VALIDATION REPORT

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Summary of this report:...............This deliverable contains a report of the Swiss and Spanish case study validation and contains detailed documentation about deployment of the smart meter monitoring system, deployment of the social awareness app, associated promotion campaign to create an online user community, subsequent data analysis and launching of water saving and pricing campaign, user feedback collection and processing, and final evaluation, based on the continuous monitoring of the KPIs defined in D7.1.
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Executive Summary

This deliverable is the first report of the Swiss and Spanish case studies and contains detailed documentation about deployment of the smart meter monitoring system, deployment of the social awareness app, associated promotion campaigns among target user groups, subsequent data analysis and launching of water saving and pricing campaign, user feedback collection and processing, based on the continuous monitoring of the KPIs defined in *D7.1 Validation methodology*.

The deliverable first presents the deployed smart metering infrastructure and the privacy-aware transfer of water consumption data from the different smart meter technologies. Subsequently, details are provided about the deployment of the SmartH2O platform. Overall representations of the run-time configuration and the components that run on the nodes deployed are presented for both deployment sites, in Terre di Pedemonte and in Valencia respectively.

The next section then details the user populations at each of the pilot sites, followed by an account of the promotion campaigns that have been carried out to recruit users for the SmartH2O portal, including e.g. presence at events, electronic and regular mail campaigns, as well as press contacts. The section also outlines the pricing campaign recruiting users for the pricing survey that collects data on customers' sensitivity to monetary and non-monetary incentives to save water.

The main part of the deliverable documents the approach to and first (interim) results of the SmartH2O validation, with respect to the current state of deployment. In the Swiss case study users positively assessed the basic portal on the level of the application as a whole, as well as on the level of individual features. Moreover, tentative evidence of water consumption reduction achieved so far (after filtering out the effect of seasonal variations), indicates the potential impact of the basic SmartH2O system (smart metering, consumption visualisation, saving tips). However, the size of the pilot population and the duration of the data collection do not allow final conclusions to be drawn yet.

Participants in the preliminary evaluation positively evaluated the utilitarian value of the overall Smart H2O portal. Also most individual success criteria that were introduced during the requirements process (see *D2.2 Final requirements*) received positive ratings, including usefulness of water saving tips and water consumption visualisations, and the extent to which users are encouraged to think more about their water consumption by inspecting consumption feedback.

Whereas the Swiss pilot is small in size, the Spanish pilot has been expanded to full-scale deployment on the entire population served by EMIVASA of nearly 800,000 inhabitants. Such large scale roll-out of the SmartH2O portal in the Spanish pilot required specific adaptations to the SmartH2O portal and incentive models with respect to the Swiss case. The adapted incentive model (see D4.3) and the SmartH2O system for such large scale roll-out in the Spanish case have been implemented, deployed, tested and prepared for the official launch. Measurement instruments for water consumption and awareness, for treatment groups and a control group have been set up and described, including baseline water consumption statistics.

In Spanish trial currently being launched particular emphasis will be placed on the validation of the gamified approach to incentivizing users to save water. Both the large-scale trial in Spain, as well as the smaller scale trial in Switzerland will yield valuable insights into the

effectiveness of the SmartH2O approach, and its impact on the defined KPI's of water consumption and user awareness.

1. Introduction

The main purpose of the SmartH2O project is to deliver solutions that can induce a quantifiable, sustainable change in water consumption behaviour and an increase in the awareness about water. For this purpose the social awareness app was deployed in two case studies: Switzerland (Terre di Pedemonte) and Spain (Valencia).

This deliverable is the first report of the Swiss and Spanish case studies validation and contains detailed documentation about deployment of the smart meter monitoring system, deployment of the social awareness app, associated promotion campaign among target user group, subsequent data analysis and launching of water saving and pricing campaign, user feedback collection and processing, and a first evaluation, based on the continuous monitoring of the KPIs defined in *D7.1 Validation methodology*.

The deployed smart metering infrastructure, the user modelling in WP3, and the research on incentives of behavioural change processes in WP4 (including the factors that determine water consumption) contribute to a better understanding of consumer behaviour. The user modelling in WP3, as reported in *D3.4 Final user behaviour models and ABM platform*, provides a clustering of users that is instrumental to validation: the clusters will be used to compare consumption reduction levels between groups of users, and to relate platform usage to these clusters, as baseline consumption levels have proved to affect the effectiveness of water efficiency interventions (e.g. [Schulz et al., 2014]).

The validation results will refine the understanding of user behaviour and the effectiveness of different incentive models, allowing for adjustments of the gamification and rewards model that has been introduced in *D4.3 Incentive models and algorithms*, and subsequently also for upcoming releases of the portal. The continuous monitoring of KPI's and portal adjustments resulting from real-world validation results aim at maximizing water saving, and securing alignment with end-user needs and their awareness of water consumption and saving.

In terms of deployment, this deliverable documents the technical deployment of the smart metering infrastructure that provides the data for the social awareness app. Furthermore, it reports on the deployment of the prototype that was as *D6.4 Platform Implementation and Integration - second prototype*, containing the actual implementation of the incentive mechanism and user interfaces for the social awareness app.

The SmartH2O application is deployed in real-world settings, with real customers as participants. As a real-life application, at this stage of the project much attention has been devoted to the release of subsequent portal releases that incentivize users to return to the portal. From this perspective, the small-scale Swiss case study (around 400 households), has been conceived as a test-bed for the testing and fine-tuning of the incentive model and SmartH2O gamification techniques, and of the measurement infrastructure and instruments (water consumption, questionnaires, and user interaction logging).

In the Swiss case study, the basic portal was launched in July 2015 (version 1), and October 25th (version 2). On December 7th the advanced portal was released, which implements the gamified incentive model that is described in *D4.3 Incentive model and algorithms*. In this deliverable, we report on the water consumption data, questionnaire responses, and portal usage logging data, we have received from participants in the Swiss case study who have used the basic portal until the release of the advanced portal.

In contrast, the Spanish portal has been expanded to a full-scale operational roll-out of a new EMIVASA customer service (not just a limited pilot anymore), addressing the entire population served by EMIVASA of ca. 800'000 inhabitants in total. This has required adapting the incentive model and including additional functions for managing utility-customer interaction (the communication tool). It has been deployed and is being launched in Valencia on the 31st of March 2016 to alpha users and in April 2016 to all EMIVASA customers, containing all currently implemented basic portal and advanced portal features, including goal setting. The Valencia population size and the committed efforts of EMIVASA to recruit users from their customer base are the basis for a robust validation of the SmartH2O concept, in line with the methodology that was defined in *D7.1 Validation design*, comparing water consumption and water awareness of SmartH2O users against a control group. At the time of writing, the portal for EMIVASA has been deployed, the alpha test is starting and recruitment efforts for the official launch have started. At present we are already able to report the data for the baseline water consumption.

In the upcoming validation results deliverable (*D7.3 Final overall validation and impact* (M36)) large-scale longitudinal data will be available to report on the impact of the SmartH2O portal on water consumption and awareness, as well as on water utilities' business operations.

2. Smart water meter infrastructure

The SmartH2O project includes two case studies, respectively run by the SmartH2O partners SES, in Terre di Pedemonte, near Locarno in the Swiss Canton of Ticino, and EMIVASA with the Third Party ADV (Aguas de Valencia) in the city of Valencia in Spain. The case studies have the twofold benefit of enabling the project team to set up an interesting real-world test field and allowing the project partners SES/EMIVASA to develop an expertise on multi-metering water and electricity data.

2.1 Smart water meter infrastructure in Swiss case study

Figure 1 depicts the SES data collection infrastructure, which assumes that the water meter communicates its readings to the energy meter installed at the customer's premise. Within the framework of the project both the water and the electricity meter have been replaced. The new electricity meter (Echelon 83332-3IVAD) has been programmed by SES to call through a WiFi M-BUS protocol every hour the new water meter (Aquametro Topas ES KR (DN 15/20/25) for residential purposes) which has an integrated transmitter. The hourly data are internally stored within the electricity meter and sent daily to the concentrator located at the nearly transformer station (data transmission by power line communication). The data are then sent to the company's NES server through a GPRS Tunnel (secure) and subsequently processed with the IDSpecto Software and exported as an xml file on the project FTP server.

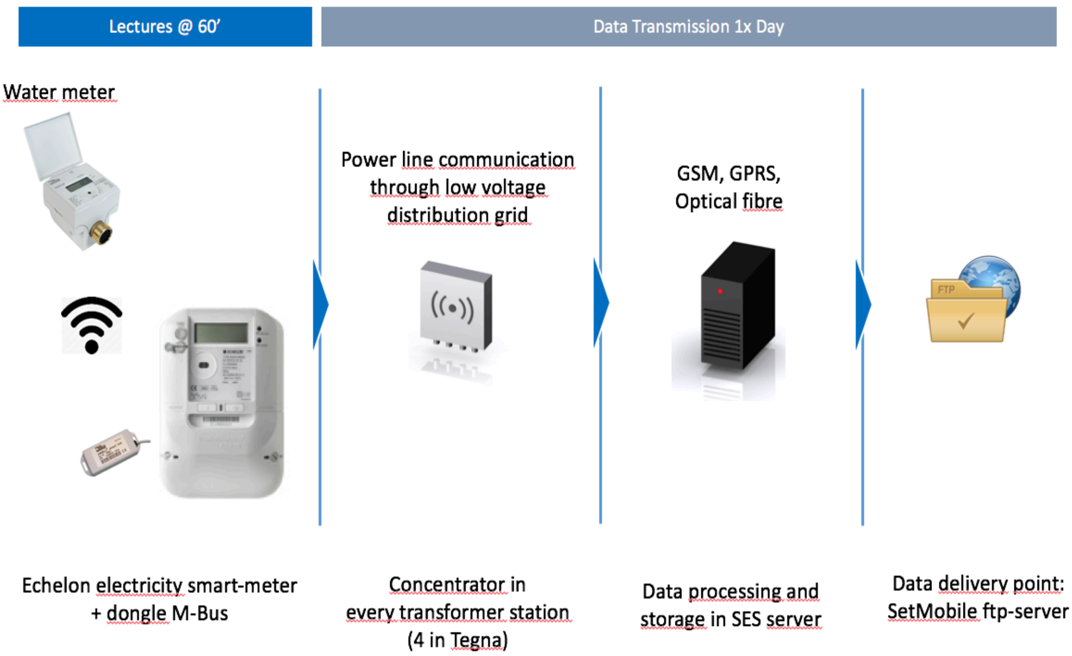


Figure 1. SES data collection infrastructure.

2.2 Smart water meter infrastructure in Spanish case study

The AGUAS DE VALENCIA Group (AVSA Group, of which the SmartH2O partner EMIVASA is the main affiliated company) has more than nine years of experience in the deployment of smart metering schemes within the water distribution infrastructures. The group is currently leading the implementation of smart metering technologies in Europe, with more than 650 000 units providing near-real time data to data centres. At early stages of deployment (year 2006), the amount of data generated was overwhelming and weekly resolution for water meters was considered enough for household metering. However, the experience gained in the analysis and further processing of Big Data suggested that receiving hourly reading from consumers could bring several operational benefits and significant improvements in the quality of the service. This step forward was possible thanks to the decision of promoting the adoption of fixed network solutions for the smart metering communication infrastructures in front of drive-by or walk-by techniques.

The exact number of water meters installed at date December 31st 2015 was **431'288** units, and they are metering a population of 787'266. This means all households in Valencia are metered. In blocks of apartments, every single apartment has its own water meter. From the total amount, 85% are smart meters (367'505 units) and only 15% (63'783 units) are still read visually. Smart meters transmit consumption data either through a fixed network or drive-by i.e. a brigade moving in a vehicle stops at some points where data from a certain number of meters is collected wirelessly. From the total number of smart meters in Valencia, 78% are connected in fixed network (288'229 units) while only 22% (79'276) are read drive-by. Figure 2 summarizes the numbers described above.

WATER METERS IN VALENCIA		
431 288		
SMART METERS		VISUAL METERS
367 505		63 783
Fixed Network	Drive-by	
288 229	79 276	

Figure 2. Number of installed meters in Valencia at December 31st 2015.

In the light of the numbers exposed, it can be observed that the number of smart meters connected in fixed network is considerable. These meters configure the actual smart water metering infrastructure of the city of Valencia, as these are the units that provide frequent, remote and safe data to the control centre of AVSA group. Visual meters and Drive-by meters are read only once every 120 days for billing purposes. It is important to highlight that drive-by meters are being progressively connected in fixed network, and so is happening with visual meters, which are being replaced by smart meters. The smart metering infrastructure in Valencia is shaped by 4 different technologies from 4 different meter manufacturers, each of them using different systems to transmit the information from the meter to the data centre. The main characteristics of these technologies are described hereafter. Due to commercial issues, the names of the manufacturers are not included in this report.

Technology 1: This solution provides 1 reading per day and data is received in the data centre every day. In terms of topology, water meters are wired together inside the meter chamber of buildings. These are connected in the same way to a RF Module that transmits data via radio to Gateways. Gateways collect data from various RF Modules and transmit data to the control centre using GPRS. Gateways have a similarly incorporated SIM CARD.

Number of Meters	Granularity	Data Reception
99 609	1 reading/day	Every day at 9 am

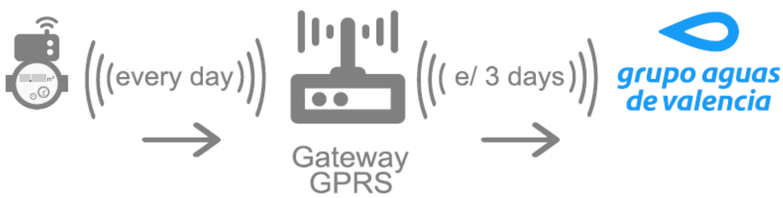
Figure 3. EMIVASA automatic metering infrastructure with technology 1.

Technology 2: The second solution provides 24 readings per day (hourly consumption) and data is received every day. This is a very robust solution. All meters have their RF module integrated. They transmit data every day to a collector via RF. Collectors transmit also via RF to Gateways every day and then via GPRS the data is received in the control centre on a daily basis as well. This network is auto-synchronised, and transmission devices auto-configure to receive data in discrete time slots.

Number of Meters	Granularity	Data Reception
114 378	24 readings/day	Every day

Figure 4. EMIVASA automatic metering infrastructure with technology 2.

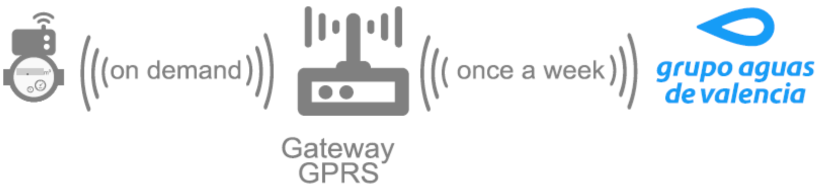
Technology 3: This technology provides 1 reading per day and data is received every three days. The RF module is integrated in the meter. This technology has only one way communication, and it is not possible retrieving missing information from meters.



Number of Meters	Granularity	Data Reception
127 356	1 reading/day	Every 3 days

Figure 5. EMIVASA automatic metering infrastructure with technology 3.

Technology 4: This technology provides 1 reading per day and data is received every Thursday. The RF module is integrated in the meter.
The day when the invoice is issued, meters are consulted to know the exact reading.



Number of Meters	Granularity	Data Reception
26 162	1 reading/day	Weekly

Figure 6. EMIVASA automatic metering infrastructure with technology 4.

2.3 Usage of water consumption data in SmartH2O

The smart metering data collected through the automatic metering infrastructures deployed in the Swiss and Spanish case study areas are used for the following scopes:

1. Yearly update of the users' consumption baseline. The baseline is used for the computation of the consumption reduction thresholds that are the basis for the goal setting function in the gamified feature: the baseline values define three goals with increasing consumption reduction, and increasing numbers of points awarded.
2. Computation of the users' weekly/monthly water consumption for scores attribution in the gamified portal, in case the water reduction goals are achieved.
3. Classification of the users' consumption patterns based on the clustering algorithm discussed in WP3, which categorizes the users according to their water usage volumes, preferred usage period within the day, and occurrence of their consumption peak (either during weekdays or weekends). The clustering algorithm will run on regular basis and changes in the classification results will be used to provide adequate feedbacks to the customers (e.g. alerts in case of significant increase of water consumption). However, such alerting mechanisms are yet not implemented in the current SH2O platform version.
4. Leakage and fault detection in the water distribution network. This feature, not yet implemented in the current SH2O platform version, will exploit the classification outputs of the clustering algorithm to identify consumption anomalies, which could be indicative of water leakages at household or distribution network level.

To these aims, raw metering data are processed to eliminate corrupted measurements and deal with missing ones (e.g. by means of interpolation).

3. Deployment of social awareness app

The SmartH2O social awareness app was built on smart metering infrastructure that has been deployed in the Swiss and Spanish case study areas, which was described in the previous section. The configuration of the platform deployment is addressed in this section. After describing the generic deployment environment, we address the planning and configuration of the platform deployment

3.1 Generic deployment environment

As a new software tool available for water companies, SmartH2O platform takes into consideration its IT context. This chapter encompasses the processes involved in getting the new hardware and software up and running properly in its environment, in regard to installing, configuring, running and maintaining the smart meter monitoring system and the social awareness application, that in practice make up the SmartH2O platform.

UML deployment diagrams have been used for representing:

- The hardware infrastructure employed by the SmartH2O platform,
- The software running on the hardware infrastructure,
- The middleware used to connect the disparate machines to one another.

In general, the components of the SmartH2O are deployed to several machines and interact with the internal servers of the water companies sustaining the case studies, behind their firewalls.

The sub sections of the current chapter contain overall representations of the run-time configuration of processing nodes and the components that run on the nodes deployed in the two case studies, in Terre di Pedemonte, Switzerland at SES premises and respectively in Valencia, Spain at EMIVASA's premises.

The meaning of notations used in the UML deployment diagrams is the following:

- <<device>> is a physical node - usually a server, a mobile device or a hardware infrastructure element. Its presence means that a hardware element is required for computation, as data source or as data destination.
- <<execution environment>> is a software environment running on a physical node. Such environments can be operating systems, database servers, application servers.
- Association links connecting devices or execution environments represent basic communication channels or software protocols.

3.2 Swiss deployment environment

The first case study of the SmartH2O platform has been implemented at the premises of SES, in Terre di Pedemonte, a small municipality near Locarno, Switzerland.

The deployment phase unfolded between M15 to M21 of the project. It followed an on-premises model using a dedicated server for SES beta users (real water consumers) invited to enrol in this case study. Prior to this phase, daily consumption data had been received and processed on the development and production server managed by SETMOB at its premises while the alpha test users had been able to use since M13 of the project.

The timeline of component deployment in production environment is presented in the following in Table 1.

Table 1. Deployment timeline of the SmartH2O platform features in Swiss case study.

M15-M16	M17-M18	M19-M21	Planned deployments
	• CAS authentication gateway	• Gamification Engine	• Admin Portal
• SmartH2O Database	• Backend services	• Customer Portal – Advanced Version	• Models of user behaviour
• Smart Meter Data Management and live integration to SES smart meter server	• Enterprise Service Bus	• DROP! mobile game	• Agent Based Modelling
	• Customer Portal - Basic Version	• DROP! the question mobile application	• Social Network Connector
		• Social Network Crawler	• Data Exchange Manager

Here is a short description of the components listed in the above table:

- **SmartH2O Database**

  Represents the structured data model used for providing the platform objectives.

