more accurate and flexible	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 5.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a smart meter device ID	(FR) Device ID selection	Successful selection of option	Pass/fail
			4. Select the flat-rate price option	(FR) Flat-rate price selection	Successful selection of option	Pass/fail
			5. Set a €2.05 unit price of water per cubic meter	(FR) Data input	Successful input of data	Pass/fail
			6. Select a date range	(FR) Start and end date selection	Successful selection of options	Pass/fail
			7. Select the volume time series method to display the results	(FR) Data display method selection	Correct display of results	Pass/fail
			8. Select the flow time series method to display the results	(FR) Data display method selection	Correct display of results	Pass/fail
			9. Select the pie chart method to display the results	(FR) Data display method selection	Correct display of results	Pass/fail
			10. Select the summary table method to display the results	(FR) Data display method selection	Correct display of results	Pass/fail
Use Case	**Test scenario**	**Test case**	**Test case steps**	**Requirement (as in MS13)**	**Success criteria**	**Key Performance Indicator**
WU_UC05.1 Receive information to make billing more accurate and flexible	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 5.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a smart meter device ID	(FR) Device ID selection	Successful selection of option	Pass/fail
			4. Select the tariff price option	(FR) Flat-rate price selection	Successful selection of option	Pass/fail
			5. Set the unit price in €/m3 (2.05, 2.55, 2.75, 2.40)	(FR) Data input	Successful input of data	Pass/fail
			6. Select a date range	(FR) Start and end date selection	Successful selection of options	Pass/fail
			7. Select the volume time series method to display the results	(FR) Data display method selection	Correct display of results	Pass/fail
			8. Select the flow time series method to display the results	(FR) Data display method selection	Correct display of results	Pass/fail
			9. Select the pie chart method to	(FR) Data display	Correct display of	Pass/fail

			display the results	method selection	results	
			10. Select the summary table method to display the results	(FR) Data display method selection	Correct display of results	Pass/fail

Table 68 – Success criteria and performance indicators for use case WU_UC05.2 Receive information to improve the management of complaints

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC05.2 – Receive information to improve the management of complaints	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "WU-UC05.2 Complaints"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select Client ID "9305"	Dfn.012 – Water consumption data Dfn.013 – Network data Nfn.008 – Billing data	Successful selection of option	Pass/fail
			4. Select date "1-12-2013"	Dfn.012 – Water consumption data Dfn.013 – Network data Nfn.008 – Billing data	Successful selection of option	Pass/fail
			5. Press the "calculate" button	Fn.145 – Diagnose complaint cause	Successful selection of option	Pass/fail
			6. iWidget displays information about relevant network issues	Fn.141 – Send request for repair Fn.143 – Send complaint-relevant data	Correct output display	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC05.2 – Receive information to improve the management of complaints	#1	#1.2	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "WU-UC05.2 Complaints"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select Client ID "9336"	Dfn.012 – Water consumption data Dfn.013 – Network data Nfn.008 – Billing data	Successful selection of option	Pass/fail
			4. Select date "19-06-2009"	Dfn.012 – Water consumption data Dfn.013 – Network data Nfn.008 – Billing data	Successful selection of option	Pass/fail
			5. Press the "calculate" button	Fn.145 – Diagnose complaint cause	Successful selection of option	Pass/fail
			6. iWidget displays information about relevant network issues	Fn.141 – Send request for repair Fn.143 – Send complaint-relevant data	Correct output display	Pass/fail

Table 69 – Success criteria and performance indicators for use case WU_UC05.3 Receive information to provide warnings to consumers

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC05.3 – Receive information to provide warnings to consumers	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Warnings UC5.3"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select Network Sector "DMA 1"	Dfn.014 - Water consumption data	Successful selection of option	Pass/fail
			4. Set Tolerance to 1E-6	Dfn.015 - Reference data	Successful selection of option	Pass/fail
			5. Set an appropriate value for Time Interval	Dfn.015 - Reference data	Successful selection of option	Pass/fail
			6. Press the "calculate" button	Dfn.017 - Reliability; Nfn.009 - Analyze consumption data.	Successful selection of option	Pass/fail
			7. iWidget displays list of active warnings in selected time	Fn.147 - Identify abnormal pattern	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC05.3 – Receive information to provide warnings to consumers	#1	#1.2	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab "Warnings UC5.3"	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Select Network Sector "DMA 3"	Dfn.014 - Water consumption data	Successful selection of option	Pass/fail
			4. Set Tolerance to 1E-4	Dfn.015 - Reference data	Successful selection of option	Pass/fail
			5. Set an appropriate value for Time Interval	Dfn.015 - Reference data	Successful selection of option	Pass/fail

			6. Press the "calculate" button	Dfn.017 - Reliability; Nfn.009 - Analyze consumption data.	Successful selection of option	Pass/fail
			7. iWidget displays list of active warnings in selected time	Fn.147 - Identify abnormal pattern	Correct display of results	Pass/fail

Table 70 – Success criteria and performance indicators for use case WU_UC06.1 Receive customized suggestions about adaptive pricing schemes

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC06.1 Receive customized suggestions about adaptive pricing schemes	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 6.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a consumption category	(FR) Consumption category selection	Successful selection of option	Pass/fail
			4. Select a billing program: Time of use	(FR) Billing program selection	Successful selection of option	Pass/fail
			5. Select a time period: any start and end dates	(FR) Time period selection	Successful selection of option	Pass/fail
			6. Select smart meter devices: any selection from DMAs 1 to 3	(FR) Devices selection	Successful selection of option	Pass/fail
			7. Enter a unit price for the weekdays (€2.35) and for the weekends (€2.1)	(FR) Data input	Successful data input	Pass/fail
			8. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			9. iWIDGET displays the results	(FR) Display results	Successful presentation of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC06.1 Receive customized suggestions about adaptive pricing schemes	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 6.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a consumption category	(FR) Consumption category selection	Successful selection of option	Pass/fail
			4. Select a billing program: Peak time rebate	(FR) Billing program selection	Successful selection of option	Pass/fail
			5. Select a time period: any start and end dates	(FR) Time period selection	Successful selection of option	Pass/fail
			6. Select smart meter devices: any	(FR) Devices	Successful selection	Pass/fail

			selection from DMAs 1 to 3	selection	of option	
			7. Enter a unit price for the weekdays (€2.35) and for the weekends (€2.1)	(FR) Data input	Successful data input	Pass/fail
			8. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			9. iWIDGET displays the results	(FR) Display results	Successful presentation of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC06.1 Receive customized suggestions about adaptive pricing schemes	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 6.1	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a consumption category	(FR) Consumption category selection	Successful selection of option	Pass/fail
			4. Select a billing program: Seasonal use	(FR) Billing program selection	Successful selection of option	Pass/fail
			5. Select a time period: any start and end dates	(FR) Time period selection	Successful selection of option	Pass/fail
			6. Select smart meter devices: any selection from DMAs 1 to 3	(FR) Devices selection	Successful selection of option	Pass/fail
			7. Enter a unit price for the weekdays (€2.35) and for the weekends (€2.1)	(FR) Data input	Successful data input	Pass/fail
			8. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			9. iWIDGET displays the results	(FR) Display results	Successful presentation of results	Pass/fail

Table 71 – Success criteria and performance indicators for use case WU_UC06.2 Receive customised suggestions about awareness campaigns

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC06.2 – Receive customised suggestions about awareness campaigns	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select the option related to the effects of awareness raising campaigns	(FR) Request information regarding awareness raising campaigns (Fn. 125)	Successful selection of information	Pass/fail
			3. Select type of awareness raising campaign	(FR) Select type of campaign (Fn.128)	Successful selection of information	Pass/fail
			4. Select type of price changes	(FR) Select initiation time (Fn. 129)	Successful selection of information	Pass/fail
			5. Select type of incentives for water saving technologies	(FR) Select technologies (Fn. 130)	Successful selection of information	Pass/fail
			6. Select the time of initiation of the campaign and its running period	(FR) Select initiation time (Fn. 129)	Successful selection of option	Pass/fail
			7. Select the time of initiation of the price changes and its running period	(FR) Select initiation time (Fn. 129)	Successful selection of option	Pass/fail
			8. Select the time of initiation of the incentives for water saving technologies	(FR) Select initiation time (Fn. 129)	Successful selection of option	Pass/fail
			9. iWIDGET calculates the result	(FR) Run scenario (Fn. 131)	Correct result is calculated	Pass/fail
			10. iWIDGET presents a time series graph	(FR) Display results (Fn. 132)	Correct display of results	Pass/fail
			11. Print the graph	(FR) Print (not defined in the initial list of system requirements)	Successful print of report	Pass/fail
			12. Save data	(FR) Download (not defined in the initial list of system requirements)	Successful data saving	Pass/fail

Table 72 – Success criteria and performance indicators for use case WU_UC07.2 Get support to decision-making on water network expansions