- **Smart Meter Data Management (SMDM)**

  This component plays an important role in Swiss case study as it performs the processing of the consumption files (XML or CSV format) daily sent by the water company and stores of the data in the SmartH2O database. The SMDM component has been developed using the Big Data technology built on the principles of map reducing and parallel processing for a speedy treatment of big volumes of meter readings. For this reason, the SMDM component has been deployed on a dedicated device - a cluster of three virtual machines registered on the same physical server.

- **Central Authentication Service (CAS)**

  This component implements a single sign-on protocol allowing a unique identity for a logged-in user, therefore avoiding to require user credentials each time he access a different component (e.g. Customer Portal, Gamification Engine or DROP! Mobile application).

- **Back-end services**

  Represents the functionality provided by the platform core to the platform internal components. It is implemented as REST web services. Example of such functionality are web services for providing to a specific user: the sign-up/sign-in procedure, his hourly / daily / monthly consumption, his average consumption, his neighbourhood average consumption, the list of the recommended tips and videos, or providing the support for saving house and building attributes or list of water devices registered by a user.

- **Enterprise Service Bus (ESB)**

  ESB is the central software component to which all internal and external services are connected. It mainly receives, dispatches and orchestrates calls from front-end components to back-end services.

- **Customer Portal – Basic Version**

  It is a component, typically embedded within the proprietary portal services of the utility company, supporting the interaction between the customers and the SmartH2O awareness functionality.

- **Gamification Engine**

  It is a component devoted to the management of the gamification mechanics, it assigns actions and badges according to the configured action rules and handles the rewards claiming.

- **Customer Portal – Advanced Version**

  It is the advanced version of the Consumer Portal including Gamification interfaces.

- **DROP!TheQuestion mobile application**

  Drop!TheQuestion is the mobile extension Drop! Board Game, it is an augmented reality quiz game implemented for mobile.

- **Social Network Crawler**

  Allows the platform to launch social data analysis campaigns to identify relevant users and content in the area of sustainable water consumption.

The following are SmartH2O components planned for deployment after M24:

- **Admin Portal**

  This is a component, integrated within the proprietary portal services of the utility company, which supports the work of the supervisor in the analysis of the water consumption data and of the outcome of the gamification rules.

- **Models of user behaviour**

  Runs models and algorithms for profiling the behaviour of water consumers.

- **Agent Based Modelling**

  Allows the water utility to simulate whole districts of users, thus extrapolating user models provided by the Models of User Behaviour component at a larger scale.

- **Social Network Connector**

  Allows the users to post the achievements of their preference from the SmartH2O Water Utility Portal and Games Platform to the social network.

- **Data Exchange Manager**

  Deals with the data exchange communication that occurs “behind the scenes” among the SmartH2O platform and the third party applications - portals or services interested to exchange data with the SmartH2O platform.

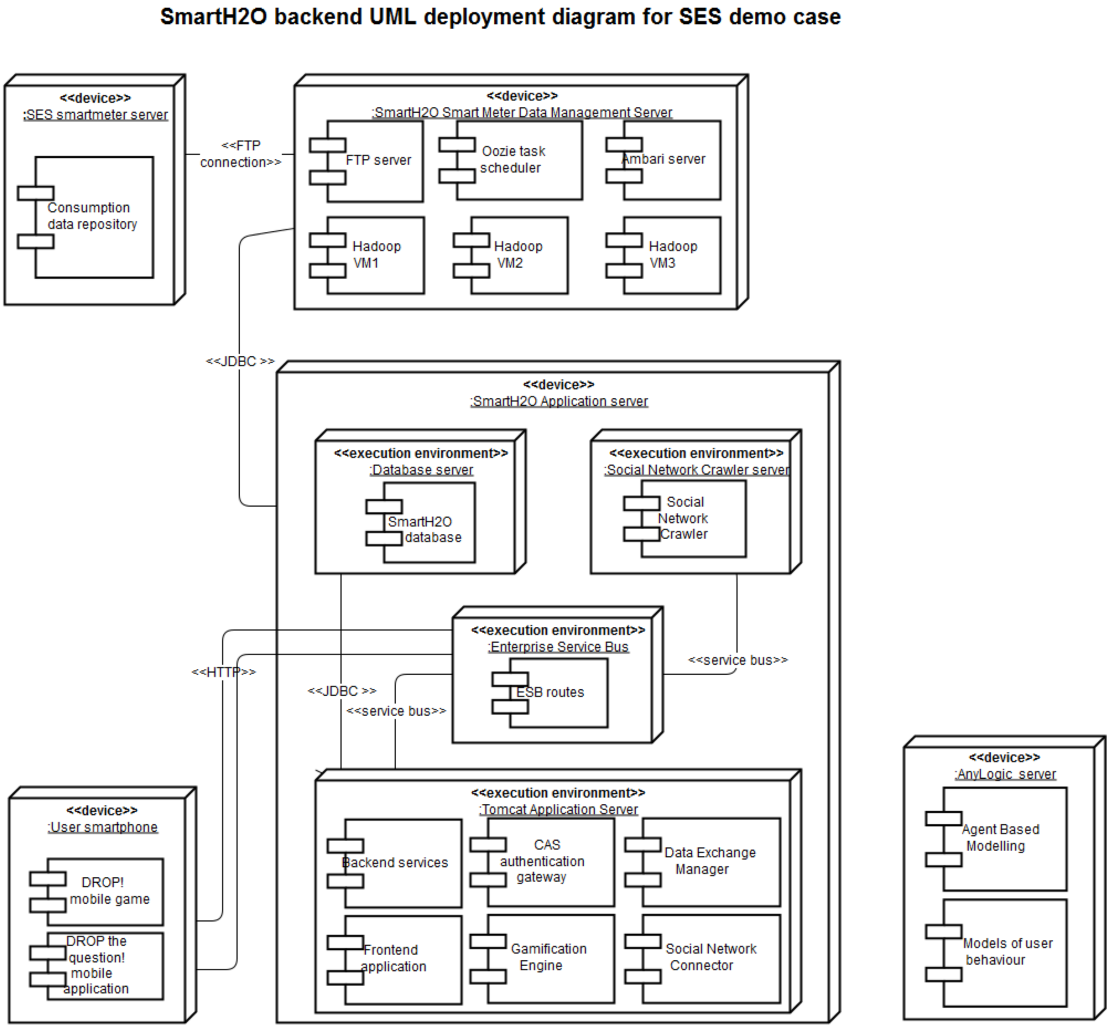


Figure 7. SmartH2O platform deployment in Terre di Pedemonte, Switzerland, for SES case study.

The deployment diagram consists in a graph of nodes connected by communication associations. In Figure 7, a node is represented by three-dimensional boxes with a name.

The nodes correspond to processing elements, usually having memory and processing capability. The nodes run component instances that can function standalone or that can be connected to each other.

The nodes contain software artefacts (components) such as the *Smart Meter Data Management Server* while in some cases, a node contains other nodes (E.g. The *SmartH2O Application Server* hardware node contains the *Database Server*, the *Enterprise Service Bus* and the *Tomcat Application Server* which are software nodes).

The software components performing the actual business logic required by the SmartH2O platform use the same notation as the component diagrams formalized in D6.2 Platform architecture and design. They are depicted as two-sectioned rectangles, with a label indicating the component name. Deployment specifications are configuration files, such as the ESB deployment descriptor (*service.properties* files), which define how a service should operate.

In the Swiss case study, the SmartH2O platform has been deployed on the following hardware configuration:

- OS Linux SMP Debian 3.16.7
- CPU 12 x Intel(R) Xeon(R) 1.60GHz 64-bit
- Memory 32 x GB RAM
- Disk and other storage unit 300 GB RAM
- Network bandwidth 5 KBs

Another important component in Swiss case study is represented by the SmartH2O Application Server node which runs the Authentication Gateway, the Backend services, the Gamification engine services and the frontend as well as the central piece of the SOA architecture implementation: the Enterprise Service Bus.

Secondary but not the less important is the AnyLogic server running the Models of user behaviour and the Agent based modelling components that foresees how a user pertaining to a segment would adjust his behaviour in front of changing variables as well.

Also, in the general picture have been represented as nodes: the water company smart meter server which from the SmartH2O platform perspective has the role of consumption data repository as well as the mobile device pertaining to the end user. The mobile device runs the mobile applications developed in for the SmartH2O platform: DROP! - the mobile game and DROP! the question - the quiz. Also, the mobile device as a platform node will run the mobile front-end of the user portal.

3.3 Spanish deployment environment

The second case study of the SmartH2O platform has been implemented at EMIVASA partner premises, in Valencia, Spain.

The timeline of this on-premises implementation using a dedicated EMIVASA server, started unfolding from M19 with the first beta release in production during M24. Prior to this phase, past consumption provided by EMIVASA for testing purposes data had been received and processed on the development server managed by SETMOB at its premises.

Table 2. Deployment timeline of SmartH2O platform features in Spanish case study.

<table>
<tr><td></td><td></td><td colspan="2">Planned deployments</td></tr>
<tr><td></td><td>M22-M24</td><td rowspan="2">DROP! mobile game</td><td rowspan="2">DROP! the question mobile application</td></tr>
<tr><td>M19-M21</td><td>CAS authentication gateway</td></tr>
<tr><td>SmartH2O Database</td><td>Backend services</td><td colspan="2">Admin Portal</td></tr>
<tr><td>Enterprise Service Bus</td><td>Gamification Engine</td><td>Models of user behaviour</td><td>Agent Based Modelling</td></tr>
<tr><td rowspan="2">Smart Meter Data Provisioning routes (ESB routes) and live integration to EMIVASA Water Meter to Machine server</td><td>Customer Portal – Basic Version</td><td>Social Network Crawler</td><td>Social Network Connector</td></tr>
<tr><td>Customer Portal – Advanced Version</td><td colspan="2">Data Exchange Manager</td></tr>
</table>

The following is a short description of the Smart Meter Data Provisioning routes and live integration to EMIVASA Water Meter to Machine server, which is a component specific to the

Spanish case study, while the description of the commonly deployed features can be retrieved in the section dedicated to Swiss case study.

- **Smart Meter Data Provisioning routes**
  This is a dedicated component that deals with the acquisition of data streams from smart meters and with their consolidation within the SmartH2O database. It implements the data privacy and security policy of the utility company and ensures that only admissible (aggregated, anonymous) data is stored within the platform database. The functionality is implemented in the following specific routes (logical channels):
  - *Trigger user subscription* for user registration and retrieval of the last two months of water consumption from EMIVASA Water meter to Machine repository into SmartH2O database;
  - *Complete user subscription* for completing the last twelve months of consumption for previously registered user;
  - *Processing daily user consumption data* from CSV files daily provided by EMIVASA to SmartH2O platform.

The main difference with respect to the SES use case regards the Consumer Portal in which:

- The education material includes infographics instead of videos;
- The rewards section includes the new, competition-based incentive model with competition management described in section 4 of the deliverable D4.3 Incentive models and algorithms;
- The communication module for utility-consumer in-portal communications has been required and included already in the system release for the Spanish EMIVASA pilot.

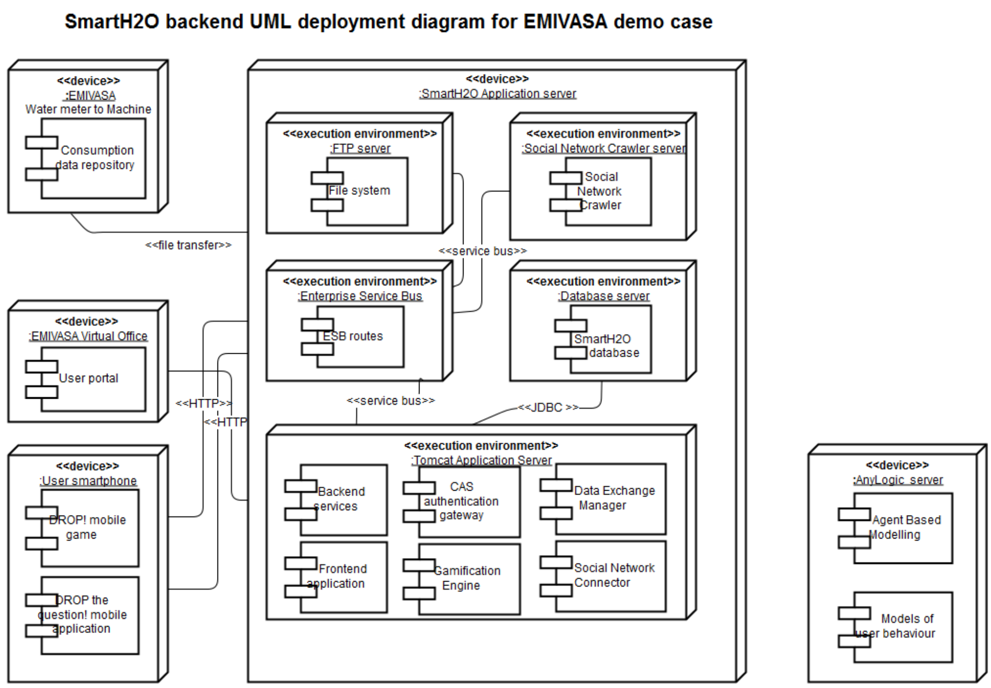


Figure 8. SmartH2O platform deployment in Valencia, Spain, for Spanish case study.

In the Spanish case study, user data for the SmartH2O platform are provided by web services made available by EMIVASA. This removed the need for the smart meter counter processing performed by the Smart Meter Data Management component based on CSV file processing using Big Data technologies, as in the Swiss case study. As a consequence, a downscaled hardware environment was selected to run the platform, as follows:

- OS Windows 2012 Server 64-bit
- CPU 4 x XEON 2,2 GHz
- Memory 8 x GB RAM
- Disk and other storage unit 2 x 40 GB HDD
- Network bandwidth 10 KBs

4. Water saving and pricing promotion campaigns

The following sections detail the characteristics of each case study population, and the water saving and pricing campaigns that have been launched / are planned for the upcoming months. The applied incentive models play a key role in the individual promotion campaigns, too, and are described in detail in *D4.3 for incentive model description and application design*.

4.1 SmartH2O promotion campaign in Swiss case study

Terre di Pedemonte is a small municipality located in the Locarno region, and includes 1206 inhabitants. Terre di Pedemonte comprises the three districts of Tegna, Verscio and Cavigliano. To monitor the water consumption at household level, the SmartH2O partner SES has installed 400 smart meters mainly in the districts of Tegna and partly in Verscio.

As the population of Terre di Pedemonte cannot be assumed to be representative of the whole Canton Ticino, we issued a questionnaire to 70’000 out of the 158’647 households which are registered in the whole Canton (total population 322’276, 2005 census) .

A total of 462 households answered to the questionnaire, and we therefore extracted a number of statistics that we assume to describe the general profile of users interested in water awareness and in increasing their water efficiency.

Age and gender statistics are reported in Figure 9.

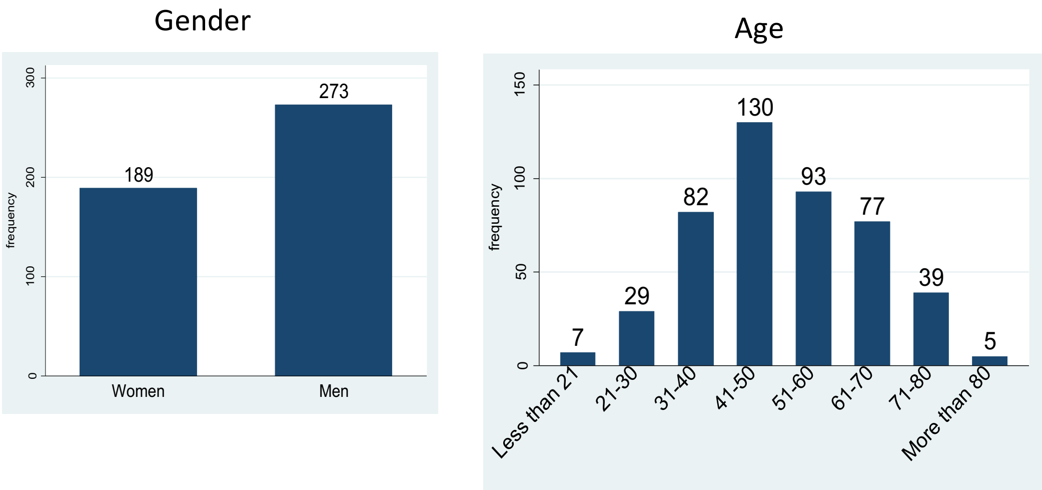


Figure 9. Distributions of users’ gender and age in Ticino.

Statistics on the job category of the principal income earner are reported in Table 3: results are very close to official statistics released by the Ticino Canton computed over the entire population.

Table 3. Statistics on the job category of the principal income earner.

Job	Sample		Population	
	462 observations		166,600 workers	
Managers and senior executives	43	9.31%	15,600	9.36%
Intellectual and scientific professionals	91	19.70%	39,100	23.49%
Technicians and associate professionals	61	13.20%	31,700	19.03%
Clerks	73	15.80%	18,800	11.30%
Service workers and shop and market sales workers	60	12.99%	28,400	17.06%
Skilled agricultural, forestry and fishery workers	3	0.65%	3,300	2.00%
Skilled craftsmen and tradesmen	32	6.93%	15,400	9.26%
Plant and machine operators and assemblers	3	0.65%	4,700	2.81%
Unskilled workers	3	0.65%	8,600	5.14%
Others	93	20.13%	-	-

The household characterization in terms of number of bathrooms per household and installed bathtubs, shower stalls and taps, as well as on the frequency and duration of shower/bath usage are shown in Figure 10 and Figure 11 whereas statistics on the number of washing machines and dishwashers per households and on their usage preferences are reported in Figure 12. Finally, statistics on the presence of a garden, plants or swimming pools per household and the related water usage actions are provided in Figure 13 and Figure 14.

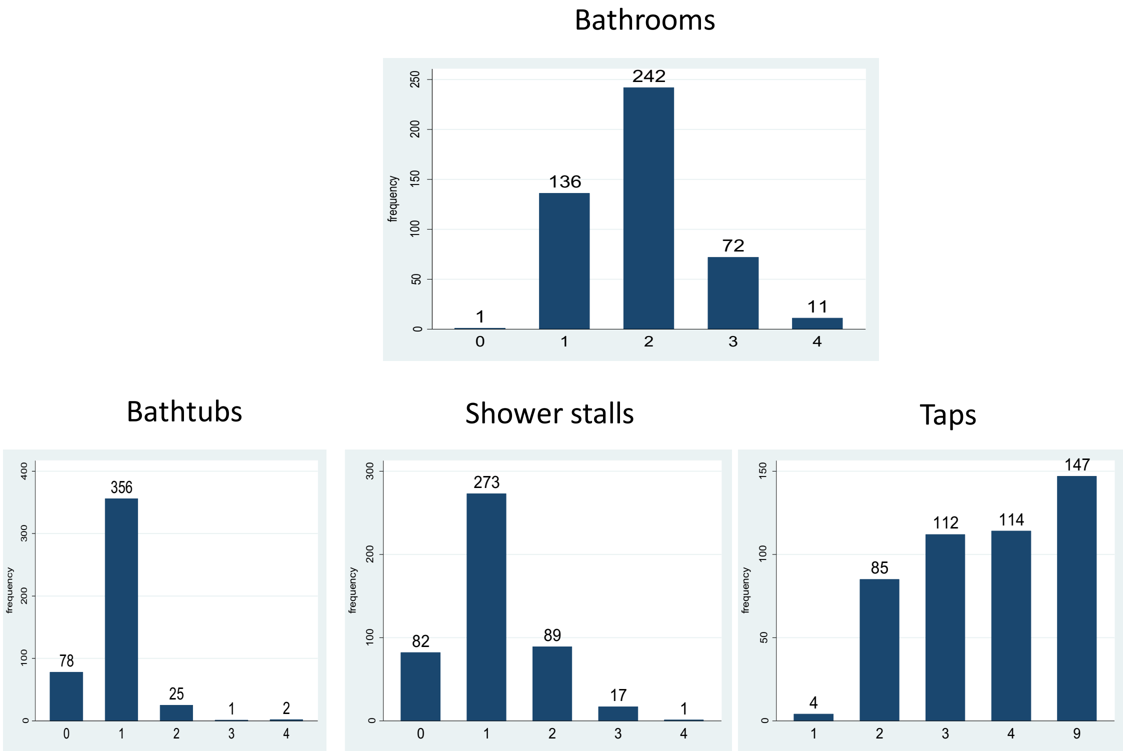


Figure 10. Household characterization in terms of number of bathrooms per household and installed bathtubs, shower stalls and taps.

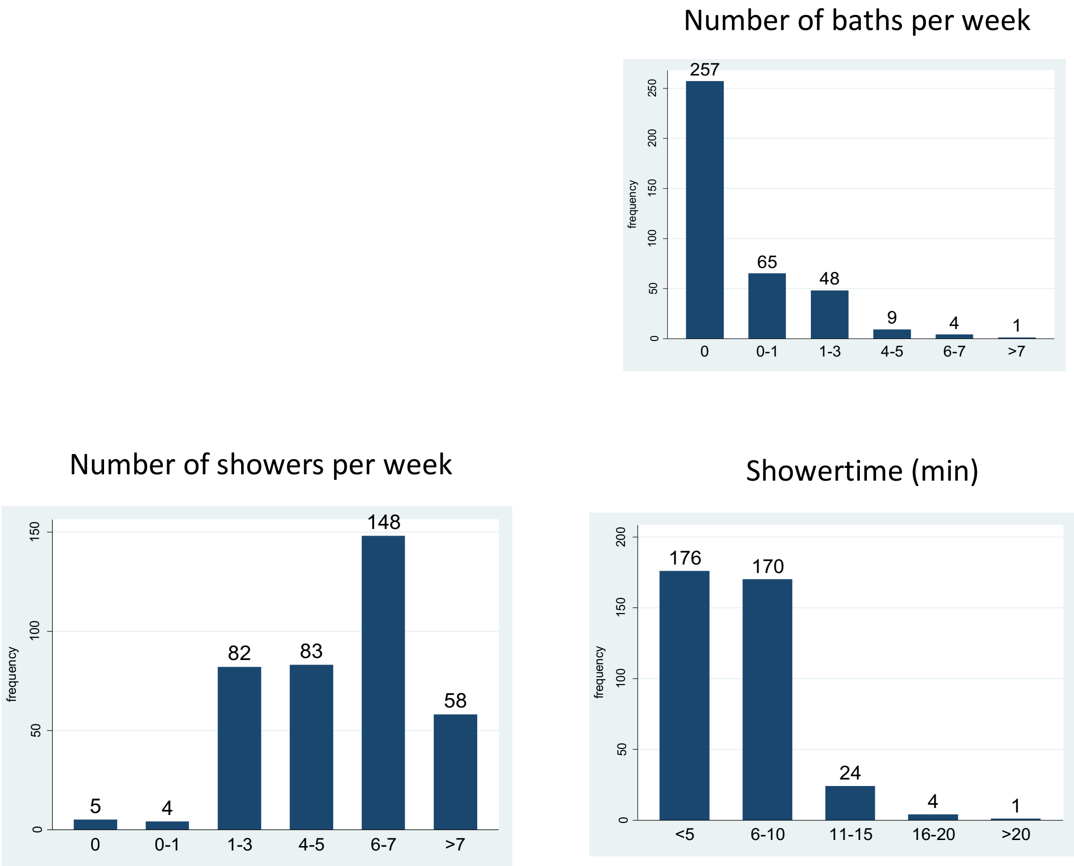


Figure 11. Statistics on frequency and duration of shower/bath usage.

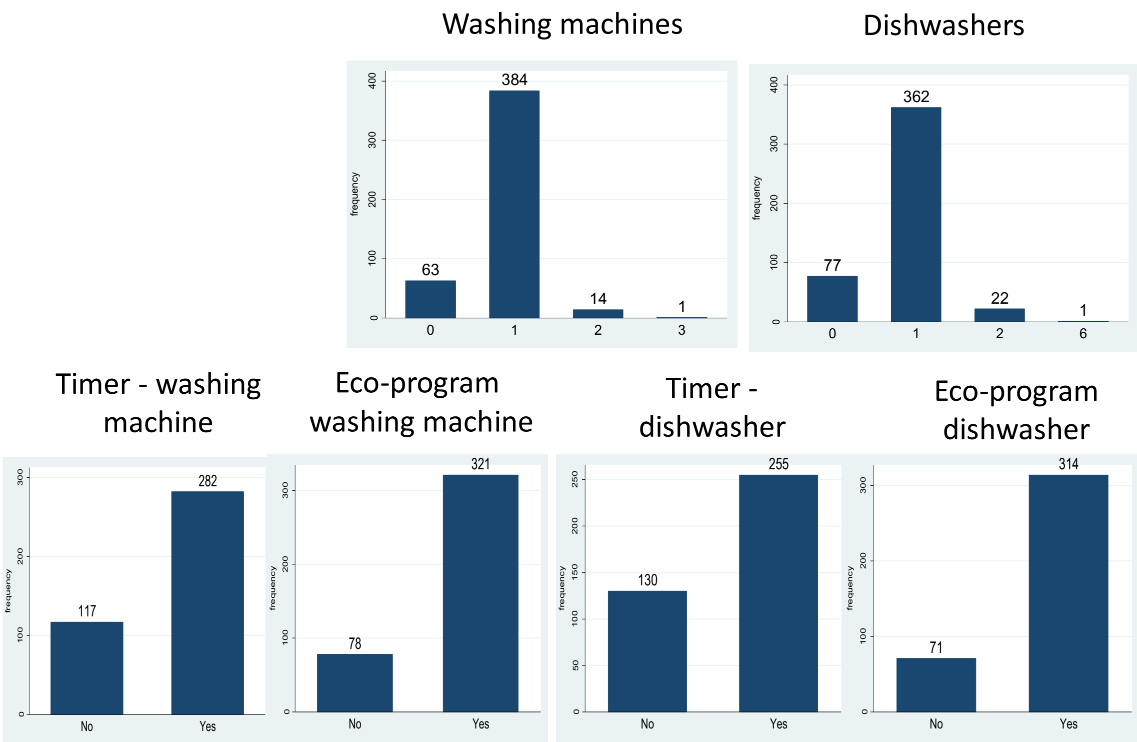


Figure 12. Statistics on the number of washing machines/dishwashers per households and on their usage preferences.

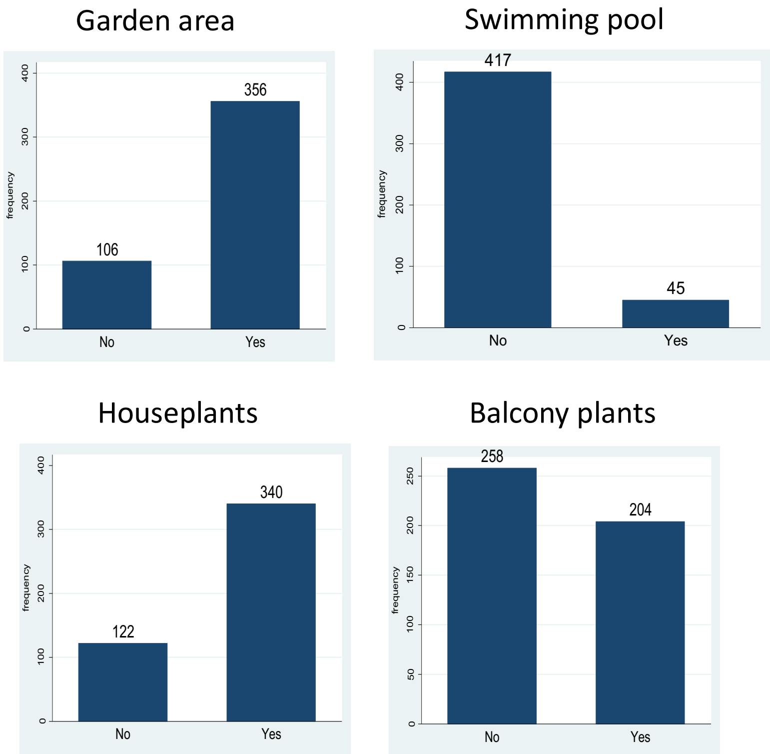


Figure 13. Frequency of water usage actions due to the presence of garden, plants or swimming pools.

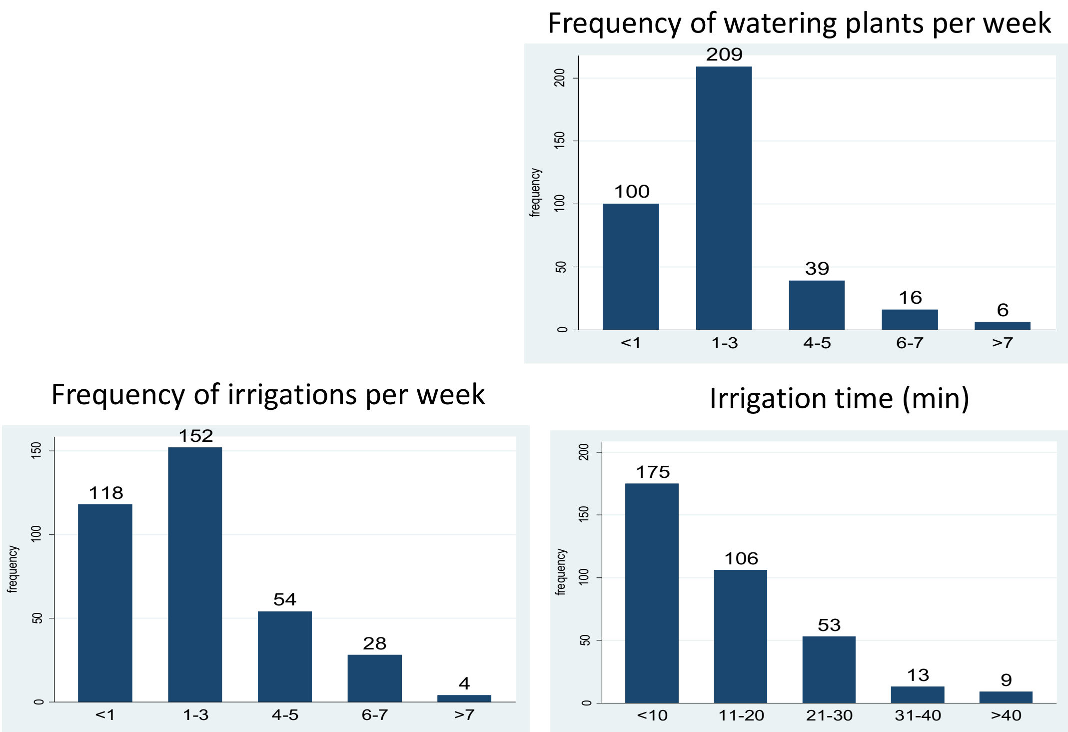


Figure 14. Statistics on the presence of garden, plants or swimming pools per household.

The above data provide a baseline description of the users in Canton Ticino. At the same time, a number of actions have been taken with the aim of recruiting users in the specific and localised case study of Terre di Pedemonte:

1. A selected group of 10 alpha users have been invited to test the pre-release of the SmartH2O platform on the 18 of May 2015. This invitation has been sent directly by SUPSI to a group of user identified by the water utility of Terre di Pedemonte.
2. In June 2015, SES has sent a letter to the first batch of users (approximately 250) where a smart water meter has been installed. The letter invited them to join the experimentation phase. In this letter, the users have received the SmartH2O meter ID, which is a necessary piece of information to create an account on the SmartH2O platform and to associate the newly created account with own meter readings.
3. In September 2015 the alpha users have been invited to test the gamified version with a new letter sent by SUPSI.
4. In October 2015 SES sent a letter to all customers with an installed smart meter, announcing the gamified platform (approx. 320 letters).
5. During the event “Tre Terre d’autunno” organized by the municipality in the district of Cavigliano, on October 11, 2015, a stand with informative flyers and a live demo of the SmartH2O portal has been displayed (Figure 15). There was also the possibility for new users to register directly on the portal.
6. Just before Christmas 2015 a letter has been sent by IDSIA to all users as a remainder to encourage the use of the gamified portal and announcing that prizes were being offered as reward for the users achieving the first ranks in the score leaderboard.
7. Weekly e-mail reminders will be sent via the communication tool to continuously engage users.

Figure 15. SmartH2O promotion stand at “Tre Terre d’autunno” (11.10.2015).

4.2 SmartH2O promotion campaign in Spanish case study

With a population of 786,189 inhabitants in 2015, Valencia is the third largest city in Spain. The population density is 5840.51 inhabitants/km². Valencia is also the capital and largest city of the Valencia Autonomous Region (*Comunitat Valenciana*). The urban water supply in Valencia is done by EMIVASA, which is a mixed company owned by the private enterprise

Aguas de Valencia S.A. (80% of the property) and the Municipality of Valencia (20%). EMIVASA is part of the Aguas de Valencia Group, which gathers different enterprises devoted to water services (urban water provision, sewer network maintenance, wastewater treatment and so on). Smart meters have been installed in the majority of the Valencia areas served by EMIVASA.

The characterization of the user population is based on the data published by the Spanish Institute of Statistics (*Instituto Nacional de Estadística*, INE) and the Valencian Institute of Statistic (*Instituto Valenciano de Estadística*, IVE). Those records refer to the city of Valencia itself and to the whole Valencian province (which mainly corresponds to the city of Valencia and its metropolitan area). Age and gender statistics are depicted in Figure 16 and Figure 17.

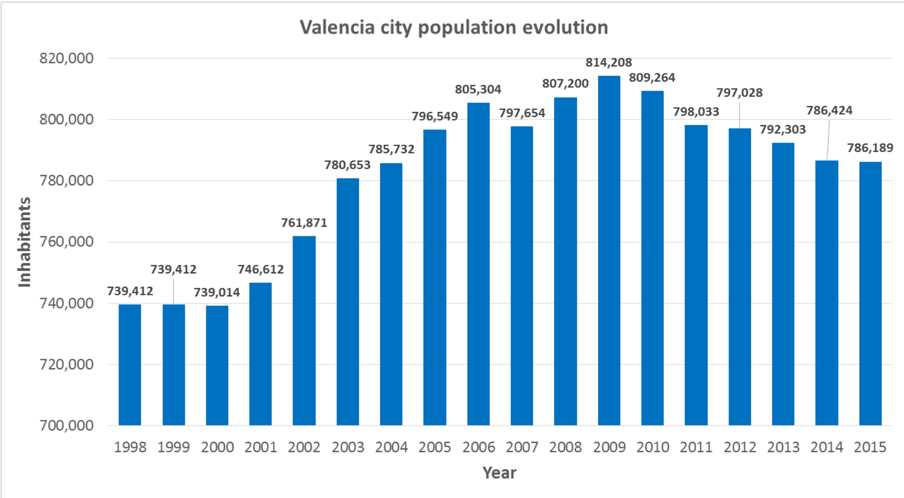


Figure 16. Valencia city population evolution (source: adapted from INE, 2015).

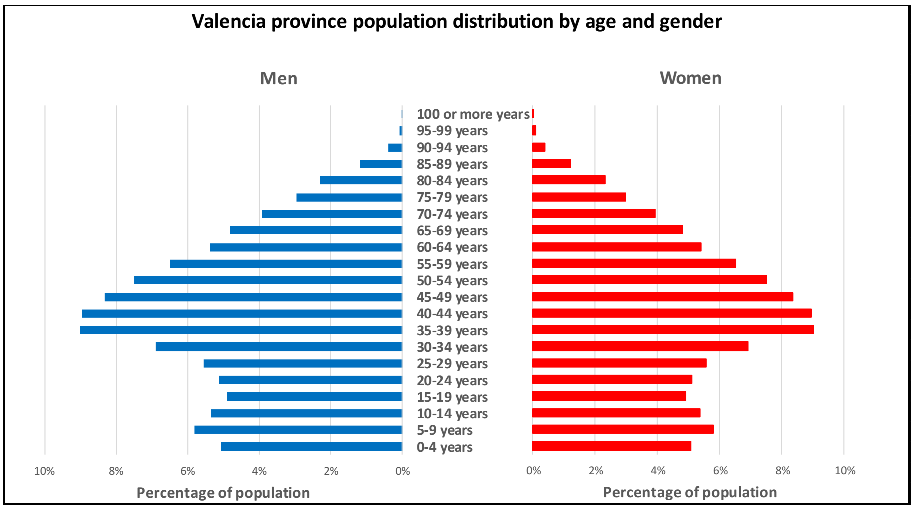


Figure 17. Valencia province age distribution by gender (source: adapted from INE, 2015).

The population by education level appears in Figure 18.

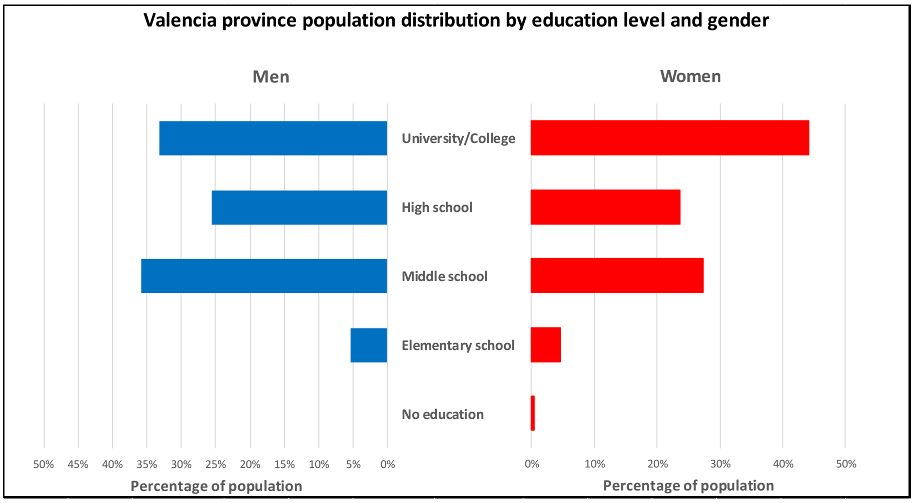


Figure 18. Population per education level and gender in the Valencia province (source: IVE, 2015).

Figure 19 and Figure 20 show the population by working sector and gender, as well as the income per gender.

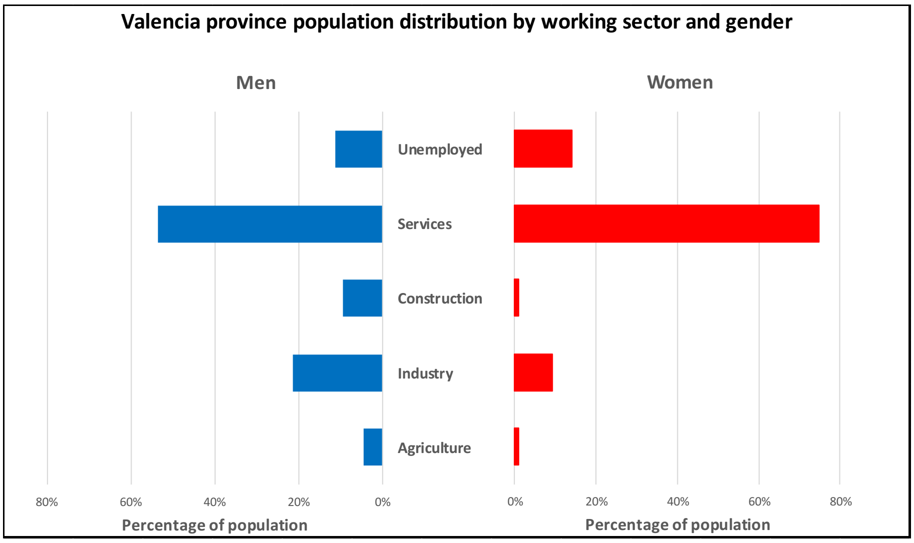


Figure 19. Population distribution in the Valencia province by working sector and gender (source: adapted from IVE, 2015).