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.2 – Get support to decision-making on wter netwrok expansions	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab “Simulations UC7.2”	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Browse and upload ".inp" file	Dfn.013 - Allow data input	Successful file upload	Pass/fail
			4. Set "Change Demand" to +10%	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			5. Set Minimum Pressure to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			6. Set Maximum Pressure to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			7. Set Velocity to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			8. Press the "calculate" button	Fn.138 - Calculate network alternatives	Successful selection of option	Pass/fail
			9. Obtain daily network Performance Index graphs	Fn.140 - Report alternatives	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.2 – Get support to decision-making on wter netwrok expansions	#1	#1.2	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab “Simulations UC7.2”	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Browse and upload ".inp" file	Dfn.013 - Allow data input	Successful file upload	Pass/fail
			4. Select "Activate range of demands"	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			5. Set demand variation parameters to arbitrary values	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			6. Set Minimum Pressure to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			7. Set Maximum Pressure to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	
			8. Set Velocity to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			9. Press the "calculate" button	Fn.138 - Calculate network alternatives	Successful selection of option	Pass/fail
			10. Obtain daily network Performance Index graphs	Fn.140 - Report alternatives	Correct display of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.2 – Get support to decision-making on wter netwrok expansions	#1	#1.3	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Go to tab “Simulations UC7.2”	(FR) Widget selection	Successful selection of option	Pass/fail
			3. Browse and upload ".inp" file	Dfn.013 - Allow data input	Successful file upload	Pass/fail
			4. Select "Activate range of demands"	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			5. Set demand variation parameters to arbitrary values	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			6. Set Minimum Pressure to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			7. Set Maximum Pressure to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			8. Set Velocity to an arbitrary value	Fn.137 - Select scenarios	Successful selection of option	Pass/fail
			9. Upload ".pat" pattern file	Dfn.013 - Allow data input	Successful file upload	Pass/fail
			10. Press the "calculate" button	Fn.138 - Calculate network alternatives	Successful selection of option	Pass/fail
			11. Obtain daily network Performance Index graphs	Fn.140 - Report alternatives	Correct display of results	Pass/fail

Table 73 – Success criteria and performance indicators for use case WU_UC07.3 Obtain information to support optimal equipment replacement scheduling

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.3 Obtain information to support optimal equipment replacement scheduling	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 7.3	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a residential meter ID: any	(FR) Device ID selection	Successful selection of option	Pass/fail
			4. Enter the meter's age in years: any value between 1 and 15	(FR) Data input	Successful input of data	Pass/fail
			5. Select a linear deterioration rate	(FR) Equipment description	Successful selection of option	Pass/fail
			6. Enter a marginal cost of non-revenue water in €/m3: any value between 1 and 10	(FR) Data input	Successful input of data	Pass/fail
			7. Enter an annual growth rate of the cost in percentage: any value between 1 and 3%	(FR) Data input	Successful input of data	Pass/fail
			8. Enter the percent cost of capital: any value between 5 and 10%	(FR) Data input	Successful input of data	Pass/fail
			9. iWIDGET calculates the result	(FR) Execute calculation	Correct result is calculated	Pass/fail
			10. iWIDGET displays the results	(FR) Display results	Successful presentation of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.3 Obtain information to support optimal equipment replacement scheduling	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 7.3	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a residential meter ID: any	(FR) Device ID selection	Successful selection of option	Pass/fail
			4. Enter the meter's age in years: any value between 1 and 15	(FR) Data input	Successful input of data	Pass/fail
			5. Select a sigmoid deterioration rate	(FR) Equipment description	Successful selection of option	Pass/fail
			6. Enter a marginal cost of non-revenue water in €/m3: any value between 1 and 10	(FR) Data input	Successful input of data	Pass/fail
			7. Enter an annual growth rate of the cost in percentage: any value between 1 and 3%	(FR) Data input	Successful input of data	Pass/fail
			8. Enter the percent cost of capital: any value between 5 and 10%	(FR) Data input	Successful input of data	Pass/fail
			9. iWIDGET calculates the result	(FR) Execute calculation	Correct result is calculated	Pass/fail
			10. iWIDGET displays the result	(FR) Display result	Successful presentation of results	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.3 Obtain information to support optimal equipment replacement scheduling	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 7.3	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a DMA: any DMA	(FR) DMA selection	Successful selection of option	Pass/fail
			4. Enter the energy price in €/kWh: (0.11, 0.21, 0.27, 0.18)	(FR) Data input	Successful input of data	Pass/fail
			5. Select a pump deterioration curve: pumpDeterioration	(FR) Equipment description	Successful selection of option	Pass/fail
			6. Enter the percent annual rise of electricity cost: any value between 1 and 5%	(FR) Data input	Successful input of data	Pass/fail
			8. Enter the cost of capital: €4,200	(FR) Data input	Successful input of data	Pass/fail
			9. iWIDGET calculates the result	(FR) Execute calculation	Correct result is calculated	Pass/fail
			10. iWIDGET displays the result	(FR) Display result	Successful	Pass/fail

					presentation of results	

Table 74 – Success criteria and performance indicators for use case WU_UC07.4 Determine optimal placement of valves and flow meters on pipes in the network

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.4 Determine optimal placement of valves and flow meters on pipes in the network	#1	#1.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 7.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select time of day from drop down menu: 08:00-09:00	(FR) Time period selection	Successful selection of option	Pass/fail
			5. Enter minimum pressure: 20	(FR) Data input	Successful selection of option	Pass/fail
			6. Select number of valves: 2	(FR) Data input	Successful selection of option	Pass/fail
			6. Choose analytics type: deterministic	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA1 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.4 Determine optimal placement of valves and flow meters on pipes in the network	#2	#2.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 7.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select time of day from drop down menu: 12:00-13:00	(FR) Time period selection	Successful selection of option	Pass/fail
			5. Enter minimum pressure: 22	(FR) Data input	Successful selection of option	Pass/fail
			6. Select number of valves: 2	(FR) Data input	Successful selection of option	Pass/fail
			6. Choose analytics type: robust, with confidence interval 80%	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA2 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.4 Determine optimal placement of valves and flow meters on pipes in the network	#3	#3.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 7.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select time of day from drop down menu: 16:00-17:00	(FR) Time period selection	Successful selection of option	Pass/fail
			5. Enter minimum pressure: 20	(FR) Data input	Successful selection of option	Pass/fail
			6. Select number of valves: 3	(FR) Data input	Successful selection of option	Pass/fail
			6. Choose analytics type: deterministic	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA3 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail

			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

Use Case	Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator
WU_UC07.4 Determine optimal placement of valves and flow meters on pipes in the network	#4	#4.1	1. Log on to iWIDGET using a password	(FR) Logon	Successful logon without errors	Pass/fail
			2. Select IBM Widget: 7.4	(FR) Request information	Successful selection of information	Pass/fail
			3. Select a day from a calendar	(FR) Time period selection	Successful selection of option	Pass/fail
			4. Select time of day from drop down menu: 20:00-21:00	(FR) Time period selection	Successful selection of option	Pass/fail
			5. Enter minimum pressure: 22	(FR) Data input	Successful selection of option	Pass/fail
			6. Select number of valves: 1	(FR) Data input	Successful selection of option	Pass/fail
			6. Choose analytics type: robust, with confidence interval of 50%	(FR) Data input	Successful selection of option	Pass/fail
			7. Choose DMA1 from drop-down menu	(FR) Network description		
			7. iWIDGET calculates the result	(FR) Execute calculations	Correct result is calculated	Pass/fail
			8. iWIDGET presents a time series graph and results	(FR) Display information	Correct display of results	Pass/fail
			9. Save data	(FR) Download	Successful data saving	Pass/fail

7.3Success criteria and performance indicators for non-functional testing

Table 75 presents the success criteria and performance indicators for non-functional testing.

Table 75 – Success criteria and performance indicators for non-functional testing

Requirement	Test scenario	Success criteria	Key Performance Indicator and target
Load	#1 Test the whole iWIDGET system with 5 users at the same time	Minimum response time	Response time < x
	#2 Test the whole iWIDGET system with 20 users at the same time	Minimum response time	Response time < x

Performance	#1 Test the iWIDGET system with data from one month of 1 DMA	Minimum response time	Response time < x
	#2 Test the iWIDGET system with data from all the period of x DMAs (x is the maximum number available in case studies)	Minimum response time	Response time < x
Compatibility	#1 Test the iWIDGET system with 3 different browsers	Minimum number of compatibility errors	Compatibility errors < x
	#2 Test the iWIDGET system from a mobile device	Minimum number of compatibility errors	Compatibility errors < x
Scalability	#1 Test the iWIDGET system with extended memory	Maximum performance improvement Minimum number of errors	Performance indicators improvement > x% Introduced errors = 0
	#2 Test the iWIDGET system with multiple processors	Maximum performance improvement Minimum number of errors	Performance indicators improvement > x% Introduced errors = 0
Usability	#1 Test the iWIDGET system with test objectives (without defining the detailed script)	Minimum number of mouse clicks Minimum time to select options Minimum overall time to execute the objective	Number of mouse clicks < Time to select specific options < x Time to execute the objective <x
Documentation	#1 Test the existence of documentation	Existence of technical documentation Existence of off-line manuals Existence of online help	Technical documentation existence (y/n) Off-line manuals existence (y/n) Online help existence (y/n)
	#2 Test the execution of UCs with users that used that documentation materials, against users without any training	Maximum improvement of usability indicators	%improvement of usability indicators > x
Security	#1 Test the iWIDGET system accessing a direct link, without previous login	Minimum number of unauthorized accesses	Number of unauthorized accesses through direct link < x
	#2 Test the iWIDGET accessing a functionality not allowed for the logged user	Minimum number of unauthorized accesses	Number of unauthorized accesses < x
	#3 Test the iWIDGET against SQL injection	Avoidance of SQL injection attacks	Number of SQL injection vulnerabilities < x
Availability	#1 Test the iWidget availability after forced errors (e.g., power failure)	Minimum recovery time from errors	Time to recover after an error < x

8 Off-line tests

8.1 General setup for off-line tests

8.1.1 Work distribution among partners

The work distribution among partners is presented in Table 76 (functional tests for consumer domain), in Table 77 (functional tests for water utility domain) and in Table 78 (non-functional tests).

The following was considered for the work distribution:

- To have some comparability of results, at least 2 partners tested a certain widget,
- For the utility domain, partners involved in testing had the scientific knowledge to assess the correctness of results and, thus, the tests were made by LNEC, UNEXE and NTUA. AGS tested all widgets in the utility domain,
- For the consumer domain, testing was also made by the remaining partners.
- In some cases, the same partner developed the widget and tested it. In this case, tests were done by team members who did not develop the widget.