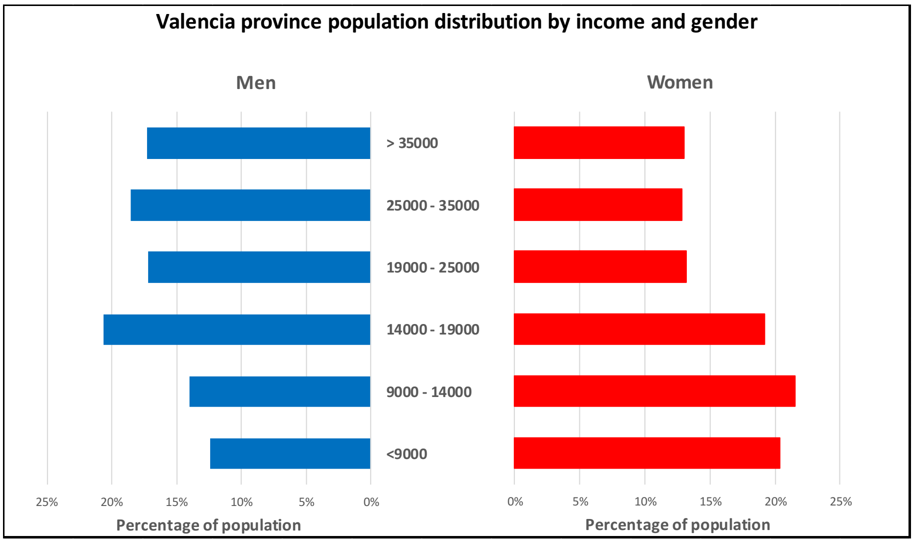


Figure 20. Population distribution in the Valencia province by income and gender (source: adapted from IVE, 2015).

The following actions will be carried out to recruit users for the SmartH2O social awareness app in Valencia.

- Emivasa has an on-going collaboration with AVACU, the Valencian consumer association. Three promotion actions will be launched in collaboration with AVACU:
  - A report of the project will be included in the quarterly magazine of the AVACU (Valencian association of consumers).
  - Ondacero, which is the second radio station in Spain and also in Valencia, has a local program the president of AVACU has access to. He will talk about the platform in the radio program.
  - AVACU also organizes workshops at schools to educate both parents and students on a variety of topics. Workshops will be organized about SmartH2O, during which also the Drop! board game will be distributed among students and their parents.
- E-mails will be sent to all customers from whom Emivasa has an e-mail address, inviting them to join the portal.
- A banner will be placed at the bottom of the first invoice after the launch of the platform (both in the paper invoice and the e-invoice). See Figure 21.
- All Aguas de Valencia workers living in Valencia will be invited to also join the platform, however without being eligible for physical rewards, such as the Drop! game or water saving gadgets.
- A banner at the home page of the company's website (Figure 22), as well as in the Virtual Office in which the users can view their invoices, basic water consumption statistics, and water saving tips.
- Emivasa's marketing department will contact local and regional radio and press.

Figure 21. Banner used on the printed invoice.

Figure 22. Banner used in the Virtual Office and on the Emivasa website.

The recruitment actions are expected to result in significant numbers joining the portal. If necessary, appropriate adjustments will be made to ensure sufficient numbers for the purpose of the trials.

4.3 SmartH2O pricing survey campaign

Ongoing work in WP5 has demonstrated that water utilities are not considering implementing dynamic pricing in the near future, because of concerns surrounding possible adverse consequences of this implementation. First, they are concerned price increases might be overwhelmingly perceived by customers as a way for the utility to make money at their expense. This is especially true if dynamic tariffs are perceived as too complicated and therefore confuse users, who may then have trouble adjusting their consumption patterns in order to benefit financially from the new tariffs. This problem arises with dynamic electricity tariffs [Hubert, 2012].

Then, the change in consumption brought about by a tariff change is uncertain. Past studies of the reaction to one-time price increases reveal unpredictable changes in consumption patterns. For instance, Inman and Jeffrey [Inman & Jeffrey, 2006] report that after a price shock, consumption may either decrease further or rebound to what it was before the tariff change, thus negating its effect on consumption. Potential reactions to dynamic pricing may be even far more surprising. Besides, dynamic pricing cannot be implemented without cautiously considering social issues such as equity, which arise in complex ways in traditional water tariffs such as increasing block tariffs, and may arise in even more complex ways with innovative pricing options.

For all these reasons, utilities have a cautious approach to dynamic pricing incentives, and seem willing to implement reward programmes before seriously considering tariff changes. There are diverse reasons for this: 1) reward programmes seek to change behaviours by engaging the public and raising its awareness, rather than by enforcing consumption change through what may be seen as a form of punishment; 2) they are seen in a positive light by the public; and 3) they are meant to bring about the same changes in consumption patterns as dynamic pricing. In engaging the public, reward programmes pursue similar objectives as the SmartH2O platform itself. This makes such programmes a better candidate for a joint implementation with the SmartH2O than dynamic pricing schemes.

Ticino

The following actions have been taken with the aim of recruiting respondents to the pricing survey:

1. A first letter has been sent by the utility SES to its customers in Tegna and Verscio (Terre di Pedemonte) inviting them to join the platform. In this letter, besides receiving the SmartH2O meter ID, the users have been invited to fill the pricing questionnaire. The letter reported also a link to the questionnaire.
2. In October 2015, a letter was sent to all SES customers (approximately 70,000), inviting them to fill the pricing questionnaire by using the same link provided to Terre di Pedemonte users. The letter was bundled with the bill invoice.

SES actively promoted the participation in the pricing survey by raffling three iPads minis. The survey was administered in the period spanning from 2015/10/15 to 2015/11/31.

Figure 23. The iPad mini award ceremony in Ticino.

Valencia

The pricing questionnaire in Valencia has been integrated with the validation questionnaire in the SmartH2O platform. The campaign promoting the engagement of Emivasa customers with the platform and new virtual office will start soon after the portal is online (1 week after).

The campaign will entail different actions:

1. Call centre campaign: selected users will be contacted by phone to promote their engagement.
2. Radio/press: promotion made by the EMIVASA marketing department.
3. Collaboration with AVACU (Valencian association of consumers): i) A report of the project will be included in their quarterly magazine; ii) Ondacero, which is the second radio station in Spain and also in Valencia, has a local program where the president of AVACU collaborates (he will talk about the platform there); iii) AVACU organises workshops in schools involving both pupils and parents. When the platform is online, these workshops will be dedicated to SH2O (Drop! board games will be distributed

among scholars and parents).

Moreover, other accompanying actions will be taken with the aim of recruiting portal's users and accordingly potential respondents of the integrated questionnaire:

1. All Aguas de Valencia workers living in Valencia will be invited to join the platform and will accordingly be proposed to fill the integrated questionnaire (but they won't be allowed to win any reward).
2. A banner will be displayed at the home page of the company's website.
3. A banner at the bottom of the invoice (both in the paper invoice and the e-invoice) announced the release of the virtual office and the possibility to sign in the SmartH2O platform, where users were asked to login and fill the integrated questionnaire. The platform users will have to respond the integrated questionnaire the very first time they access the portal.
4. An email will be sent to all of those whom EMIVASA has email account inviting them to join the platform.

5. Case study results

5.1 Objectives of feedback collection

The case studies were set up to quantitatively and qualitatively measure the reduction in water consumption, as well as the impact of the SmartH2O app on social awareness. In this section we report on the first results obtained from the validation activities. The complete, longitudinal results will be reported in *D7.3 Final overall validation and impact report*.

As has been argued in D7.1, the feedback collection serves the following objectives:

- To collect smart metered water consumption data for both case studies.
- To assess the KPIs related to water consumption by comparing target values against the baseline.

Table 4. KPIs related to water consumption.

Description	Target
Water saved per capita per period	5%
Peak-period reduction of water consumption	10-20%

As the other KPI's that are the result of reduced water consumption (e.g. energy saving for pumping water, investments avoided) require longitudinal data over the full duration of the trials, we will report on these KPIs in the final validation results deliverable (*D7.3 Final overall validation and impact report*, M36).

- To assess KPIs and success criteria related to social awareness, based on an operationalization of the awareness concept into measurable determinants of water consumption behaviour.

Table 5. KPIs related to social awareness.

Description	Target
Awareness increase of customer portal users	>=1 Likert-scale point on a five-point scale in questionnaire

- To assess the success criteria related to technology acceptance.
  In D2.2 several user-based performance indicators have been introduced that reflect the user's acceptance of the SmartH2O, on the level of the application as a whole, and on the level of individual use cases.

Table 6. User-based performance indicators.

Application-level indicators	Use case-specific indicators
Effort expectancy	Usefulness
Performance expectancy	Comprehension
Attitude towards technology	Perceived incentive
Social influence	
Hedonic quality	
Pragmatic quality	

At this moment in time, we report:

- baseline water consumption statistics in both Spain and Switzerland;
- preliminary assessment of the impact of the basic portal on water consumption measures (first results, Switzerland);
- success criteria with respect to the basic portal (Switzerland).

5.2 Validation approach

5.2.1 Experimental set-up

In *D7.1 Validation methodology* the experimental set up was explained that formed the basis for the feedback collection in the case studies. Four trials were planned that are aligned with releases of the SmartH2O platform. A trial has been defined as a period of time during which the user actions and behaviour are observed and collected. Two trials were foreseen during summer periods, and two trials during winter periods. A mixed repeated-measures and between-subjects design was introduced to be able to attribute effects on awareness and/or water consumption to the SmartH2O platform and to be able to exclude effects of exogenous circumstances, such as seasonal variations in the availability of water.

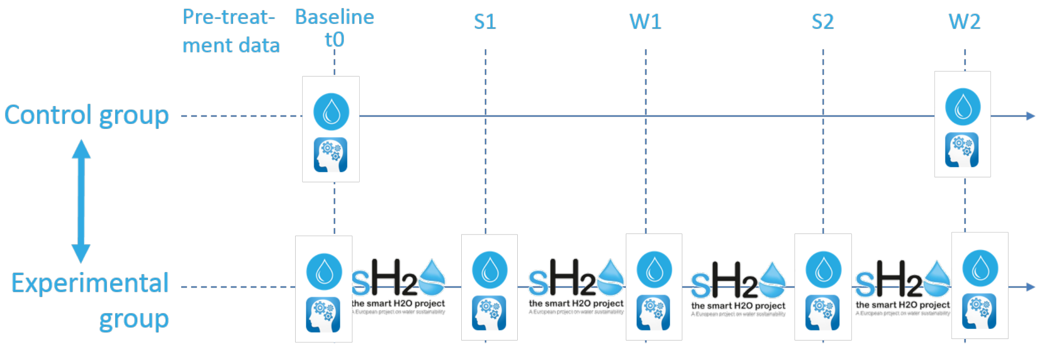


Figure 24. Experimental set-up of SmartH2O validation.

Water consumption is continuously monitored, whereas social awareness is assessed after each trial period. The objectives of the feedback collection require a quantitative approach that allows the SmartH2O project to relate measures of social awareness and technology acceptance to the smart metered water consumption measurements. For this purpose, we make use of questionnaires, which are commonly used both in research on technology acceptance and in environmental psychology.

The introduction of EMIVASA to the consortium has led to a shift in the planning of the trials, and adjustments in the methodology. Whereas the Swiss case study is relatively small in size, the Valencian case study allows for a large scale validation of the portal impact over a longer period of time.

Notwithstanding the on-going effort to recruit users for the SmartH2O portal, the population size in Switzerland is too small to validly attribute observed differences to user or household characteristics, differences in pre-treatment water consumption patterns, or differences in behavioural determinants. From that perspective the Swiss case study needs to be perceived as the groundwork and test of the validation design for the Valencia case in which the population comprises 787’266 metered households, of which 10% have a Virtual Office account. The specific approach is explained in Section 5.2.2 and Section 5.2.5 for the Swiss and Spanish case study respectively.

The relatively late introduction of EMIVASA to the consortium has limited the number of trials. This is however not problematic, as the total duration of the planned trials is still long enough to rule out seasonal variations, while the iterative development of the platform in the Swiss case study has improved the technological maturity of the platform, allowing for large-scale validation.

5.2.2 Water consumption measurement

Consistently with the description already provided in deliverable D7.1, in the Swiss case study data were collected every hour; the progressive meter readings, in cubic metres with a precision up to the third digit (i.e. litres), are sent daily to the SmartH2O platform. Conversely, for the Valencia case study, since the water metering infrastructure presents 4 different technologies from four different meter manufacturers, the frequency in which data is receive is not unique, an can vary from hourly resolution to readings received once every 120 days. All meters have a litre resolution.

In the SmartH2O database each smart water meter is identified by a unique random ID, which is totally anonymous. For the Swiss case study, being the case study location limited in its dimension, there will be no further information on its location. For the Valencia case study, the meter will also be associated to a postcode.

The Swiss case study user sample is composed of 45 users who created an account on the SmartH2O platform up to February 2016 and participated to the experiments. The meter ID of those users will be then associated with their user ID in the SmartH2O platform. The association can take place in a totally anonymous way thanks to an anonymisation table similar to the one provided in Table 7, maintained by the water utility.

Table 7. Example of Meter ID mapping table.

Customer ID	*True meter ID*	*SmartH2O meter ID*
1234	CH_AQU_1234	431242445

The data contained in Table 7, are managed by the water utility. The water utility knows the “Customer ID” and the true meter ID. On the basis of this information, the water utility generates an anonymous “SmartH2O meter ID”, which is uniquely mapped to the “True meter ID”. This “SmartH2O meter ID” is transmitted to the SmartH2O platform, together with the meter readings.

5.2.3 Questionnaire construction

The objectives of the feedback collection require a quantitative approach that allows the SmartH2O project to statistically relate measures of social awareness and technology acceptance to water consumption. Questionnaires are commonly used for this purpose, both in technology acceptance literature, and in environmental psychology.

The questionnaires contain five classes of questions that assess:

- technology acceptance;
- user-based performance indicators;
- determinants of water behaviour;
- user and household characteristics.

Questionnaires are administered that contain different combinations of questions, depending on the case studies and the timing of the questionnaire in relation to the trial and the implemented features of the platform. In this subsection we explain the measurement instruments that were used, whereas in the following sub sections the composition of the different questionnaires tailored to the case studies and the trial is described.

Operationalization of the social awareness construct

Research in WP4 has led to a redefinition of the social awareness concept into multiple psychological factors – called determinants – that influence water consumption behaviour. The theory of planned behaviour was introduced as a general model to explain behaviour based on a user’s behavioural intentions, which are in turn affected by attitudes and beliefs towards the behaviour. An extension and application of the model was introduced, based on [Jorgensen et al., 2009] who reviewed existing TPB-based and econometric models, and combined them into a model with an increased explained variance.

The model has been discussed in detail in *D4.3 Incentive models and algorithms.* It covers psychological, demographic, economic, as well as climatological factors. The validation addresses the determinants that relate to the user's water behaviour:

- Attitudes towards water conservation,
- Perceived risk of shortage,
- Attitudes towards restrictions in water consumption,
- Water conservation intention,
- Subjective norm,
- Perceived behavioural control,
- Factual past (e.g. historic) and current (smart metered) water consumption.

Note that the longitudinal validation with a repeated measures design allows us to make inferences about the formation of habits, an important factor in the model from [Jorgensen et al., 2009]. The behavioural change theories that have been reviewed in *D4.3 Incentive* models and algorithms suggest that sustainable change of behaviour occurs when habits have been frozen, changed, and when new habits have formed to replace the old habits [Dahlstrand & Biel, 1997]. These new habits can be observed from users who have decreased their water consumption over a longer period of time, without fall-backs.

Finally, the operationalization and refinement has led to a change in the questionnaire that is administered when new users sign up for the Swiss case study (see section 5.2.4).

Selection of technology acceptance measurement instruments

In addition to the water consumption determinants, technology acceptance is assessed on two levels: on the level of the SmartH2O application as a whole, and on the level of individual use cases. A well-established technology acceptance framework, the Unified theory of acceptance and use of technology [Venkatesh et al., 2003; Venkatesh et al., 2012], is used that has been validated in various application contexts and with various user populations. We measure:

- Effort expectancy,
- Performance expectancy,
- Social influences,
- Attitude towards technology.

For effort expectancy, two items were discarded as they are relevant in this context and therefore cannot be reliably interpreted by the respondents: "Using the system enables me to accomplish tasks more quickly" and "Using the system increases my productivity".

As the SmartH2O application is set up to increase the engagement of users, not only the utilitarian value of the application (e.g. effectiveness, and efficiency of task performance), but also the hedonic value (joy of use). Therefore, we administer the AttrakDiff2 questionnaire [Hassenzahl, 2004], which has been validated and widely used in ICT product design and industrial design settings.

In addition to these platform-level measurements, data is collected on the user-based performance indicators that were introduced in *D2.2 Final requirements*. As for these indicators there is no point of reference because the indicators highly depend on a large number of factors beyond the control of the application (e.g. composition of the user population, context of use, digital skills, and so on), no target values can be specified.

The following user-based performance indicators are addressed:

- perceived usefulness (one-item five-point Likert scale);
- ease of use (one-item five-point Likert scale);
- comprehension (one or multiple-item five-point Likert scale, depending on the complexity of the feature);
- impact on awareness. Two seven-point Likert items, tailored to the functionality. For

example: “The water consumption overview makes me think about water conservation more often than before”;
- (for the water saving tips): five-point Likert item that measures the extent to which users were able to put the water saving tips into practice.

As has been argued in Section 4.3, business constraints and the need for additional research to investigate the effectiveness of pricing measure for inducing a sustainable change in water consumption have prompted the development and dissemination of a pricing questionnaire, rather than the development of features that influence the user’s willingness to adopt a dynamic pricing scheme. As a consequence, the success criterion (“*Percentage of customer portal users expressing intention to voluntarily adopt a dynamic pricing scheme if available* >=5% increase”) cannot be assessed at this point.

Demographics, personal, and household characteristics

In terms of personal characteristics, the questionnaire measured the user’s personal innovativeness. Personal innovativeness, the willingness of an individual to try out any new information technology [Lu et al., 2005], was expected to impact the evaluation of the SmartH2O application. It is measured with a four-item seven-point Likert scale.

Finally, the following data are collected about the users and their households:

- no. of adults and children in the household;
- educational level;
- type of house.

Questionnaire administration

- **Sign-up questionnaire:** after signing up to the portal, users receive a notification on screen with the request to fill out the questionnaire. Swiss users are not rewarded directly, but can claim their first reward (Drop! board game) immediately after their first login in exchange for 50 points. Users in the Spanish case study receive 2100 extra points after filling out the questionnaire. To earn their first reward (Drop! board game they have to reach 5000 points through their initial actions. The readjustment of the point system was introduced to balance the rewards against the size of the population, as well as to provide additional incentives for filling out the questionnaire, a prerequisite for a successful validation.

- **Control group questionnaire** *(Valencia only)*: the control group questionnaire is administered by phone. A call centre script has been constructed and tested with students at UPV in two iterations. While remaining as close to original questions as possible to avoid effects on the questionnaire’s reliability, minor adjustments have been made based on the results, primarily to improve comprehension of the questions during a phone interview.

All questionnaires are constructed in English, translated to the language of the users by native speakers or professional translators, and checked by at least one other native speaker. The full set of items can be found in Appendix A.

5.2.4 Set-up and data analysis approach in Swiss case study

In this sub section we explain the specific constellation of the Swiss case study.

Experimental set-up

The small-scale Swiss case study allowed for a finely tuned first assessment of the SmartH2O platform, as well as for testing the measurement infrastructure of both smart metered water consumption, and the questionnaires that have been developed. As a result of the population size, it was impossible to employ a between-subjects design with a control group and a treatment group (e.g. the SmartH2O application). It was decided to prioritize on the recruitment of users for the portal, rather than for a control group, because even when e.g. 20-30 users could have been recruited, statistical power would be too low to draw reliable conclusions on the impact of the SmartH2O application.

Measurements are planned in accordance with the release schedule. To collect data for a longer amount of time, the present trial in Valencia has been extended from three months to nine months in total, starting in April 2016 and ending by the end of December 2016. To facilitate comparability, the same approach is applied to the Swiss case study. At least one intermediate release is foreseen, before which we will release an intermediate questionnaire to elicit opinions on the current platform versions before it gets upgraded.

Questionnaire construction

Table 8 provides an overview of the questionnaires that were developed for the Swiss case study. The clusters of questions indicated in the table header are explained in the previous sub section.

Table 8. Questionnaires employed in Swiss case study.

Questionnaire	User characteristics	Water consumption determinants	Technology acceptance	User-based performance indicators
Basic portal questionnaire		X	X	X
Sign-up questionnaire	X	X		
Upgrade questionnaire			X	X

All questionnaires have been constructed in Google Forms. Below we explain the content, recruitment, and administration of the questionnaires.

- **Basic portal questionnaire** *(Swiss case study only)*: distribution via e-mail to all registered users. To promote the response rate, participants could take part in a lottery in which they could win SUPSI merchandising (2 umbrellas, and 1 jacket). Reminder e-mails were sent to further promote the response rate. The recruitment messages contained a direct link to the online form (Figure 25, left).

  Questions assess users' current assessment of water consumption determinants, as well as the user's opinion on the basic portal, both at the level of the application as a whole (technology acceptance criteria), and at the level of individual use cases.

  Results for the Swiss case study are reported in section 5.3.1 and 5.3.3.

- **Sign-up questionnaire:** the sign-up questionnaire contains basic user information, and assesses the user's current water consumption behaviour determinants before using the portal (Figure 25, right). Note that the sign-up questionnaire has been implemented at the release of the second basic portal version. This questionnaire extends the two awareness questions that until now have already been asked at sign-up. Right after the sign-up form, a pop-up is displayed with the request to fill out this questionnaire. Current results for the Swiss case study are reported in section 5.3.4.

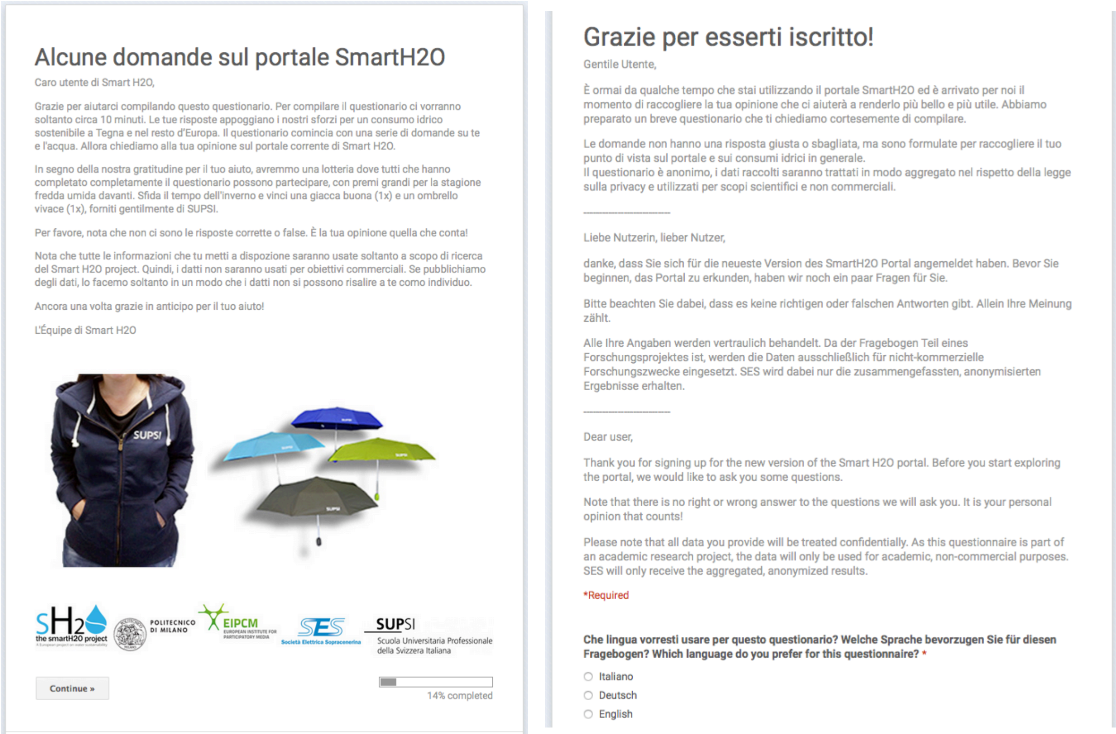


Figure 25. Basic portal questionnaire (l) and sign-up questionnaire (r).

- **Upgrade questionnaire** *(Swiss case study only)*: after users upgrade to the advanced portal they receive a notification on their screen with the request to fill out the questionnaire (Figure 26). Questions address the user's perception of the basic portal, at the application level and at the use case level. After clicking on the link, a pop-up opens in which the Google Form questionnaire is displayed. Note that this questionnaire is only administered to users who have not filled out the basic portal questionnaire.

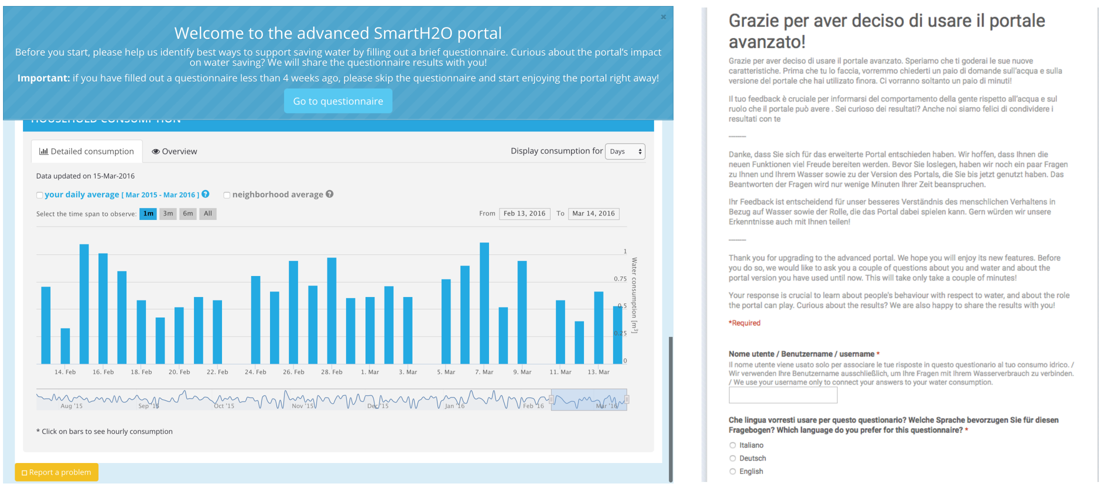


Figure 26. Link to upgrade questionnaire in SmartH2O portal (l) and online form (r).

Data analysis

The limited number of users does not allow for experimental comparisons between different groups of users. Therefore, a control group could not be established. Given the small numbers, non-parametric correlations are used to investigate the relationship between on the one hand the usage of different platform features, water behaviour determinants, and technology acceptance, and on the other hand the delta in water consumption before and after usage of the platform.

The results of the basic portal questionnaire and the water consumption measurements during the first trial in comparison to the baseline can be found in Section 5.3.

5.2.5 Set-up and data analysis approach in Spanish case study

The Valencia case study allows for a large scale evaluation of the SmartH2O application, in line with the methodology that has been defined in D7.1. This sub section addresses the specifics of the pilot that will start running in April.

At this moment, EMIVASA customers can make use of the Virtual Office, which features a visualisation of the water consumption, online billing, and water saving tips. Currently, 10% of EMIVASA customers use the Virtual Office. At least 3% of the users log in to the Virtual Office once a month. A screenshot of the current Virtual Office's homepage is provided in Figure 27.

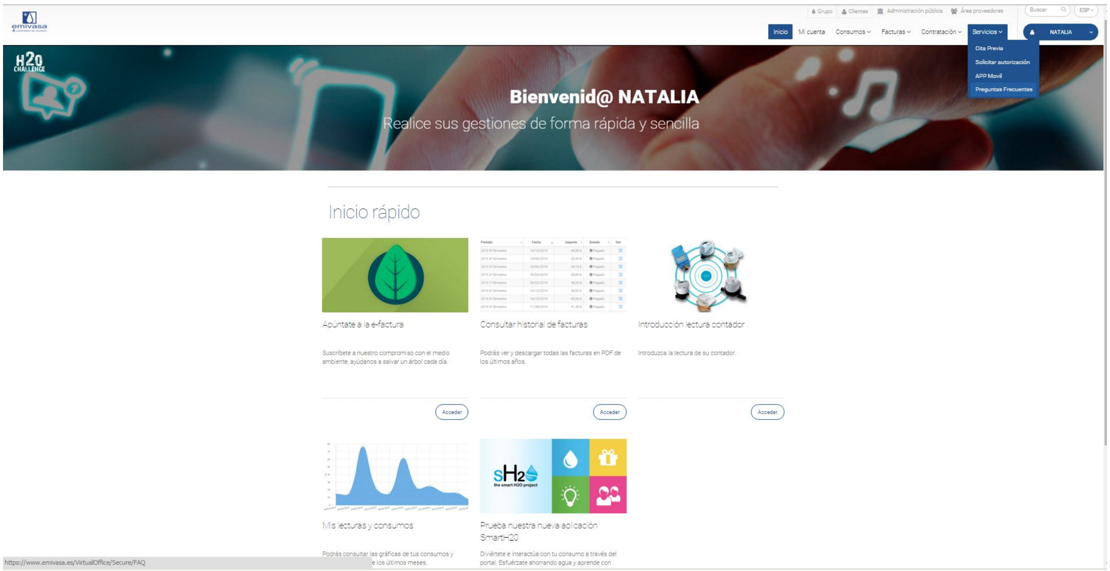


Figure 27. Screenshot of the virtual office, with the SmartH2O banner included.

A screenshot of the basic water consumption visualisation is provided in Figure 28.

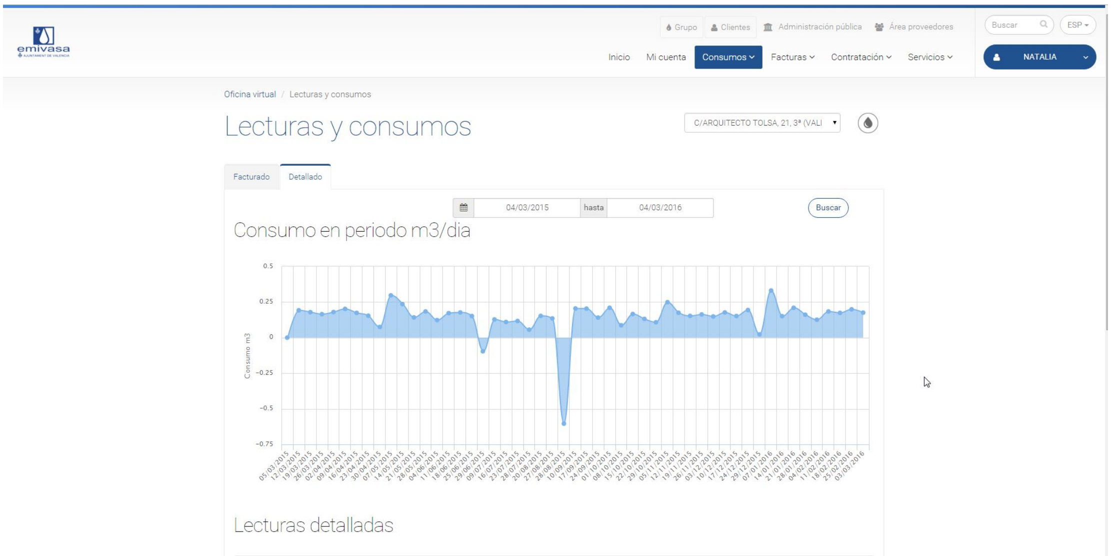


Figure 28. Basic water consumption visualisation in the Virtual Office.

Experimental set-up

The set-up allows for a set-up with a distinction between three groups: one control group, and two treatment groups: Virtual Office users, and SmartH2O users. These groups are experimentally compared, in accordance with *D7.1 Validation Planning* and with the general experimental set-up described in Section 5.2.1. Table 9 shows the control group and treatment groups, and outlines the incentives that are provided to the users.

Table 9. Treatments in the Valencia trial.

Condition	Consumption visualisation	Water saving tips	Goal setting	Gamified incentives	Virtual and physical rewards
Control group	No	No	No	No	No
Virtual Office	Yes	Yes	No	No	No
SmartH2O app	Yes	Yes	Yes	Yes	Yes

Note that the **Virtual Office condition** is established a-posteriori. Users are assigned to this condition if they have a Virtual Office account, but have not signed up for the SmartH2O application. Second, users are recruited who have signed up for SmartH2O, but do not use the SmartH2O application after signing up. Thus, users in this condition have not been exposed to the incentives in the SmartH2O application, but have been using the Virtual Office features.

The addition of this condition allows for systematic comparison of two different water consumption visualisation approaches, and of the effect of the absence or presence of gamified incentives.

However, the feasibility of a posteriori establishing the Virtual Office condition is contingent on the number of users we are able to recruit and how many of these users will decide to sign up for the SmartH2O portal.

Participants for the **SmartH2O app** condition are recruited by means of the recruitment actions that have been described in Section 4. Participants for the **control group** condition are recruited via a call centre. Only users who do not have an account for the Virtual Office are contacted. As a result, the participants in the control group have not been exposed to any detailed custom water consumption feedback.

The following measurements are planned:

- **Control group:**
  - Baseline (at the start of Trial 1, April 2016)
  - Final evaluation (after the last trial, November/December 2016)
- **Virtual office users:**
  - Baseline (at the start of Trial 1, April 2016)
  - Final evaluation (after the last trial, November/December 2016)
- **SmartH2O app:**
  - Baseline (at the start of Trial 1, April 2016)
  - Final evaluation (after the last trial x, November/December 2016)

The **baseline control group questionnaire** is administered by phone. A call centre script has been constructed, translated, and tested with students at UPV in two iterations. While remaining as close to original questions as possible to avoid effects on the questionnaire's reliability, minor adjustments have been made based on the results, primarily to improve easy comprehension of the questions. The call centre script can be found in Appendix A.

The **SmartH2O sign-up questionnaire** is prompted after participants have completed the sign-up process: Participants in the SmartH2O condition see a pop-up on the screen, in which they are asked to fill out the questionnaire as the logical next step in the sign-up process but on a voluntary basis. However, users are motivated to fill out the questionnaire as they are rewarded with 2100 points on the gamified portal, almost half of the points required for receiving the Drop! board game (see Figure 29).

Figure 29. Sign-up questionnaire online form.

Questionnaire construction

In contrast to the Swiss case study, for the Valencia pilot the pricing questionnaire was integrated with the sign-up and control group questionnaire, creating a fifth class of questions. In Table 10 we display the classes of questions in the questionnaire.

Table 10. Content of the different questionnaires.

Questionnaire	User characteristics	Water consumption determinants	Technology acceptance	User-based performance indicators	Pricing/ incentives
Baseline control group questionnaire	X	X			X
SmartH2O sign-up questionnaire	X	X			X
SmartH2O portal evaluation questionnaire		X	X	X	
Virtual Office evaluation questionnaire		X	X	X	

Data analysis

Multivariate analyses of variance are used to determine differences between the control group and the treatment group (e.g. the SmartH2O app), as well as between the different measurements over time. Thus, a mixed between-subjects (control group vs. SmartH2O app), and within-subjects (repeated measures after each trial) design is used.

Structural equation modelling is used to analyse the fit of the underlying model of water consumption determinants (e.g. [Jorgensen et al., 2009]) and the relationship between these determinants and water consumption behaviour.

Stepwise linear regression analyses are used to determine the effect of using different features in the platform on the water consumption difference between baseline and post-treatment measurements.

The employment of data analysis techniques is subject to the sample sizes, and the (normal) distribution of the observed variables.

5.3 First Swiss case study results

This section presents the first validation results from the Swiss case study, containing the users' feedback on the basic portal, as well as precise data on their awareness with respect to water consumption. Additionally, baseline and first water consumption measurements after the launch of the SmartH2O portal are reported. Even though the time frame does not yet cover a full year – to rule out seasonal variations – first results are promising.

As has been explained in the introduction, the small-scale Swiss pilot has been conceived as a test bed for the testing and fine-tuning of the SmartH2O system, especially with respect to the incentive model and gamification techniques. Over the course of 2015, multiple versions of the portal have been released iteratively (phase-based deployment) accompanied by associated promotion actions to recruit users by attracting their attention towards new functionalities.

The evaluation of the basic portal preceded the advanced platform releases in fall 2015. At this stage, promoting activity on the portal was considered most important. This has put some constraints on the data we have been able to collect, in terms of the length and frequency of the questionnaires, since long questionnaires tend to discourage users. Priority was given to a set of extensive awareness indicators based on the Theory of Planned Behaviour (TPB) that will be used for the evaluation of water consumption awareness before and after the launch of the gamified advanced portal, as this is the core of the SmartH2O incentive model described in *D4.3 Incentive models and algorithms*.

Below we outline the technology acceptance results and the water consumption measurements for the first trial, including the Planned Behaviour results that will be used to assess the impact of the advanced gamified portal on awareness after the upcoming trial.

We first evaluate the participants' assessment of the Smart H2O portal, in terms of technological acceptance and the success criteria that were formulated in *D2.2 Final requirements*. We then do a first assessment of the impact of the portal. Impact is first assessed in terms of differences in water consumption, while taking into account that not a full year of data is available. Second, preliminary user awareness data is presented for the basic portal, as well as the results on the TPB-determinants against which ultimately the impact of the gamified portal will be evaluated, as a refinement of the awareness KPI. Finally, we provide an outlook towards the impact of the gamified portal by assessing first portal usage statistics.

5.3.1 Technology acceptance of the basic portal

Prior to the release of the second version of the basic portal in the Swiss case study at the end of October 2015, users' attitudes towards the first basic portal version (see Figure 30 for snapshot of the initial basic portal) were evaluated through an online questionnaire that was distributed via e-mail; the questionnaire was accessible for 3 weeks.