Table 76 – Partners responsible for executing functional tests (consumer domain)

Consumer domain use cases	Partner leading widget development in WP2	Partners responsible for off-line testing in WP3					
		LNEC	UNEXE	NTUA	SAP	IBM	AGS
C_UC01: Obtain water consumption data							
C_UC01.1: Obtain total water consumption and costs using real-time data from smart meters	NTUA		X	X		X	X
C_UC01.2: Obtain per appliance water consumption and costs using real-time data from smart meters	NTUA		X	X		X	
C_UC02: Obtain energy data associated with water consumption							
C_UC02.1: Obtain total energy consumption and costs associated with water consumption using real-time data from smart meters	NTUA		X	X		X	
C_UC02.2: Obtain per appliance energy consumption and costs associated with water consumption using real-time data from smart meters C_UC02.3: Display carbon emissions related to water consumption	NTUA		X	X		X	
C_UC03: Understand water consumption							

C_UC03.1: Compare current water use pattern with historical consumption data of the same household	NTUA		X	X		X	X
C_UC03.2: Compare water consumption with other consumers	UNEXE		X	X		X	X
C_UC03.3: Compare water consumption with standard profiles	UNEXE		X	X		X	X
C_UC03.4: Compare household water consumption with most efficient users	UNEXE		X	X		X	X
C_UC03.5: Obtain information on inefficient water uses	NTUA		X	X			X
C_UC03.6: Receive warnings about faults (leakages, bursts) and unusual water consumptions	NTUA		X	X			X
C_UC04: Understand energy associated with water consumption							
C_UC04.1: Compare energy pattern associated with water use in the same household	UNEXE		X	X			
C_UC05: Assistance to increase water use efficiency							
C_UC05.1: Receive customised suggestions on how to reduce water consumption	NTUA		X	X			
C_UC05.2: Receive information on specific and alternatives pricing schemes	UNEXE		X	X	X		
C_UC05.3: Forecast the next water bill	UNEXE		X	X	X		
C_UC05.4: Forecast the component of next energy bill associated with water consumption	UNEXE		X	X	X		
C_UC06: Control water use							
C_UC06.1: Direct control of water consumption C_UC06.2: Scheduling of appliances use in order to optimize water/energy bill	NTUA		X	X			

Table 77 – Partners responsible for executing functional tests (water utility domain)

Water utility domain use cases	Partner leading widget development in WP2	Partners responsible for off-line testing in WP3					
		LNEC	UNEXE	NTUA	SAP	IBM	AGS
WU_UC01: Obtain water consumption and related energy consumption data							
WU_UC01.1: Obtain inflow (and associated energy consumption) and total water consumption per network sector using real-time data	SAP	X	X[1]				X
WU_UC01.2: Obtain water consumption data per category of consumer using real-time data	SAP	X	X[1]				X
WU_UC02: Understand water consumption							
WU_UC02.1: Obtain real-time water balance data	SAP	X	X[1]				X
WU_UC02.2: Benchmark water losses against reference values	SAP	X	X[1]				X
WU_UC02.3: Obtain information on consumption profiling	SAP	X	X[1]				X

WU_UC02.4: Obtain detailed information on operational inefficiency	SAP	X	X[1]				X
WU_UC03: Understand energy associated with water consumption							
WU_UC03.1: Obtain information on energy consumption associated with pumping	IBM		X[1]				X
WU_UC04: Get support to increasing operational efficiency							
WU_UC04.1: Receive warnings about faults and unusual water consumptions in the network	SAP		X[1]				X
WU_UC04.2: Receive warnings about the status and sizing adequacy of water meters	SAP		X[1]				X
WU_UC04.3: Obtain information on the effect of pressure control on leakage components and consumption.	LNEC	X	X[1]				X
WU_UC04.4: Receive customized suggestions about pressure reducing valve settings	IBM		X[1]				X
WU_UC04.5: Receive customized suggestions about pumping scheduling	IBM		X[1]				X
WU_UC05:Get support to increasing the quality of service							
WU_UC05.1: Receive information to make billing more accurate and flexible	IBM		X[1]				X
WU_UC05.2: Receive information to improve the management of complaints	LNEC	X	X[1]				X
WU_UC05.3: Receive information to provide warnings to consumers	LNEC	X	X[1]				X
WU_UC06: Get support to influence consumers to modify their behaviour							
WU_UC06.1: Receive customized suggestions about adaptive pricing schemes	IBM		X[1]				X
WU_UC06.2: Receive customized suggestions about awareness campaigns	NTUA		X[1]	X			X
WU_UC07: Get support for system planning and design							
WU_UC07.1: Obtain water consumption trends regarding "what-if" scenarios	NTUA		X[1]	X			X
WU_UC07.2: Get support to decision-making on water network expansions	LNEC	X	X[1]				X
WU_UC07.3: Obtain information to support optimal equipment replacement scheduling	IBM		X[1]				X
WU_UC07.4: Determine optimal placement of valves and flow meters on pipes in the network	IBM		X[1]				X

[1] The tests carried out by UNEXE did not follow exactly the general test scenario/test case approach. They were preliminary tests carried out before the formal off-line testing and aimed at monitoring the status of the widgets and at finding any serious problems the widgets might had at the beginning. Results from these preliminary tests are presented in Annex 3.

Table 78 – Partners responsible for executing non-functional tests

	LNEC	IBM	UPL
Load		x (WU)	x (C)
Performance	x		
Compatibility	x		
Scalability	x	x (WU)	x (C)
Security	x		
Usability	x		
Documentation	x		
Availability		x (WU)	x (C)

8.1.2 Access to widgets under test

When off-line tests were carried out, Widgets under test were hosted by:

- Utility domain: IBM
- Consumer domain: UPL

For the off-line tests widgets were accessed by the following links:

- Utility domain: http://195.212.132.10:10039/wps/myportal
- Consumer domain: http://iwidget.up-ltd.co.uk/

8.1.3 Confidentiality issues

As persons from outside the iWIDGET project did some of the tests, thus having access to data from case studies, data confidentiality issues were considered. To safeguard data confidentiality, testers who were not part of the project team did not know the origin of the historic data that they had access to.

8.2 Procedure to execute an off-line test

The execution of a functional off-line test was composed of two parts: the functionality test itself and the usability enquiry.

During the **functionality test**, tasks were executed by users (the testers) instructed to carry out a sequence of predefined steps according to the test scenarios and test cases previously defined by the project team and reported in chapters 5 and 6. When the tester was someone from outside the project, he was accompanied by a project partner team member, called the observer. The observer takes notes and records user testing.

Usability enquires use subjective measures to gather feedback from the users perspective on the more qualitative aspects of the tests related to users expectations. The usability enquiry comprised the execution of a standardized questionnaire based on the System Usability Scale (SUS) approach (Brooke, 1996; Bangor *et al*., 2009) widely used in the IT domain. After using the system under test, the user filled the questionnaire presented in Annex 2. A modified version of the SUS was used in iWIDGET: 2 additional questions were included in the usual set of 10 questions to assess aspects not covered by the traditional SUS: documentation and support aspects. The answers were rated according to a 5-point Likert scale.

In the iWIDGET project, people other than the code developers did the system testing in WP3. They did not have access to the source code and were only responsible for testing the fully integrated system. When they found symptoms of faults (that is, when failures occur in response to test cases), this information was transmitted to the development team (WP2) for fault isolation and repair.

Off-line WP3 functional testing was done in two phases so that end-users (consumers and water utilities staff) tested a version which had already been corrected for the main faults:

Phase 1) **Testing done by project partners** team members not directly involved in the widgets development, i.e, in code writing.

Phase 2) **Testing done by end-users** with adequate profile: for the consumer domain, widgets testers are domestic consumers; for the utility domain, widgets testers are staff members from water utilities.

In Phase 1 testers did not necessarily have to be accompanied by an observer, they themselves could fill the result records and they did not fill the usability enquiry. But test cases were always followed and test results recorded according to section 8.4. However, in Phase 2, the complete procedure described above was followed as testers are not system experts.

Another group of off-line tests are non-functional tests which were carried out only by the project partners team members and not by end-users.

8.3 Historical data used for tests

The historical data used for off-line testing came from Barcelos case study. Barcelos is a town located in Northern Portugal. The case study consists of three District Metered Areas within the town. Network flow and pressure data are available from a SCADA

system for these areas, alongside with telemetry systems that collect real-time water consumption data for 311 households. This data was provided by AGS and covers a 2 years period starting from January 2009 to October 2010.

For household analytics testing, water consumption data from households was used. The raw data is cumulative water consumption in litres, logged in 15 minute time step.

For water supplier side analytics testing, the following type of data was used: network flow, network pressure, characteristics of network equipment (flow meters, valves, pumps), type of consumers, network hydraulic model, water and energy prices.

8.4 Recording of tests results and communication to WP2

Excel spreadsheets were used to record the results of all test runs.

Annex 1 presents the template to record the results of functional tests for a use case under test. During each test run in Phase 1, the tester filled this record. During each test run in Phase 2, the observer filled this record while the tester performed the test.

Results from usability enquiries were recorded according to the template in Annex 2. In Phase 2, the tester filled this record.

Results were sent by the tester partner to LNEC and to the WP2 partner that developed the widget under test for faults correction.

9 Results of off-line tests

9.1 Results of functional tests

9.1.1 Results from test cases execution

Table 79 presents an overview of the results from the off-line functionality tests of each use case for all test cases. These functionality tests were performed according to the procedure described in section 8.2. For each test case, results include the number of times the test case was executed, the number of total failures, the steps where failures occurred and the final status of the test case, i.e. if it passed or if it failed in the test. A test case was considered to fail if a failure occurred in at least one of its steps.