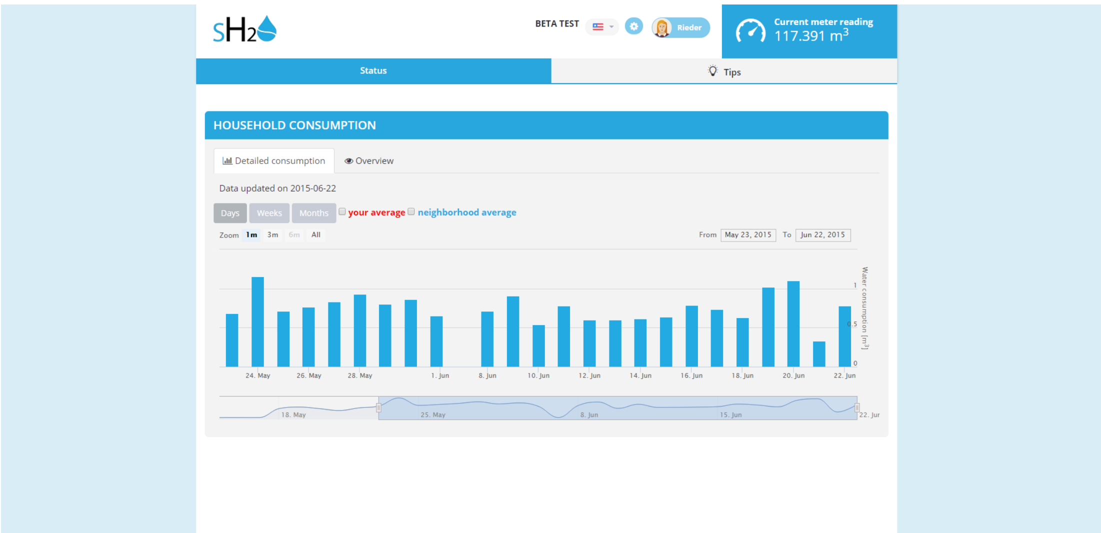


Figure 30. Basic portal snapshot at the time of the evaluation.

The basic portal had been launched to a selected group of 10 alpha users in the Swiss case study in May 2015, and to the general public in July, allowing most users to try out the basic features (consumption chart, basic consumption overview visualization, tips and videos; see D6.1) over the course of the summer months before responding to the questionnaire. At the time of the evaluation of the basic portal, 33 users (incl. 10 alpha users) were registered on the SmartH2O portal and 15 users (incl. 5 alpha users) responded to the questionnaire (return rate = 45,45%). To incentivize users to fill out the questionnaire, a raffle was conducted among respondents (prizes: 2 umbrellas and 1 jacket sponsored by SUPSI).

Figure 31 shows the characteristics of participating households, and Figure 32 their technology affinity, indicating that the majority of respondents is rather technology affine.

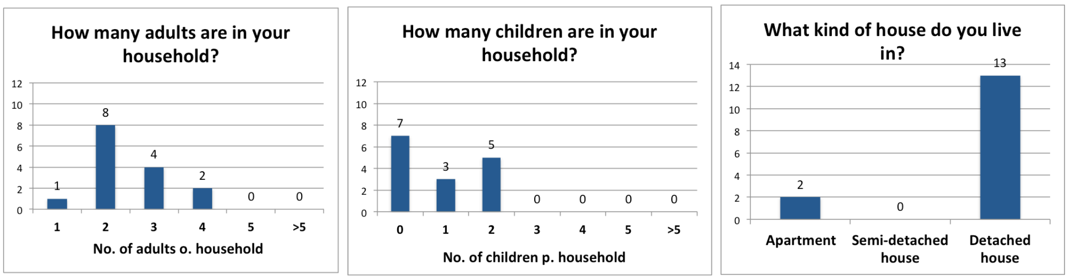


Figure 31. Household characteristics of respondents.

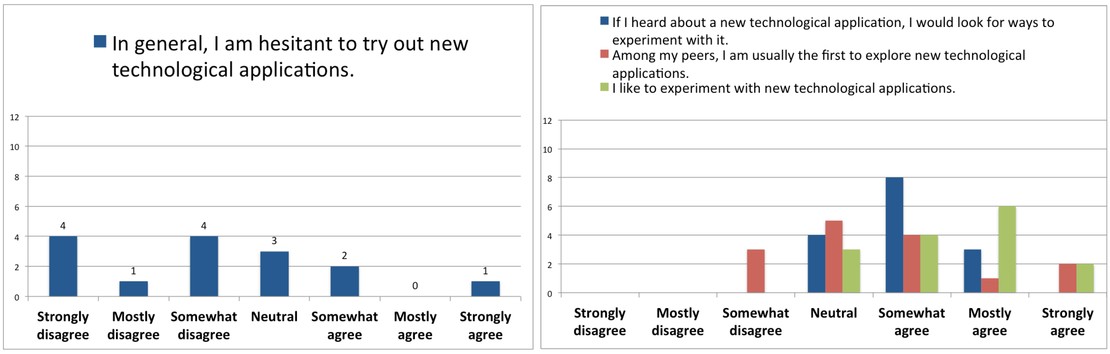


Figure 32. Technology affinity of respondents.

As stated in D2.2, users' technology acceptance is assessed on two levels: the level of an application as a whole and the level of specific application functionalities (human-computer interactions). The general application level needs to be addressed, as the perception of the users of the individual functionalities is influenced by their perception of the application as a whole – and vice versa.

Technology acceptance on the main application level (UTAUT)

To assess technology acceptance on the level of the main applications, we apply the Unified Theory of Acceptance and Use of Technology (UTAUT) [Venkatesh et al., 2003] as our starting point. The model is the validated result of integrating eight different user acceptance theories and their measurement instruments. In this first evaluation round, the following indicators that were derived from the UTAUT framework were used in this first evaluation [Venkatesh et al., 2003]:

- Effort expectancy: the degree of ease associated with the use of the system;
- Attitude towards using technology: an individual's overall affective reaction to using a system;
- Performance expectancy: the degree to which an individual believes that using the system will help him or her to attain gains in job performance / the tasks at hand.

Each indicator was evaluated with a subset of standardized questionnaire items using a 5-point Likert scale. The items have been slightly adapted to fit each application context. Figure 33, Figure 34 and Figure 35 show the responses. Most respondents assessed the ease of use positively (Figure 33) and the majority of respondents also expressed a positive attitude towards using the system, while the rest remained neutral. And while respondents are still mainly undecided whether they find the SmartH2O basic portal useful in their daily lives, 6 out of 15 did indicate that the portal increased their chances of achieving things that are important to them (Figure 35).

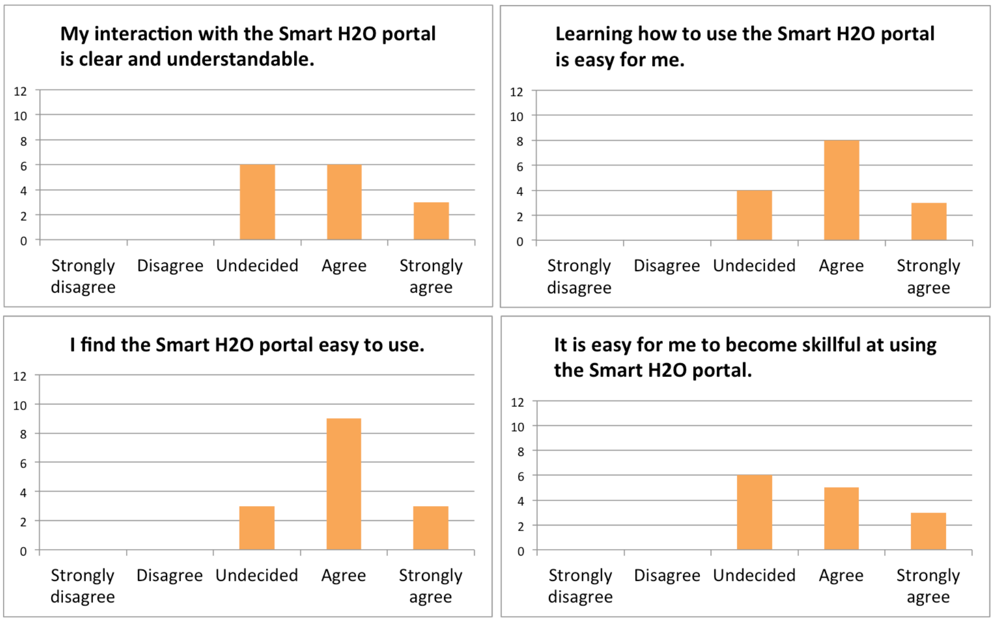


Figure 33. Effort expectancy (ease of use).

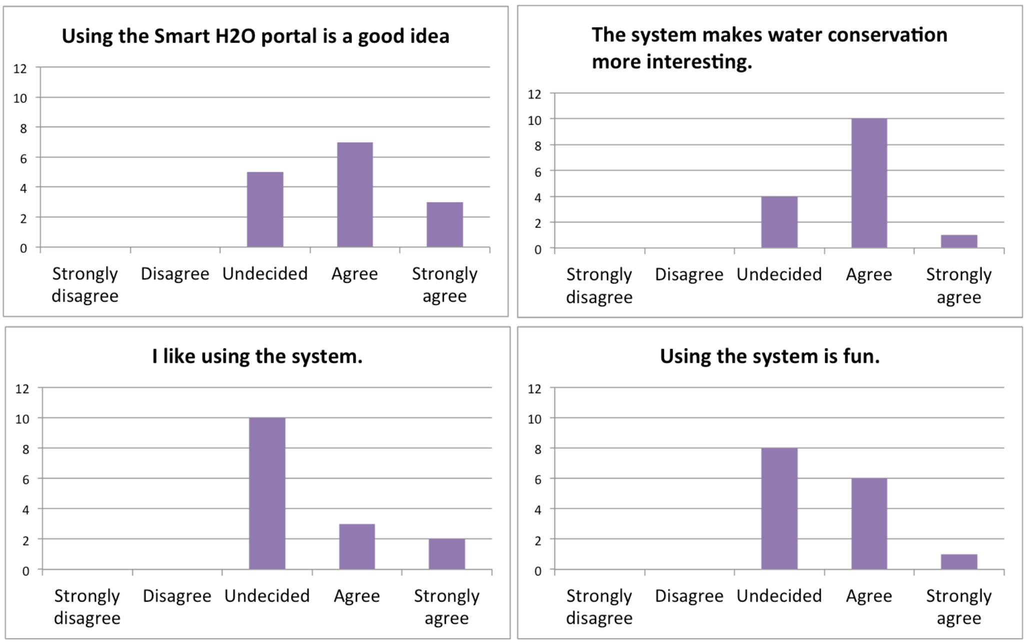


Figure 34. Attitude towards using technology.

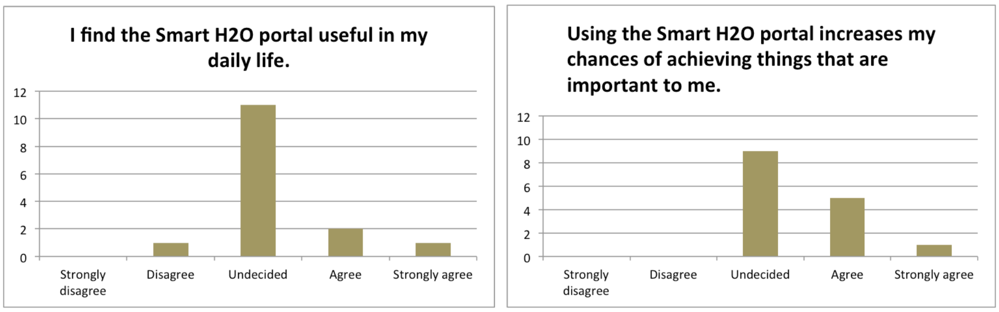


Figure 35. Performance expectancy.

Hedonic quality stimulation and pragmatic quality

In addition to the UTAUT indicators, we assessed Hedonic Quality Stimulation (HQS) and Pragmatic Quality (PQ) according to [Hassenzahl, 2004]: HQS measures if a system stimulates users, e.g. by its challenging or novel character, and PQ measures pragmatic aspects of a system, e.g. ease of use. Each indicator was evaluated with a standardized set of bipolar verbal anchors: in a questionnaire, users position themselves regarding their impression of a given system on a 7-point bipolar scale. Items can be found in Appendix A.

The comparison of the means of HQS and PQ items shows positive values for both aspects with a stronger tendency towards pragmatic quality (see Figure 36). This reflects the expectations, as the basic portal has been anticipated to cover mainly needs of more pragmatic users, and does not contain specific hedonic elements besides from appealing visuals and an interactive visualization. The HQS value is expected to be higher in the gamified portal and results will be compared as soon as a user evaluation of the gamified portal in CH has been conducted.

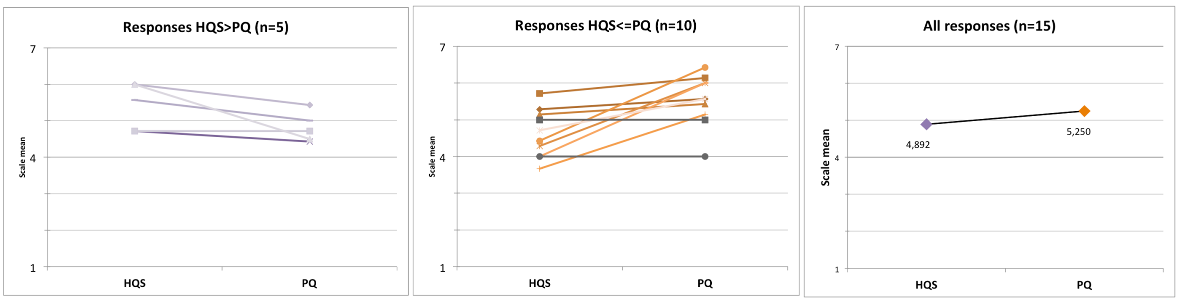


Figure 36. Hedonic quality (stimulation) vs. pragmatic quality.

Assessment of use-case-specific aspects

In addition to the main application level, we also assessed use-case-specific aspects of the two main implemented user-centred use cases (8.3 and 8.7, see D2.2), in terms of usability, usefulness, comprehension and the users' perception on the incentive models that are employed (in accordance with the success criteria defined in D2.2).

Use case 8.3 – User explores consumption visualization:

At the time of the basic portal evaluation, the following two consumption visualizations were available to users: Detailed interactive consumption chart (see Figure 37) and consumption overview visualization (see Figure 38).

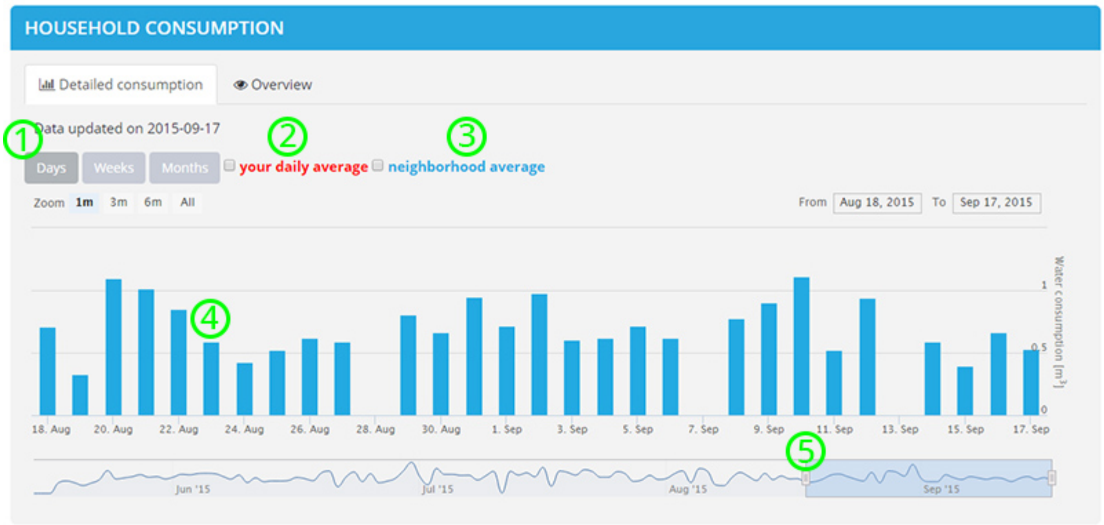


Figure 37. Consumption chart with highlighted functionalities.

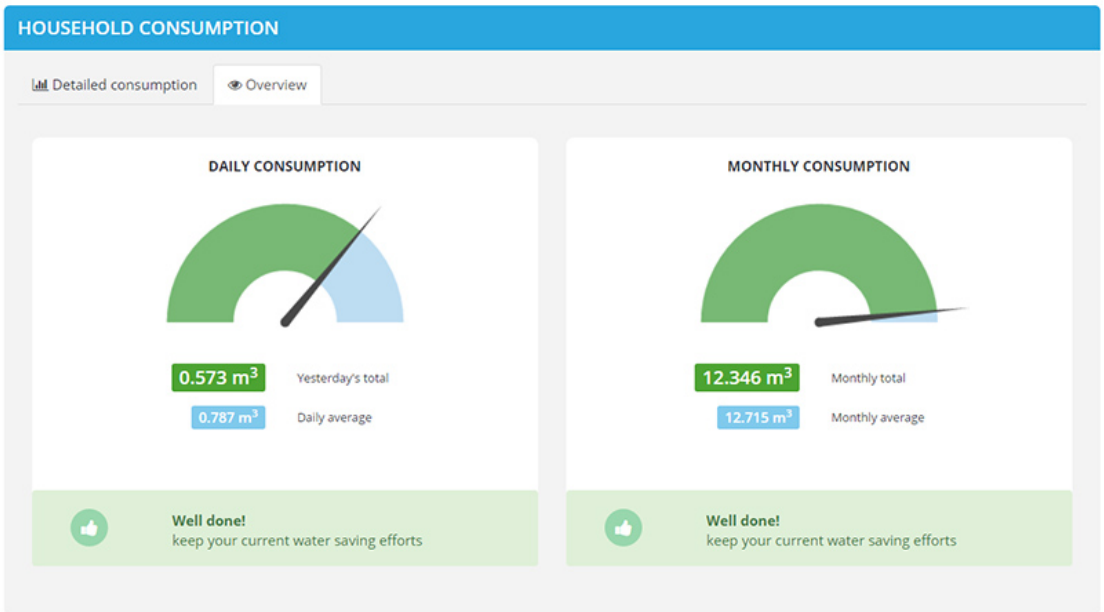


Figure 38. Consumption overview visualization (as shown in basic portal September – November 2015).

Using the interactive water consumption chart was assessed easy to very easy by over half the respondents while the others remained neutral (Figure 39-l). And nearly all respondents somewhat or mostly agreed that they could understand from both the chart and the overview visualization how much water their household consumes over time (Figure 39-c). At least half the participants found the consumption chart and overview visualization useful and only 3 and 2 respectively of the 15 didn't see their use yet (Figure 39-r). The majority of filters of the water consumption chart and the overview page were clear to respondents (Figure 40), but the fact that one third hasn't viewed their hourly consumption may indicate either a possible usability issue or the lack of a need to see hourly consumption data and will require further investigations in the next evaluation round.

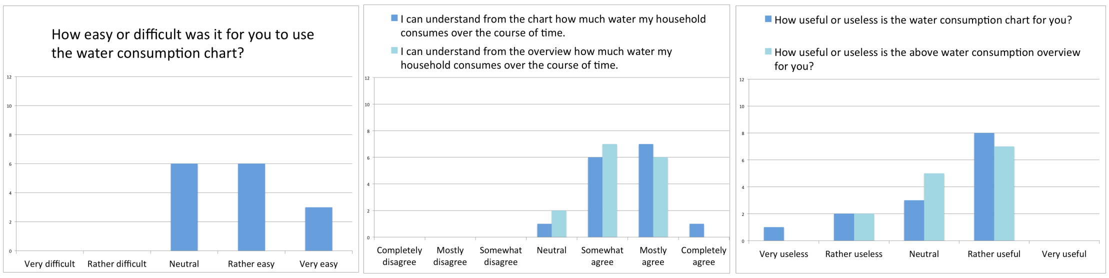


Figure 39. Ease of use of water consumption chart (l); Comprehension of consumption chart and overview (c); Usefulness of water consumption chart and overview (r).