Table 79 – Test case results from off-line testing – consumer domain

Use Case ID	Test case ID	# Executions	# Failures	# Passes	Steps where failing	Status
C_UC01.1	1.1	3	3	0	4. Select 15-minutes resolution from the time resolution list 8. Print the report 9. Download data	FAIL
	2.1	3	3	0	8. Print the report 9. Download data	FAIL
	3.1	3	3	0	9. Print the report 10. Download data	FAIL
	4.1	3	3	0	9. Print the report 10. Download data	FAIL
	5.1	3	3	0	9. Print the report 10. Download data	FAIL
	6.1	3	3	0	9. Print the report	FAIL
	7.1	3	3	0	9. Print the report	FAIL
	8.1	3	3	0	8. Print the report	FAIL
	9.1	3	3	0	9. Print the report	FAIL
C_UC01.2	1.1	1	1	0	7. Print the report	FAIL
C_UC02.1	1.1	1	1	0	8. Print the report	FAIL
	2.1	1	1	0	6. Print the report	FAIL
C_UC02.2	1.1	1	1	0	7. Print the report	FAIL
C_UC02.3	1.1	1	1	0	6. Print the report	FAIL
C_UC03.1	1.1	4	2	2	6. Print the report	FAIL
	2.1	3	2	1	6. Print the report	FAIL
	3.1	3	0	3		PASS

	4.1	3	0	3		PASS
	5.1	3	0	3		PASS

Table 79 (cont.) - Test case results from off-line testing – consumer domain

C_UC03.2	1.1	6	5	1	3.Select a specific day from the calendar (7 January 2009) 6. iWIDGET presents a time series graph and a report 7. Print the report	FAIL
C_UC03.3	1.1	6	4	2	3. iWidget calculates the result 7. Print the report	FAIL
C_UC03.4	1.1	6	2	4	3. iWidget calculates the result 7. Print the report	FAIL
C_UC03.5	1.1	3	1	2	3. Access the on-line course that is displayed via a new tab in the browser	FAIL
	2.1	1	1	0	3. Access the on-line course that is displayed via a new tab in the browser	FAIL
C_UC03.6	1.1	1	1	0	8. Print the report	FAIL
C_UC04.1	1.1	5	2	3	2. Select time-period of consumer data (energy use) 3. iWIDGET displays consumer data and energy consumption 4. Input energy tariff information 8. Print the report 9. Save data	FAIL
C_UC05.1	1.1	2	0	2		PASS
	2.1	2	0	2		PASS
C_UC05.2	1.1	5	3	2	2. Select water pricing tariff 3. iWIDGET displays pricing tariff 4. iWIDGET displays water cost 5. iWIDGET displays comparative tariff costs 6. iWIDGET identifies best tariff cost 7. iWIDGET yields ease of interpreting water cost 8. iWIDGET yields ease of interpretation 9. Print the report 10. Save data	FAIL
C_UC05.3	1.1	5	3	2	4. iWIDGET displays future water bill 5. iWIDGET displays alternative future bills 6. Print the report 7. Save data	FAIL
C_UC5.4	1.1	5	2	3	2. Select time-period of consumer data (energy use) 3. iWIDGET displays consumer data and energy consumption 4. Input energy tariff information 8. Print the report 9. Save data	FAIL
C_UC6.1	1.1	1	0	1		PASS
C_UC6.2	1.1	1	0	1		PASS

Except for C_UC5.1, C_UC6.1 and C_UC6.2, all use cases from the consumer domain failed in at least one test case.

The most common types of failures found during the tests were related to print and save/download data. These failures occurred in most of the use cases.

Other failures were related to the following requirements:

- Selection of options
- Data input
- Display of results
- Correct calculation of results

Table 80 – Test case results from off-line testing – water utility domain

Use Case ID	Test case ID	# Executions	# Failures	# Passes	Steps where failing	Status
WU_UC1.1	1.1	2	1	1	2.Go to tab "utility overview"	FAIL
	2.1	2	1	1	2.Go to tab "utility overview"	FAIL
	3.1	2	1	1	7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	4.1	2	1	1	5.Select minimum temporal resolution, "15 minutes" 7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	5.1	2	1	1	7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	6.1	2	1	1	7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	7.1	2	1	1	7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	8.1	2	1	1	7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
WU_UC1.2	1.1	2	1	1	7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	2.1	2	1	1	5.Select minimum temporal resolution, "15 minutes" 6. Select all DMA 7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	2.2	1	1	0	5.Select minimum temporal resolution, "15 minutes" 8. iWIDGET presents a time series graph and a bar chart	FAIL
	3.1	2	1	1	6. Select all DMA 7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
	3.2	2	1	1	7. iWIDGET calculates the result	FAIL

	3.3	2	1	1	7. iWIDGET calculates the result 8. iWIDGET presents a time series graph and a bar chart	FAIL
WU_UC02.1	1.1	2	2	0	6. iWIDGET calculates the result 2.Go to tab “Water balance” 3.Go to sub-tab “Water balance overview” 8. iWIDGET presents a bar chart and a water balance table	FAIL
	2.1	2	2	0	6. iWIDGET calculates the result 2.Go to tab “Water balance” 3.Go to sub-tab “Water balance overview” 5. Select Network Sector “all DMAs" 7. iWIDGET presents a bar chart and a water balance table	FAIL
	3.1	2	2	0	6. iWIDGET calculates the result 2.Go to tab “Water balance” 3.Go to sub-tab “Water balance overview” 5. Select Network Sector “all DMAs” 7. iWIDGET presents a bar chart and a water balance table	FAIL
	3.2	1	1	0	6. iWIDGET calculates the result 2.Go to tab “Water balance” 3.Go to sub-tab “Water balance overview” 7. iWIDGET presents a bar chart and a water balance table	FAIL
WU_UC02.2	1.1	2	2	0	7. iWIDGET presents a bar chart and a water balance table 10. Print information 2. Go to “Water Analysis” Tab 8. Press calculate	FAIL
WU_UC02.3	1.1	1	1	0	6. Select consumer ID "00062382" 13. Check the information displayed in the graph 14. Print the report 15. Save data	FAIL
	2.1	1	1	0	13. Check the information displayed in the graph 14. Print the report	FAIL
	3.1	1	1	0	13. Check the information displayed in the graph 14. Print the report	FAIL
WU_UC02.4	1.1	2	2	0	4. Select Network Sector “all DMA” 5. Select Time Series “Apparent losses” 10. Print the information 11. Save the information	FAIL
	2.1	1	1	0	7. Select Time Interval 21.09.2009 00:00 hours to 27.09.2009	FAIL
	3.1	1	1	0	8. Press calculate 9. Check the information displayed for accuracy 10. Print information 11. Save the information	FAIL
	4.1	1	1	0	6. Select temporal resolution 8. Press calculate 9. Check the information displayed for accuracy 10. Print information 11. Save the information	FAIL
WU_UC03.1	1.1	1	1	0	9. Save data	FAIL
	2.1	1	1	0	9. Save data	FAIL
	3.1	1	1	0	9. Save data	FAIL

	4.1	1	1	0	9. Save data	FAIL
WU_UC04.1	1.1	1	1	0	12. Print information 13. Save the information	FAIL
WU_UC04.2	1.1	1	1	0	7. Select consumer ID "00062648" 11. Check the information displayed 12. Print information 13. Save the information	FAIL
WU_UC04.3	1.1	2	1	1	7. iWIDGET presents a time series graph and a pressure graph	FAIL
	1.2	2	1	1	7. iWIDGET presents a time series graph and a pressure graph	FAIL
	1.3	2	0	2		PASS
	1.4	2	0	2		PASS
	1.5	2	1	1	7. iWIDGET presents a time series graph and a pressure graph	FAIL
	1.6	2	1	1	7. iWIDGET presents a time series graph and a pressure graph	FAIL
	1.7	2	0	2		PASS
	1.8	2	0	2		PASS
	2.1	2	0	2		PASS
	2.2	2	0	2		PASS
	2.3	2	0	2		PASS
	2.4	2	0	2		PASS
	2.5	2	1	1	8. iWIDGET presents a time series graph and a pressure graph	FAIL
	2.6	2	1	1	8. iWIDGET presents a time series graph and a pressure graph	FAIL
	3.1	2	2	0	4. Select network sector "all DMAs" 6. Enter number of monitoring campaigns "2"	FAIL
	3.2	2	2	0	6. Enter number of monitoring campaigns “3”	FAIL
	3.3	2	2	0	6. Enter number of monitoring campaigns "5"	FAIL
	3.4	2	2	0	6. Enter number of monitoring campaigns “1”	FAIL
WU_UC04.4	1.1	1	1	0	9. Save data	FAIL
	2.1	1	1	0	9. Save data	FAIL
	3.1	1	1	0	9. Save data	FAIL
	4.1	1	1	0	9. Save data	FAIL
WU_UC04.5	1.1	1	0	1		PASS
	2.1	1	0	1		PASS
	3.1	1	0	1		PASS
WU_UC05.1	1.1	1	0	1		PASS
	2.1	1	0	1		PASS
WU_UC05.2	1.1	2	0	2		PASS
	2.1	2	0	2		PASS
WU_UC05.3	1.1	2	0	2		PASS
	2.1	2	0	2		PASS
WU_UC06.1	1.1	1	0	1		PASS
	2.1	1	0	1		PASS
	3.1	1	0	1		PASS
WU_UC06.2	1.1	2	0	2		PASS
WU_UC07.2	1.1	1	0	1		PASS
	1.2	1	0	1		PASS
	1.3	1	0	1		PASS
WU_UC07.3	1.1	1	0	1		PASS
	2.1	1	0	1		PASS
	3.1	1	0	1		PASS

WU_UC07.4	1.1	1	1	0	11. Save data	FAIL
	2.1	1	1	0	7. Choose analytics type: robust, with confidence interval 80% 11. Save data	FAIL
	3.1	1	1	0	11. Save data	FAIL
	4.1	1	1	0	7. Choose analytics type: robust, with confidence interval 50% 11. Save data	FAIL

From a total of 20 use cases from the water utility domain that were off-line tested, only 8 passed in all corresponding test cases. The remaining use cases failed in at least one test case.