Figure 40. Comprehension of individual elements of the water consumption chart (no. 1 - no. 5) and overview visualization (bottom right).

Use case 8.7 – User gets a water saving tip

In addition to displaying users' their consumption in an interactive manner, the basic portal also provides water saving tips as shown in Figure 41.

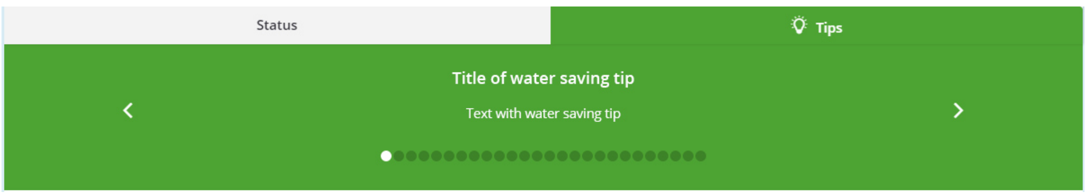


Figure 41. Water saving tips in the basic portal.

Most respondents found the water saving tips rather useful, but at the same time stated a neutral opinion in terms of to which extent they were able to put them into practice (Figure 42). This could reflect that they were able to put some of them into practice while not others, which was to be expected since there were more and less complex tips in the database. A second explanation comes from the gap between a user's opinions on water saving and their behaviour (see also 5.3.3). However, the exact impact of different water saving tips needs to be investigated in more detail in upcoming evaluations, and more tips need to be provided to address different needs and comfort levels.

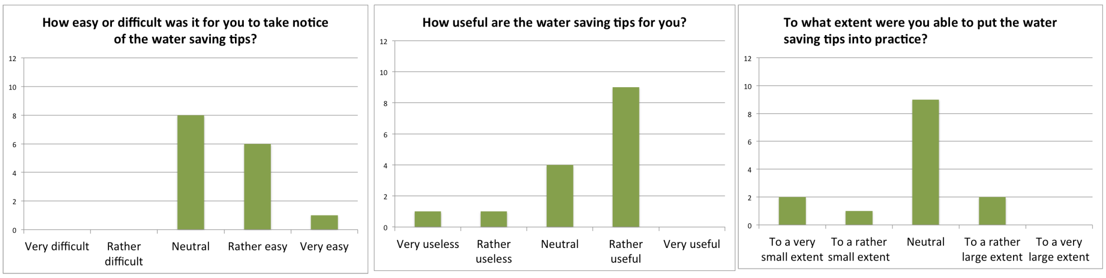


Figure 42. Perception of ease of use and usefulness of water saving tips.

A comparison of the perception of the three main elements water consumption chart, consumption overview and water saving tips indicates that the perceived usefulness of respondents is balanced among the individual features (Figure 43-l). Most importantly, for all three features most users agreed that they made them think about water conservation more often than before (Figure 43-r).

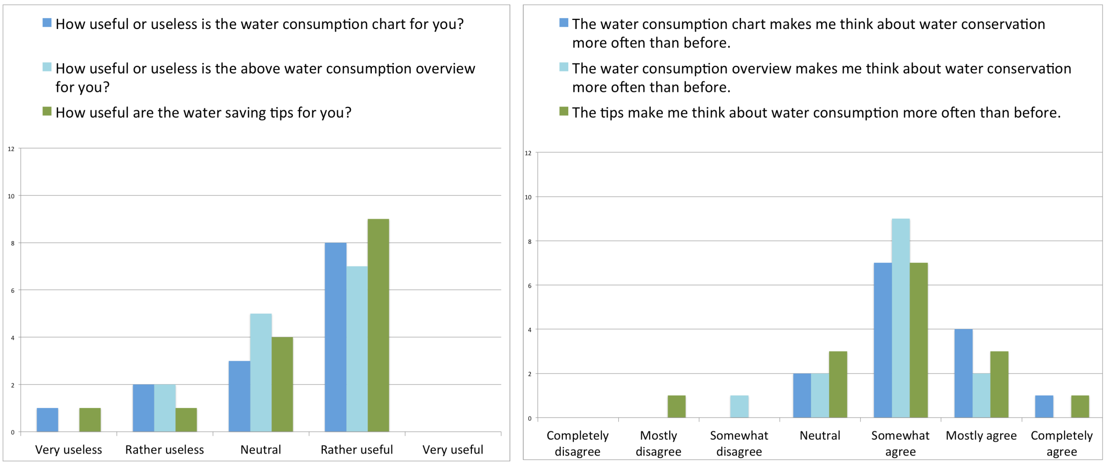


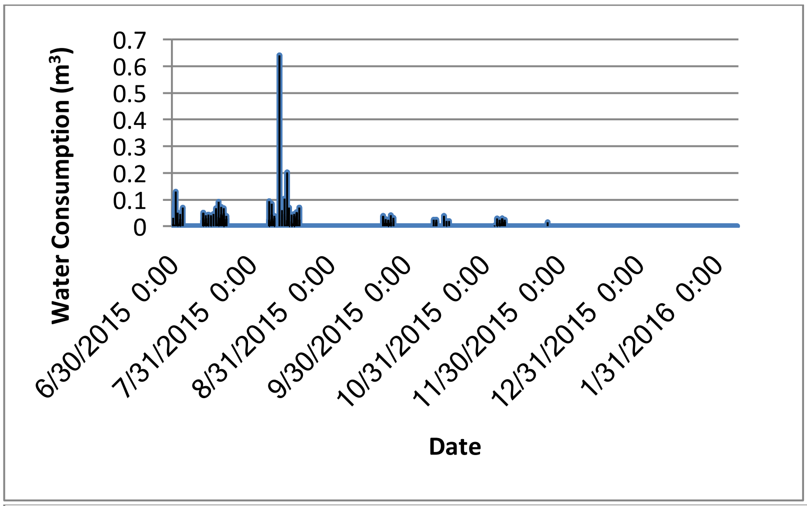
Figure 43. Perceived usefulness of the main basic portal elements (l) and perceived awareness increase of main basic portal elements (r).

5.3.2 Water consumption data evaluation

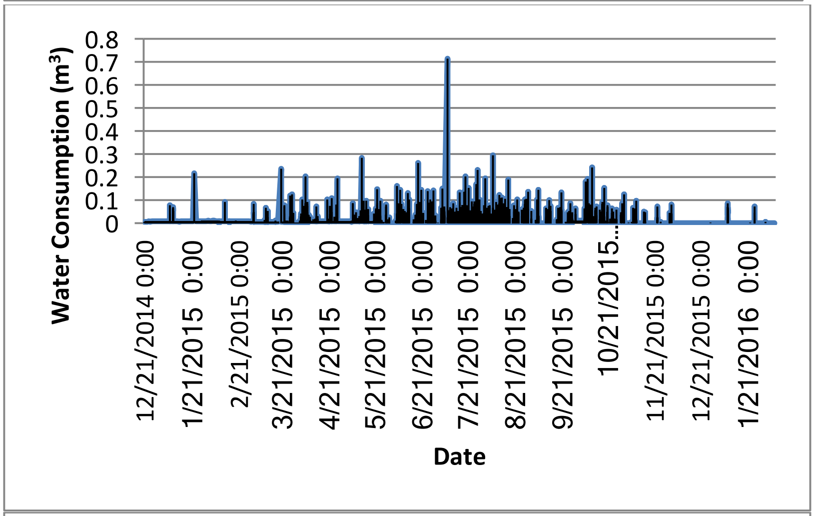
In order to characterize the users in terms of their water consumption volumes, smart meter measurements collected from the moment of the smart meter installation up to October 31st 2015 (i.e. when the second version of the basic portal was released) have been used for the baseline computation. The date when the smart meter was installed at the user's premises varied from user to user in a range between December 2014 and September 2015. From that moment on, consumption data began to be collected by the SES metering data collection infrastructure.

The baseline has then been compared to the average daily consumption computed over data spanning from November 1st 2015 to February 6th 2016. According to their average consumption values, users have been classified as low, low/medium, medium/high or high consumers. The ranges of each consumption class have been computed based on the classification outputs of the clustering algorithm developed in WP3 (see D3.4). Finally, the consumption reduction percentage in comparison to the baseline value has been calculated.

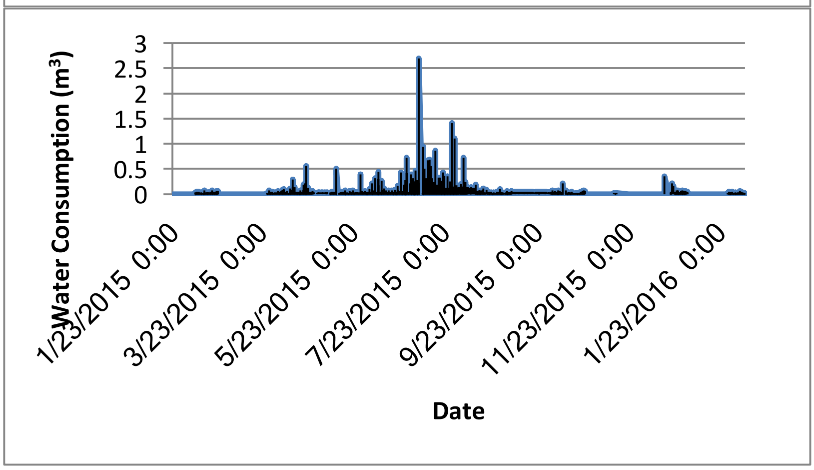
Table 11 displays a subset of the 43 smart metered users in the Swiss case study who have signed up for the SmartH2O portal. More in detail, two users were excluded because the installation date of their smart meter (end July and end September 2015, respectively) was too recent to collect a sufficient amount of data for the computation of a statistically meaningful baseline. Additionally, 6 users were excluded after manual inspection of their daily water consumption trends, which showed that the households were not regularly used (e.g. summer houses, or houses unrented for most of the validation period). For the sake of completeness, Figure 44 reports the consumption patterns of the 6 above mentioned households. Note that user f) presents an almost constant hourly consumption around 0.03-0.05 m^3 which is due to the fact that the user runs a small commercial plant nursery. Since such user cannot be fully classified as "residential", we decided to exclude him/her from our analysis.



a)



b)



c)

d)

e)

f)

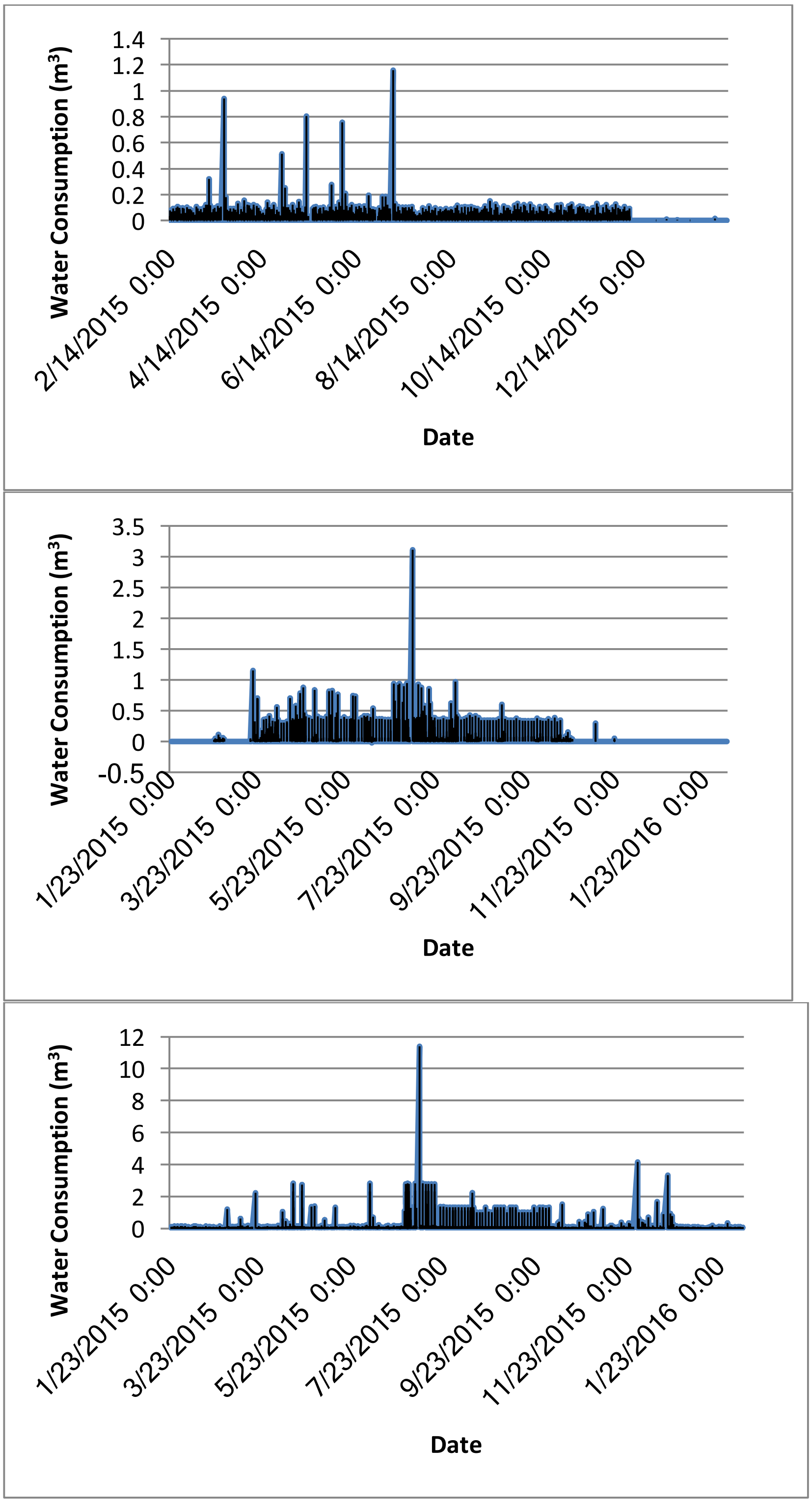


Figure 44. Water consumption patterns of outlier users.

Results are grouped by the aforementioned consumption classes: low consumers, low/medium consumers, medium/high consumers, and high consumers. The table also displays the portal version each user is currently using (either basic or gamified).

Table 11. First water consumption results (Swiss case study).

Smart Meter ID	Platform Version	Baseline Average Daily Consumption (m^3)	Average Daily Consumption (m^3) from 1/11/2015 to 6/2/2016	Individual Consumption Reduction (%)
Low consumers				
1	gamified	0.06	0.02	61.10
2	basic	0.29	0.28	2.96
3	basic	0.31	0.21	33.14
4	basic	0.32	0.32	-0.12
5	gamified	0.35	0.26	25.95
6	basic	0.38	0.26	31.38
			Mean *S.d.*	*25.73* *20.51*
Low/medium				
1	basic	0.42	0.37	10.85
2	gamified	0.42	0.22	47.89
3	basic	0.44	0.36	17.48
4	gamified	0.44	0.36	17.48
5	basic	0.50	0.32	35.97
6	gamified	0.57	0.62	-8.53
7	basic	0.58	0.34	41.68
8	basic	0.65	0.56	13.59
9	basic	0.65	0.42	35.73
10	basic	0.69	0.75	-8.06
11	gamified	0.69	0.48	30.61
12	gamified	0.76	0.70	8.59
13	basic	0.78	0.32	59.20
14	gamified	0.78	0.43	45.35
15	basic	0.79	0.28	65.05
16	basic	0.81	1.08	-33.82
17	gamified	0.83	0.33	60.62
18	gamified	0.93	0.90	3.93
19	basic	0.97	0.96	0.85
			Mean *S.d.*	*23.39* *26.05*
Medium/high				
1	basic	1.02	0.44	56.84
2	basic	1.08	0.74	31.76
3	basic	1.13	0.90	20.23
4	basic	1.17	0.79	32.90
5	basic	1.30	0.45	65.54
6	basic	1.33	0.60	54.90
7	basic	1.83	1.50	18.06
8	gamified	2.02	1.45	28.10
			Mean *S.d.*	*38.54* *16.86*
High				
1	basic	2.52	0.94	62.67
2	basic	3.26	2.57	21.22
			Mean *S.d.*	*41.95* *20.72*
			Total mean **S.d.**	**28.32** **24.41**

Figure 45 displays the averages for each of the consumption classes.

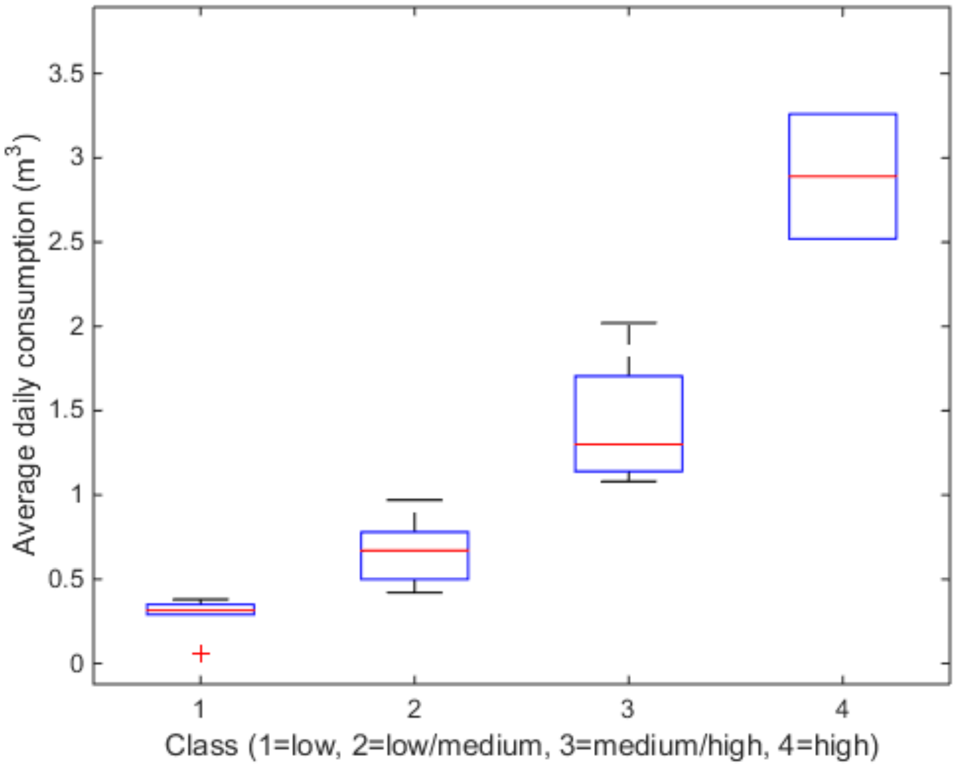


Figure 45. Consumption class averages.

Results demonstrate that the average consumption reduction varies per consumption class, ranging from 23% to 41%, with an average reduction of 27.5% across consumption classes. The high standard deviations demonstrate that there are large differences between users.

Note that the high-consuming class only contains two users. This is probably due to a self-selection effect: users most interested in water efficiency – with low water consumption levels – are more likely to join the platform in an early phase than users with little awareness and high consumption levels.