The failures found during the tests were related to the following requirements:

- Selection of input options
- Selection of analytics type
- Display of results
- Correct calculation of results
- Print data
- Save/download data

The failure 'incorrect calculation of results' which can be considered more serious than the others occurred in a significant number of use cases (7 out of a total of 20 use cases). To eliminate this failure the implemented algorithms have to checked and corrected by software developers.

9.1.2 Results from usability tests

After using the widgets, users filled the usability enquiry presented in Annex 2, following the procedure described in section 8.2. Answers were rated according to a 5-point Likert scale. Afterwards, a score contribution ranging from 1-4 (with four being the most positive response) was given to each answer according to the following (Brooke, 1996): for questions 1, 3, 5, 7, 9 and 11 the score contribution is the Likert classification minus 1; for questions 2, 4, 6, 8, 10 and 12 the score contribution is 5 minus the Likert classification. Finally, to obtain the overall System Usability score in a 0-100 scale, the sum of all score contributions was multiplied by 2.08.

Figure 2 and Figure 3 present, for each use case, the scores obtained in each question of the usability enquiries for the consumer domain and for the water utility domain, respectively. For the consumer domain, average question scores, as well as the range of scores obtained from all answers to each question are shown in the graphs of Figure 2. For the utility domain, only one Task 3.2 partner had a 'water utility user profile' (AGS)

and could perform the usability tests, thus no average values or ranges are presented in the graphs of Figure 3.

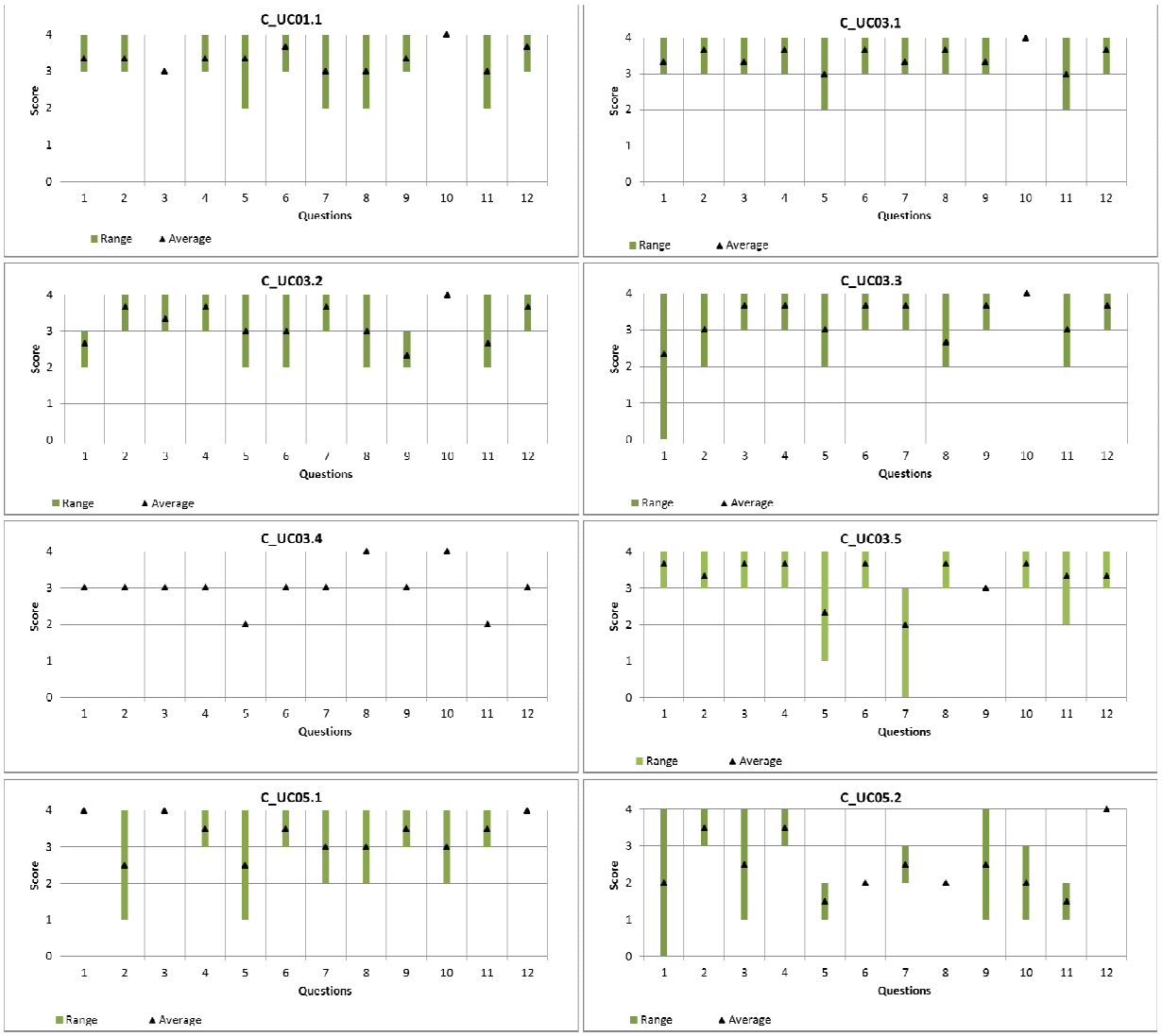

Figure 2 – Usability results from off-line testing – scores for each question of the usability enquiry (consumer domain)

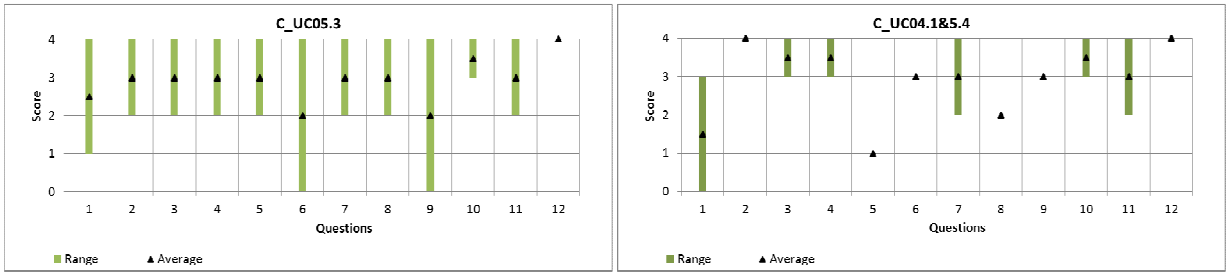

Figure 2 (cont.) – Usability results from off-line testing – scores for each question of the usability enquiry (consumer domain)

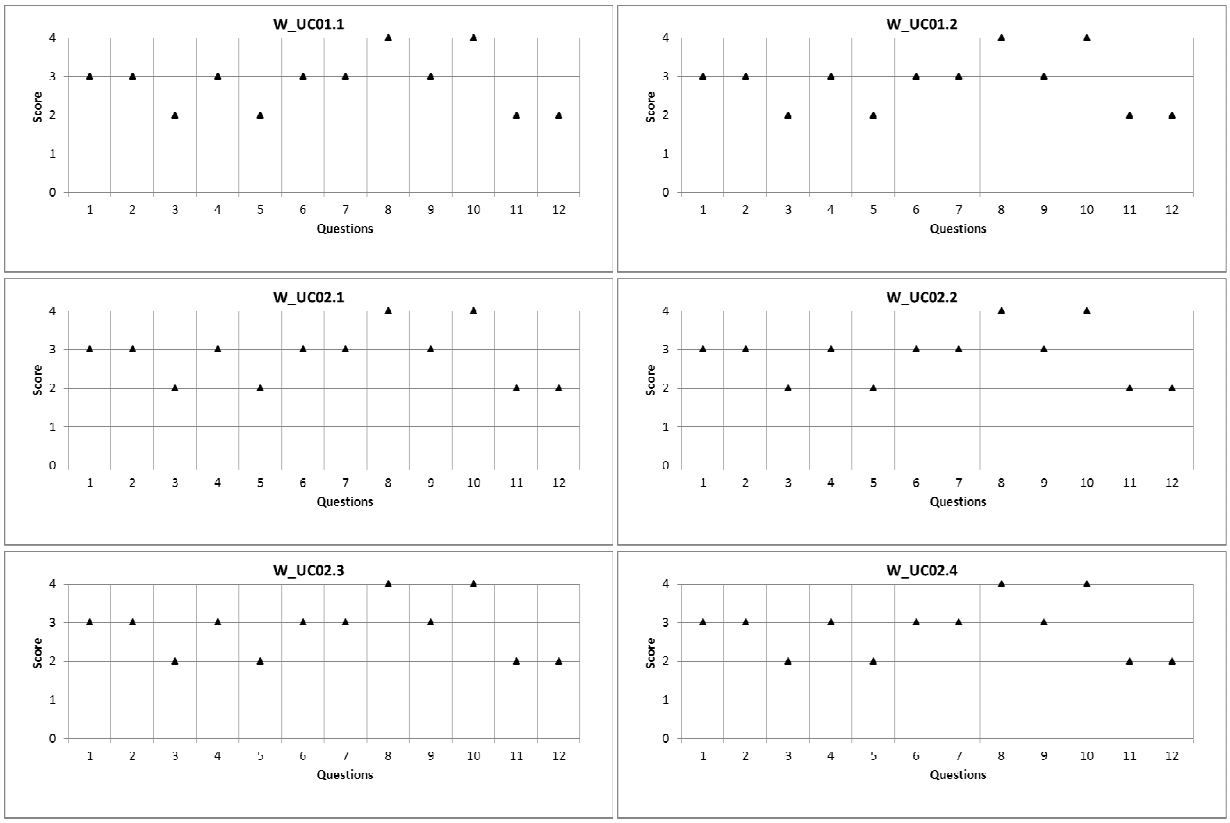

Figure 3 – Usability results from off-line testing – scores for each question of the usability enquiry (water utility domain)

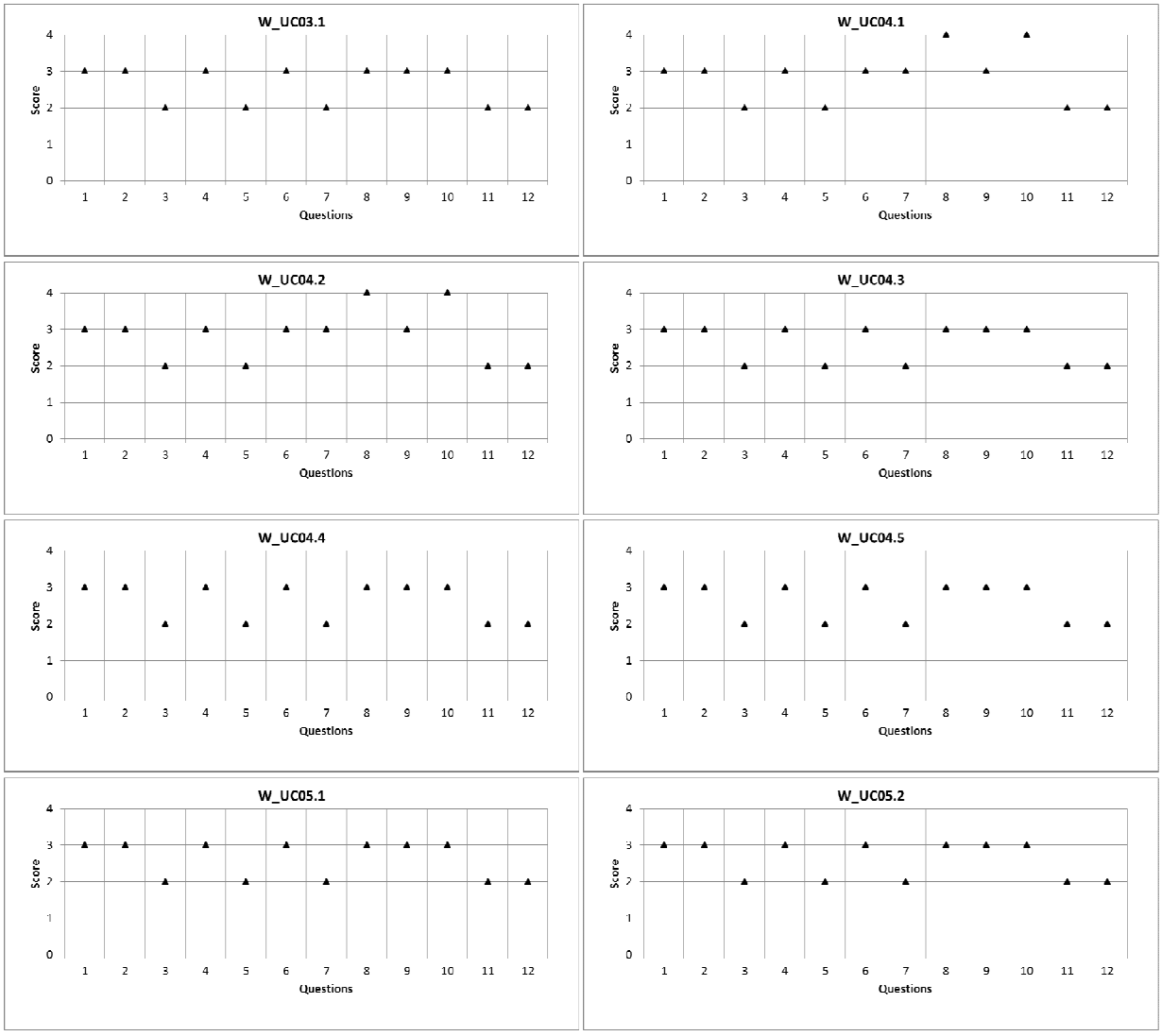

Figure 3 (cont.) - Usability results from off-line testing – scores for each question of the usability enquiry (water utility domain)

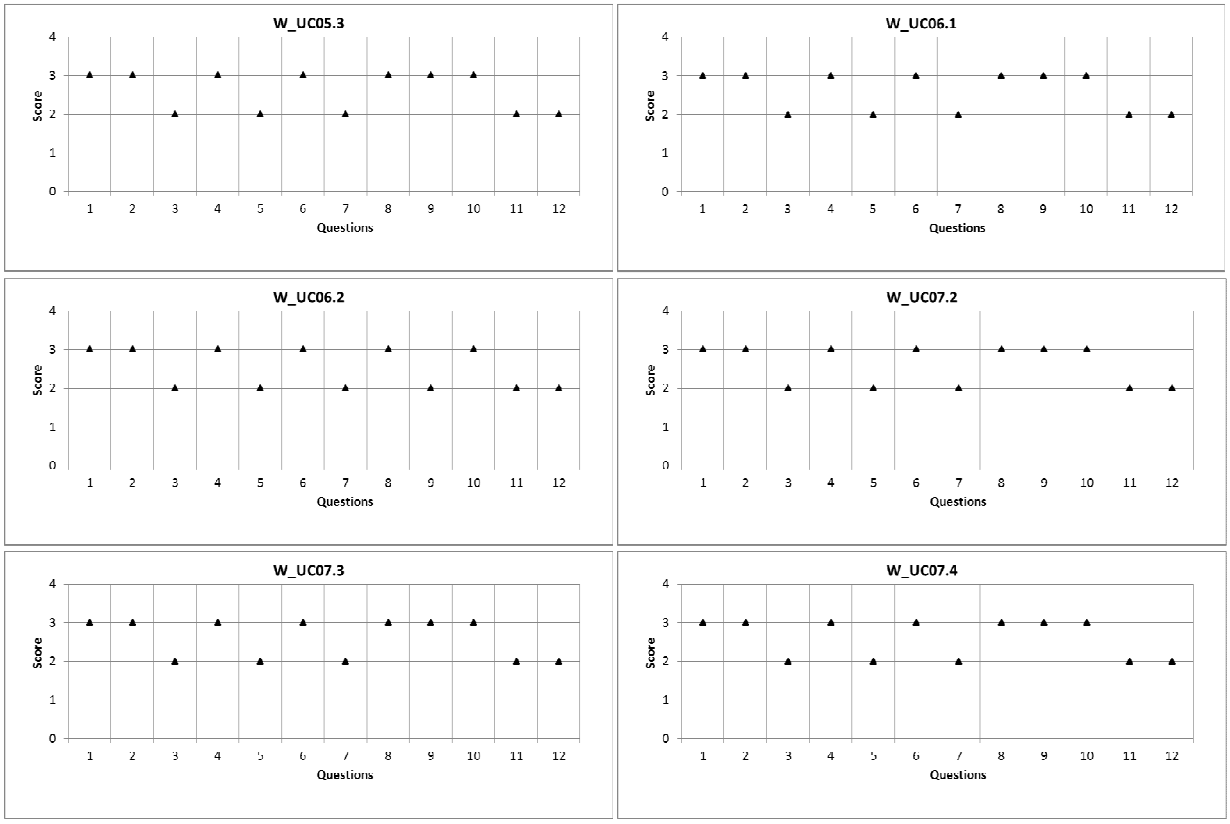

Figure 3 (cont.) - Usability results from off-line testing – scores for each question of the usability enquiry (water utility domain)

Figure 2 shows that results for the consumer domain are good with scores, in general, in the upper part of the 0-4 scale (4 is the highest score). Use cases that have lower scores than 2 in some of the questions are mostly the ones related to the assistance to increase water use efficiency: C_UC05.1 Receive customised suggestions on how to reduce water consumption, C_UC05.2 Receive information on specific and alternatives pricing schemes, C_UC05.3 Forecast the next water bill and C_UC04.1&5.4 Compare energy pattern associated with water use in the same household/Forecast the component of next energy bill associated with water consumption.

For the consumer domain, questions 4, 8, 10 and 12 received the highest scores in most of the use cases, meaning that users were more satisfied with aspects related to the

ease of use of the widgets, the need for technical support and the need to have previous knowledge on the subject before using the system. The remaining questions that received lower scores in some of the use cases are 1, 2, 3, 5, 6, 7, 9. Although the average scores for questions 2, 3, 6, 7, 9 are higher than 2, the range of values can reach zero. In some cases, questions 1 (in C_UC03.3, C_UC05.2 and C_WU04.1&5.4), 5 (in C_UC05.2 and C_WU04.1&5.4) and 11 (in C_UC05.2) have both average values and ranges below 2. So, aspects that worst meet users' expectations are mostly related to the integration of the different functionalities, the quality of the support documentation and the intention to use of the system.

Figure 3 shows that, for the utility domain, all questions scored higher than 2. Questions 8 and 10 received the highest scores (this occurred in use cases UC_WU01.1, WU_UC1.2, WU_UC02.1, WU_UC02.2, WU_UC02.3, WU_UC02.4), meaning that users were more satisfied with aspects related to the awkwardness of the widgets and the need to have previous knowledge on the subject before using the system. Questions that received lower scores in most of the use cases are 3, 5, 7, 11, 12, meaning that users were least satisfied with aspects related to the complexity and ease of use of the system, the integration of different functionalities, the quality of the support documentation and the need for a continuous technical support by e-mail or phone.

Figure 4 and Figure 5 present the overall System Usability scores obtained for each use case of the consumer domain and for the water utility domain, respectively. Average scores, as well as the range of scores obtained are shown in the graphs.

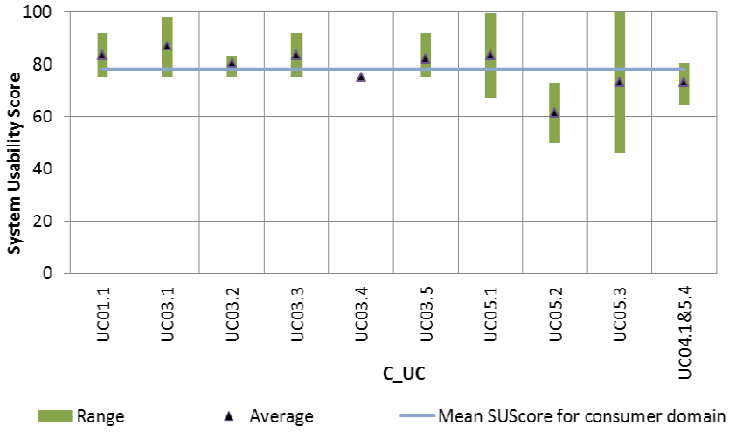

Figure 4 – Usability results from off-line testing – System Usability Scores for consumer domain

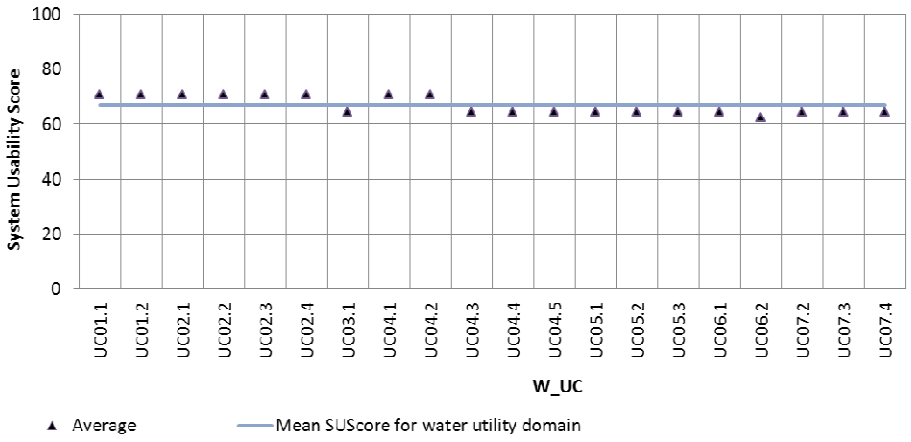

Figure 5 – Usability results from off-line testing – System Usability Scores for water utility domain

Bangor et al. (2008) proposed the set of acceptability ranges in Figure 6 to determine if a given System Usability score indicates an acceptable system or not.

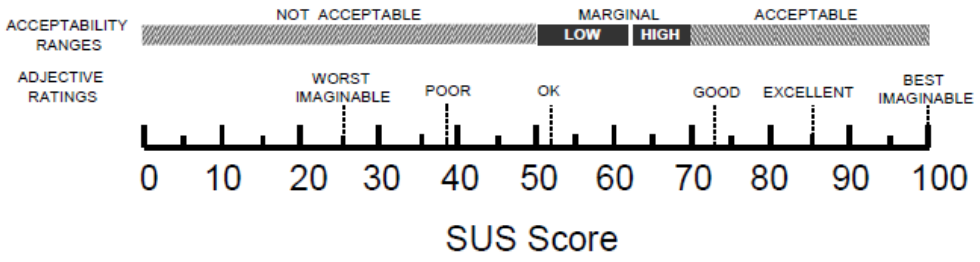

Figure 6 – SUS acceptability ranges (Bangor et al., 2008)

According to Bangor's classification, all use cases from the consumer domain except one had, in average, acceptable System Usability scores in the range 73-87. Use case C_UC5.2 Receive information on specific and alternatives pricing schemes was classified as having a marginal acceptability with a SU score of 61.

For the consumer domain, use cases C_UC01.1, C_UC03.1, C_UC03.3 and C_UC05.1 had the highest SU scores, meaning that they met more closely user expectations. Therefore, the usability aspects of the remaining use cases could be improved so that the usability model of the best classified use cases is followed more closely.

For the utility domain and considering again Bangor's classification, 8 use cases out of 20 tested use cases had acceptable System Usability Scores. The remaining use cases were classified as having a marginal acceptability with values in the range 63-65.

For the utility domain, use cases related to obtaining water consumption and energy related data (WU_UC01.1, WU_UC01.2) understanding water consumption (WU_UC02.1, WU_UC02.2, WU_UC02.3, WU_UC02.4) and getting support to increase operational efficiency through warnings of faults in the network and status and sizing adequacy of water meters (WU_UC04.1, WU_UC04.2) had the highest SU scores. The remaining use cases could be improved by adopting their usability model.

The mean System Usability score for the consumer domain (78) was higher than for the utility domain (67) suggesting that, in general, users' expectations were better met for the consumer use cases.

9.2Results of non-functional tests

Table 81 presents an overview of the results from the non-functional tests executed to on the off-line environment. These tests were performed according to settings described in chapter 8, using the test scenarios for non-functional testing defined in section 5.3. Depending on the test case, the results can be just qualitative (e.g., "pass" if the test was carried with success), or quantitative (e.g., seconds taken to perform one specific action).

Table 81 – Results of Non-function tests

Requirement	Test scenario	Results
Load	#1 Test the whole iWIDGET system with 5 users at the same time	Max response time: 30s
	#2 Test the whole iWIDGET system with 20 users at the same time	Max response time: 90s
Performance	#1 Test the iWIDGET system with data from one month of 1 DMA	4s
	#2 Test the iWIDGET system with data from all the period of x DMAs (x is the maximum	166s

	number available in case studies)	
Compatibility	#1 Test the iWIDGET system with 3 different browsers	Mozilla Firefox 33 fully functional (PASS); Internet Explorer 11 fails; Google Chrome 39.0 FAIL
	#2 Test the iWIDGET system from a mobile device	FAIL
Scalability	#1 Test the iWIDGET system with extended memory	PASS
	#2 Test the iWIDGET system with multiple processors	PASS
Usability	#1 Test the iWIDGET system with test objectives (without defining the detailed script)	number of mouse clicks: 38 (avg) number of *backtacks:* 4.75 (avg) overall time to execute the objective: 213s (avg)
Documentation	#1 Test the existence of documentation	Existence of technical documentation PASS Existence of off-line manuals PASS Existence of online help FAIL
	#2 Test the execution of UCs with users that used that documentation materials, against users without any training	Mouse clicks improvement: 65% Backtracks improvement: 84% Overall time improvement: 61%
Security	#1 Test the iWIDGET system accessing a direct link, without previous login	PASS
	#2 Test the iWIDGET accessing a functionality not allowed for the logged user	PASS
	#3 Test the iWIDGET against SQL injection	PASS
Availability	#1 Test the iWidget availability after forced errors (e.g., power failure)	PASS (manual step required on WebSphere configuration)

The use case "WU_UC07.2: Get support to decision-making on water network expansions" was chosen to test the load requirement. This is due to the fact that this use case is the more time consuming as it performs the simulation of network efficiency. As a result of the load test, one can verify that concurrent accesses to the system increase the time in a scale of 3. Although we just report the time consumption for two scenarios (5 and 20 concurrent users), tests with more users were stabilized on 90 seconds.

The performance tests were done on use case "WU_UC04.3: Obtain information about the effect of pressure control on leakage components and on consumption", using data filtered from one month and one DMA, and executing the same use case with the full data set. Using the offline database, the filtered data was presented in 4s, while the full dataset took 166s to be rendered. Note that the time to render the full data set depends on the amount of data present in the database.

In order to test the compatibility requirement, access to the system was tested with three distinct browsers, namely: Mozilla Firefox v33, Google Chrome v39 and Internet

Explorer v11. Mozilla Firefox is fully compatible with iWIDGET, but the experience with both Google Chrome and Internet Explorer reveal compatibility issues, especially on the *JavaScript* controls used to select data and to render graphics. Also, the tests with mobile devices also raised compatibility issues, which were expected as the interface elements were not conceived to be used by mobile applications.
Table 82 resumes the multiple hardware configuration settings that were used to develop and test the developed widgets. As can be seen from this table, we have three distinct configurations. Configurations C1 and C2 run on separated servers for the application and database components. In these cases, the servers have 2 cores and 32GB of memory. Configuration C3 runs on a single server with 4 cores and 4GB of memory. Based on these configurations, the scalability tests with extended memory and multiple processors were successful. The system is able to run on both 2 and 4 cores, as well as it can run with 4GB or 32GB of memory, without any additional configuration requirement.
In order to test the system usability, we tested 4 distinct objectives (without defining the real script). The users were allowed to follow any path in the system. The results reported on Table 81 correspond to the average value achieved for each indicator. Note that the users involved on this test did not have any experience with iWIDGET.

Table 82 – Server hardware configuration settings

Configuration	Server description	Memory	# Cores	CPU
C1. Development environment with 2 servers	Application server (IBM WebSphere and Apache Tomcat) -Dev	32GB	2	Intel Xeon 8850 @ 2GHz
	Database server -Dev	32GB	2	Intel Xeon 8850 @ 2GHz
C2. Test environment with 2 servers	Application server (IBM WebSphere) -Test	32GB	2	Intel Xeon 8850 @ 2GHz
	Database server -Test	32GB	2	Intel Xeon 8850 @ 2GHz
C3. Deployment environment with 1 server	Application server and Database server	4GB	4	Intel Xeon

With regard to the existence of documentation, the tests are performed in a binary way (pass if the documentation exists, fail if the documentation does not exist). For the three

types of tested documentation, it was verified that technical documentation and offline manuals exist[1]
In order to test the documentation effect on the users' ability to use the system, a set of goal-driven tasks based on the available use case scenarios was created. These tasks were intended to be undertaken by users with and without previous access to iWidget documentation, so that the contribution of the documentation to the widgets usability could be evaluated. Four trial tasks (TT), concerning both the water utility and the consumer side widgets, were defined as follows:

Table 83- Usability test trial tasks

Task	Goal
TT1 (WU_UC04.3)	Obtain the leaking profile and associated pressure variation in a DMA
TT2 (WU_UC07.3)	Obtain the optimal schedule for the replacement of a water meter
TT3 (C_UC01.1)	Obtain total water consumption and associated cost
TT4 (C_UC03.1)	Obtain a comparison of current water consumption data with historical data

The following metrics were used to assess trial results:

- Time (s) – total time spent on each TT.
- # mouseclicks – total number of mouse clicks.
- # backtracks – total number of times the user had to return to a previous widget state.
- Success (Y/N) – whether the user achieved the proposed goal.

Table 84 and Table 85 show test results for users with and without previous access to relevant documentation. From the aggregated overall values, we computed the generalized improvement achieved by the use of documentation, considering results without documentation as the baseline result (BR) and the results with documentation as the achieved result (AR), the improvement is computed as follows: (1 – AR/BR) x 100.

[1] Technical documentation and offline manuals are reported on "D2.2.1 Methodology, conceptual and architectural design of the iWIDGET systems" and "D2.2.2 Final report on the working prototype for iWIDGET"

Based on that, the results represent 65% improvement on mouse clicks, 84% improvement on backtracks and overall time improvement of 61%.

Table 84 - Results of tests with documentation

	TT1	TT2	TT2	TT4	Overall
Time (s)	70	110	120	30	330
# mouseclicks	18	16	12	8	54
# backtracks	0	3	0	0	3
Success (Y/N)	Y	Y	Y	Y	-

Table 85 - Results of tests without documentation

	TT1	TT2	TT2	TT4	Overall
Time (s)	135	480	180	60	855
# mouseclicks	65	54	25	8	152
# backtracks	1	10	7	1	19
Success (Y/N)	Y	N	Y	Y	-

Concerning the security requirement, three test scenarios were tested with full success:

- Test the iWIDGET system accessing a direct link, without previous login: for all tested forms, the system did not allow any operation, redirecting the user to the login page.
- Test the iWIDGET accessing a functionality not allowed for the logged user: for all tested forms, the system did not allow any operation, redirecting the user to the login page.
- Test the iWIDGET against SQL injection: the system was tested against direct SQL and REST requests,

With relation to the availability, the system was tested with "forced shutdown" operations. Both servers (application and database) have rebooted cleanly and the servers restarted. Due to the current configuration, the WebSphere application server does not restart automatically, but his issue is related to the WebSphere configuration and not with the iWidget components per se. The database services restart automatically with no need for any manual step.

10 Conclusions

This milestone reports the off-line testing method adopted to provide a real life full scale testing of the iWIDGET systems. This method is based on the best practices on the software engineering filed, assuming distinct test scenarios and test cases to assess the system functionality and quality (non-functional properties). While ensuring a comprehensive assessment, the testing scenarios must also be aligned with the system requirements. Also, the effective testing required a close collaboration with the system analysts, software developers and end users (households and utility stakeholders).

The widgets both from the consumer domain and the utility domain did not always provide a correct behaviour with respect to the functional requirements for tested conditions and input parameters. Some minor failures were found during off-line testing but also major failures (incorrect calculation of results) that require changes in the algorithms of the widgets to be made by software developers. As a first understanding, this might seem as bad results but, in fact, that is what is expected from system testing. All issues identified by this testing were reported to the software developers and system analysts and are being corrected. Indeed, all failures described in chapter 9 were reported by WP3 testing partners to WP2 developing partners of each widget as soon as they were becoming known during the testing period. This way, improvements in the widgets could be made by software developers as soon as test results were available.

Finally, we would like to remark that testing must be seen as a critical process and application improvement activity, where anomalies are detected in advance, making it possible to correct (or being aware of) functional and non-functional issues before deploying the system to the final users.

11 References

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ANNEX 1 – Template for recording off-line functional test results

Use Case: *use case ID and name*

WIDGET developer in WP2 (partner):

Test scenario	Test case	Test case steps	Requirement (as in MS13)	Success criteria	Key Performance Indicator	Type of failure	Obs.	Comment from WP2 development team (solved, not solved, other comments)
test scenario number	*test case number*	1. *step 1 description*	*requirement corresponding to step 1*	*success criteria for step 1*	*KPI to access success criteria 1*	*In case of KPI=fail, type of failure that occurred*		
		2. *step 1 description*	*requirement corresponding to step 2*	*success criteria for step 2*	*KPI to access success criteria 2*	*In case of KPI=fail, type of failure that occurred*		
		3. *step 1 description*	*requirement corresponding to step 3*	*success criteria for step 3*	*KPI to access success criteria 3*	*In case of KPI=fail, type of failure that occurred*		
		…						
Tester (name/organization): **Observer (name/organization):** **Date of test run:** **Overall test case status (pass/fail/inconclusive):**								

(grey cells are to be filled by tester or by observer during the off-line test, except for the grey cells in last column that are to be filled by the WP2 development team)

ANNEX 2 – Template for recording results from usability enquiries (based on the System Usability Scale)

Use Case: *use case ID and name*

Tester (name/organization):
Date of test run:

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5
11. I found the user documentation comprehensive, appropriate and well-structured	1	2	3	4	5
12. When using the system, I would need more support by e-mail or phone.	1	2	3	4	5

Comments and suggestions for improvement made by the tester

(Note1: the tester fills one survey by widget; Note 2: the survey is filled in excel format)

ANNEX 3 – Results from preliminary tests carried out by UNEXE

Use case	Comments
Consumer domain	
1.1	Almost ready-small adjustments needed
3.1	Ready
3.2	Ready
3.3	Ready
3.4	Major modification of requirements for lack of data
5.1	Ask Panagiotis, but I think it's ready
5.2	Ready
5.3	Ready
Water utility domain	
1.1	C1: All the SAP widgets present some inconsistencies in terms of unit of measurement. Another problem arisen is that the uploading on the IBM site seem to have cut some screenshots.
1.2	C1
2.1	C1 How to activate billed and unbilled metered consumption? Which values do they take on?
2.2	C1 The graph above should be a histogram and not a line graph. It's clear neither from the widget nor from the training material how can this widget be used and what information does it yield?
2.3	C1 Don't understand the relationship between lower and upper graphs
2.4	C1
3.1	C2 – The widget deals with pumps and tanks. An image with the layout of the network, that shows where these pumps and tanks are, should be provided. The features of the pumps and the tanks should be written. C3 – Here you use euro as currency. Consistently with the other widgets, it is better not to specify the currency, in order to make the widget itself more general. C4 – From the hydraulic viewpoint, the 6 hour time step is too large. C5 – You set 6 hour long energy tariff slots. In reality, it is seldom like this. It should be more flexible, to accommodate variable duration time slots.
4.3	C20 – As far as I understand, the data concerning inflow, leakage, real loss and pipe burst are scattered. It would be great to have a slot of time where all the data are present because this would help me testing the widget better. C21 – What is the downstream pressure? In which node? Please use meter as unit of measure of pressure heads, rather than bar, like in the other widgets. C22 – A network layout image should be provided. C23 – How can leakage be around 20 m3/s and inflow around 0.03 m3/s in may 2009 for DMA1?
4.4	C10 – An image of the network, where the positions of the PRV and of the node with the lowest pressure are indicated, should be provided. C11 – It seems quite slow in processing.

4.5	C6 – The widget deals with pumps and tanks. An image with the layout of the network, that shows where these pumps and tanks are, should be provided. The features of the pumps and the tanks should be written. C7 – Which optimization time step do you use? I assume that it is shorter than in widget 3.1. So I will never be able test the results of this widget with widget 3.1. C8 – You set 6 hour long energy tariff slots. In reality, it is seldom like this. It should be more flexible, to accommodate variable duration time slots. C9 – It seems quite slow in processing.
5.1	Ready
6.1	C16 – Graphs are illegible, as to x and y axis values, poor titles and scales. C17 – It seems quite slow in processing. C18 –I cannot understand the operation of the widget without assistance.
6.2	Ready
7.1	Ready-Unified with 6.2
7.4	C12 – Here I like the presence of the network layout. However, the possibility of zooming in and out should be given. Otherwise, in some cases, valve positions are hard to detect. Other fundamental elements, such as tanks or reservoirs, should be present in the layout. C13 – The widget enables the user to choose the positions of the valves according to the time slot. The user then also needs to see the demand coefficient and the tank level of all the time slots, in order to understand which the best one for optimizing valve positions is. Alternatively, presented without this information, time slots are useless and it is better to optimize in a straightforward way with respect to the tank and water demand average values. C14 – It seems quite slow in processing. C15 – Reference to flow meters is absent. Is it sure that we do not have to work on this?

iWIDGET

Smart meters
Smart water
Smart societies

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