However, it should be noted that between 10% and 20% of this reduction can be related to seasonal variations (i.e. the reduction occurring during the 3 winter months w.r.t. the average yearly consumption, as observed in literature, e.g. [Firat et al., 2009], [Zhou et al., 2000], [Griffin & Chang, 1991]), therefore it is difficult to accurately assess the effects of the platform usage after only 100 days of validation. An accurate quantification of the consumption reduction due to the platform usage will be provided in deliverable D7.3, when validation data over at least 12 months will be available. This will allow for the elimination of the biases due to seasonal variations.

Subsequently we analysed the average consumption reduction for each of the classes. The results are depicted in Figure 46.

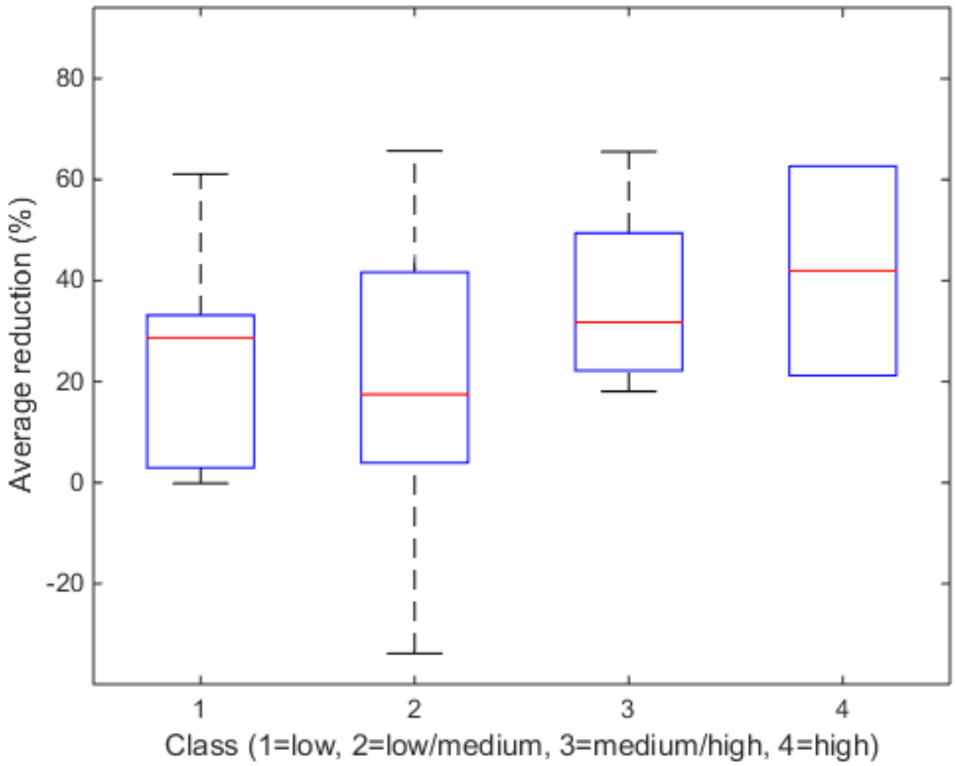


Figure 46. Average consumption reduction by consumption class.

As can be seen from Figure 46, the average consumption reductions vary per class, with the highest consumption reductions achieved for the high-consuming households and the medium-high consumers.

Differences between consumption classes might be explained from differences in awareness and attitudes towards water consumption. We investigate this point in more depth in the next sub section.

Even though the results are promising in terms of the water consumption reduction percentages, a more detailed analysis of water consumption reduction results can only be done once a longer period of smart metered water consumption data and platform usage data is available. Nevertheless, the first results are positive when compared against the target level of the associated KPI (5% reduction), also given the fact that the peak summer period – during which most savings can be achieved – has not yet been measured.

5.3.3 User awareness and behavioural properties

In the Swiss case study, a small sample size was to be expected due to the small population of metered users. Because we didn't want to confront the initial users with a big questionnaire, we limited the measuring of awareness prior to their signup to two short questions directly in the sign-up form (see Figure 47). Other setups would have been too risky, possibly scaring away potential users that would have posed a major risk to the project. Thus the experimental design was adapted to the constraints of such a real world setting. For those initial users, the main focus was thence to evaluate awareness differences after using the basic portal and after users had switched to the gamified portal. Accordingly, in the online questionnaire distributed amongst basic portal users before the gamified portal release, more elaborate user awareness and behavioural change baseline questions based on the Theory of planned behaviour were introduced (see section 5.2.3).

New users who are signing up ever since the second basic portal release (Oct 26th) are requested to fill out a similar elaborate baseline questionnaire covering the user awareness indicators. The questionnaire is prompted right after submitting the sign-up form in the portal.

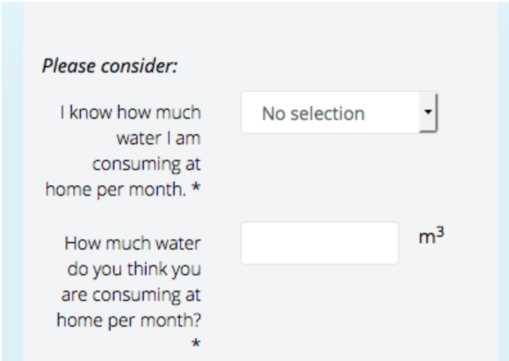


Figure 47. Sign-up questions.

Basic awareness assessment before portal usage

Users who sign up to the portal are required to respond the two initial awareness questions presented above (excl. alpha users). Most users were undecided or didn't know how much water they consumed per month (Figure 48).

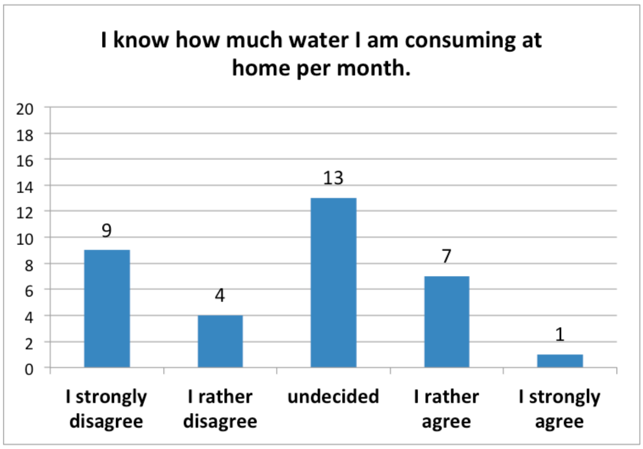


Figure 48. Responses to initial awareness question during sign-up.

Comparing users' consumption estimates to their actual consumption baseline (see Figure 48) confirms this self-reported assumption: 58,8% of users were off by 10m^3 or more, and 76% were off by more than 25% compared to their actual consumption. This observation is illustrated when comparing responses to the awareness question to the accuracy of users' monthly consumption guesses (Figure 49): Most users (18 in total) were unaware of their water consumption (undecided – strongly disagree) and estimated their consumption wrongly, too.

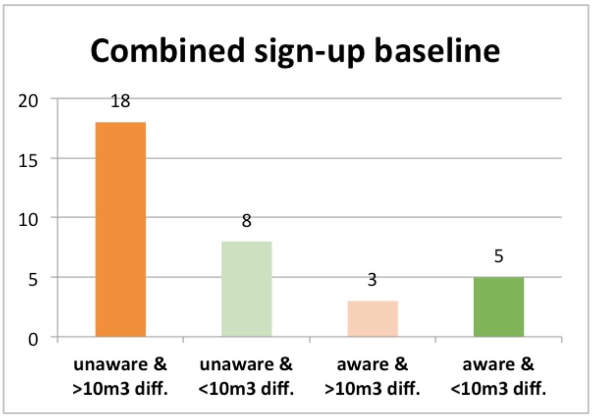


Figure 49. Comparison of responses to the awareness question to the accuracy of users' monthly consumption guesses.

The high mean difference of measured vs. estimated consumption of 638,70m^3 and s.d. of 3032 (Table 12) also illustrates that several people who estimated wrongly had absolutely no idea of how much they consume (estimates of up to 18000m^3), and / or into the meaning of the unit "m^3". Even without the 3 extreme outliers, the mean consumption difference of 27,64m^3 (s.d.=38) is still relatively large (Table 12). Since users will have had the chance to interact with and better understand their consumption as well as the meaning of units, we would expect better results after portal usage at the end of the trial.

Another observation is that nearly all users who guessed correctly consumed relatively little water (18m^3 and less), while most users with a larger difference between estimate and measurement consumed 20m^3 and more per month. This could indicate that users with a higher awareness of their actual consumption tend to consume less water, and that closing this knowledge gap by providing less-aware users with more information and details of their consumption could ultimately lead to a consumption reduction on their side.

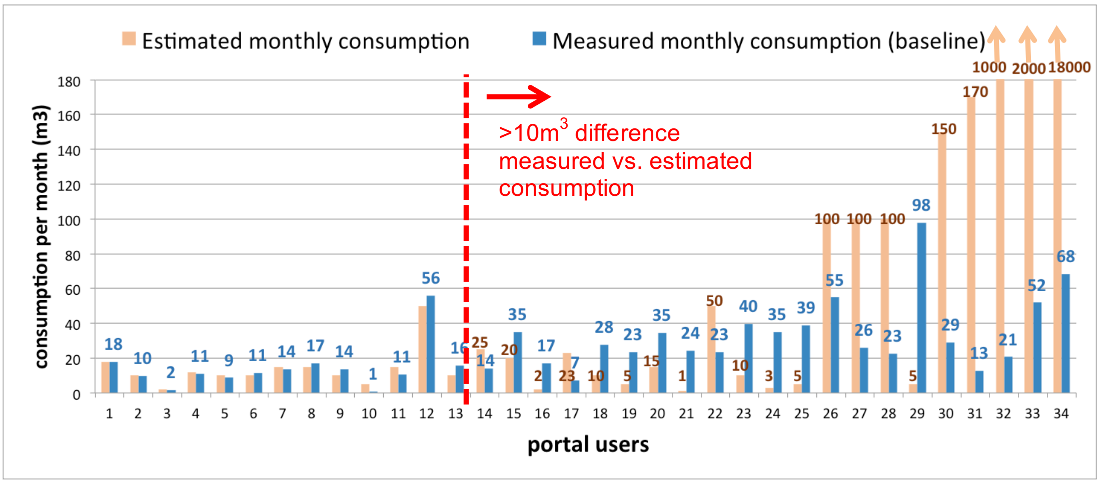


Figure 50. Responses to initial awareness question during signup on estimated consumption vs. actual consumption baseline (in m^3).

Table 12. Means and standard deviation of measured vs. estimated monthly consumption.

	Measured monthly cons. (baseline) (m^3)	Estimated monthly consumption (m^3)	Absolute difference (m^3)	Absolute difference (%)
	With outliers (n=34)			
Mean	26,27	646,35	638,70	1143,27%
S.d.	20	3043	3032	4477,07%
	Without outliers (n=31)[a]			
Mean	24,26	31,48	27,64	134,54 %
S.d.	19	44	38	230,00 %

[a] Three outliers were removed with estimated water consumption levels > 1000 m^3

As the results above demonstrate, before using the portal, users are relatively unaware of their water consumption, which in the incentive model has been defined as a prerequisite for behavioural change (see *D4.3 Incentive model and algorithms*).

To further investigate if the difference between the estimated and the real consumption is related to the actual water consumption, we computed the average difference for each of the water consumption classes defined in WP3. Table 13 lists the results.

Table 13. Difference between estimated and real consumption by consumption class.

Consumption class	Difference between estimated and real consumption
Low	3.50
Low – Medium	95.89
Medium – High[a]	266.16
High[b]	92.80

[a] Outlier with difference 17931.60 has been removed; [b] Consumption class 'high' contains only one user.

Notwithstanding the high consumption class with only one user, these results also suggest that the more water users consume, the bigger the difference between estimated and the real consumption. The Spearman correlation between water consumption and the estimated difference was strong and significant (Rho=.64; p<.001).

User awareness after basic portal usage

In the online questionnaire that was distributed to basic portal users, the psychological determinants with respect to water saving in the house and around the garden were addressed. In this part we report on the first results. Note that in this questionnaire the questions were asked before the questions on the basic portal, to avoid the respondent's reflections on the portal influencing the Theory of Planned Behaviour constructs (e.g. attitudes, beliefs, perceived behavioural control, behavioural intention).

After the last trial, we will measure these constructs again for the same users to calculate differences in water saving awareness, and to assess the differences between the gamified advanced portal and the users who are still using the basic portal.

In addition, to the TPB constructs, questions were asked to with respect to user's estimated difference with other households in the neighbourhood, supplementing the data on the subjective norm. Finally, a question was asked about the knowledge of the user with respect to the water consumption of appliances, which adds to the behavioural beliefs. All items can be found in Appendix A.

Two aspects of behavioural beliefs were addressed that have shown to be most important (e.g. [Jorgensen et al., 2009; Fielding et al., 2012; Corral-Verdugo et al., 2002]): utilitarian beliefs, referring to beliefs about the practical necessity to save water, as well as ecological beliefs, referring to how participants think about the environment and the use of resources in general. These two aspects were measured with a four-point Likert scale items (1= completely disagree; 4=completely agree), based on [Corral-Verdugo et al., 2003]. Results are depicted in Figure 51 and Figure 52. Note that lower values represent stronger beliefs about the necessity of saving water.

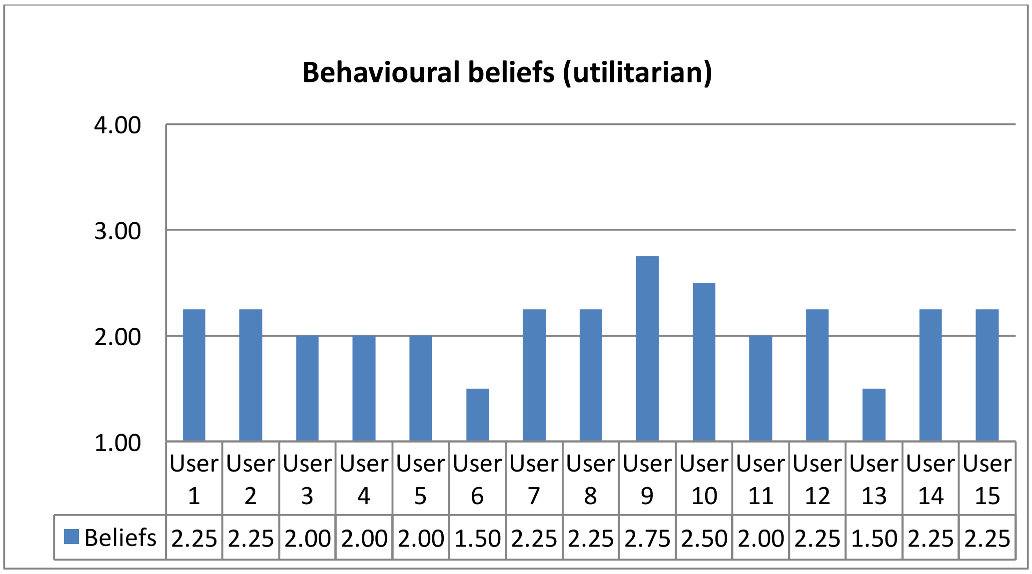


Figure 51. Behavioural beliefs (utiliatarian).

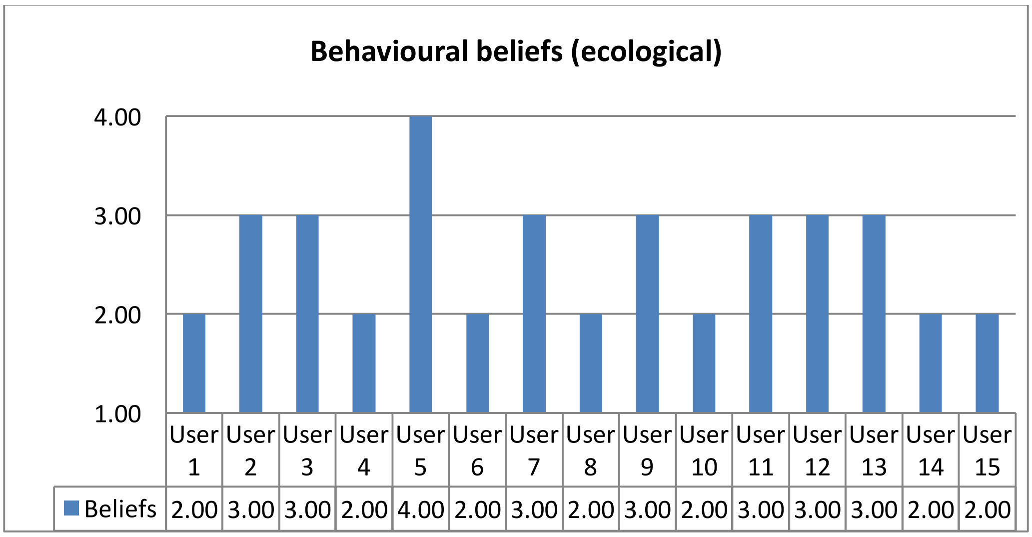


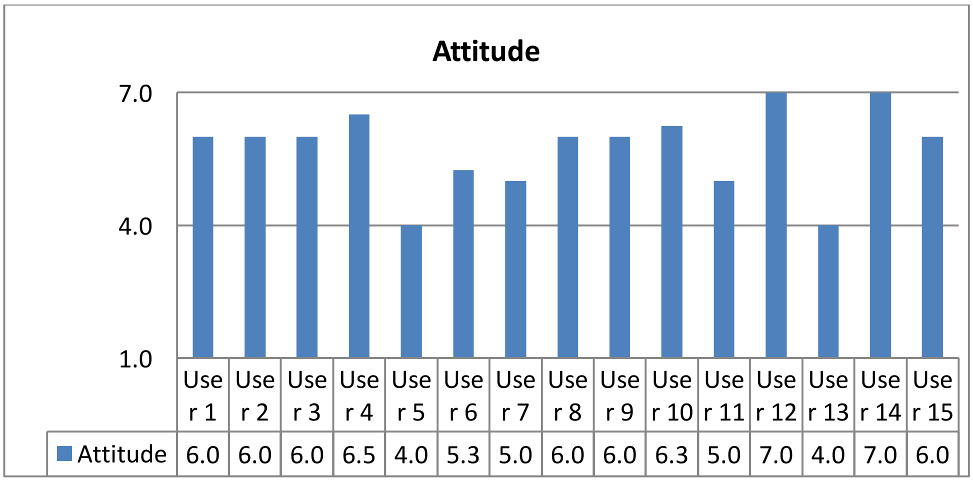
Figure 52. Behavioural beliefs (ecological).

Table 14. Items of Utilitarian and Ecological beliefs.

Utilitarian beliefs items	Ecological beliefs item
• There is much water in [area name]. We just have to conduct it to our cities. • Science surely will solve the problem of water scarcity. • Drinkable water is an unlimited resource. • Drinkable water will exhaust very soon if we do not save it.	• A way of preventing water exhaustion is using it when absolutely necessary.

The results indicate that utilitarian beliefs are more favourable towards water saving than ecological beliefs. Ecological beliefs also demonstrate larger variability between users (s.d.=.6 for ecological beliefs, and .3 for utilitarian beliefs). The moderate values for both aspects demonstrate that there is a necessity for incentives and information with respect to water saving. That is, ecological beliefs can be influenced by providing information that highlights what an individual can do to save water.

The attitudes represent the subjective evaluation of the behavioural beliefs [Ajzen, 1997] with respect to water saving. Four seven-point semantic differentials were used to assess the attitudes, with higher values indicating more positive attitudes. The averaged results are depicted in Figure 53.

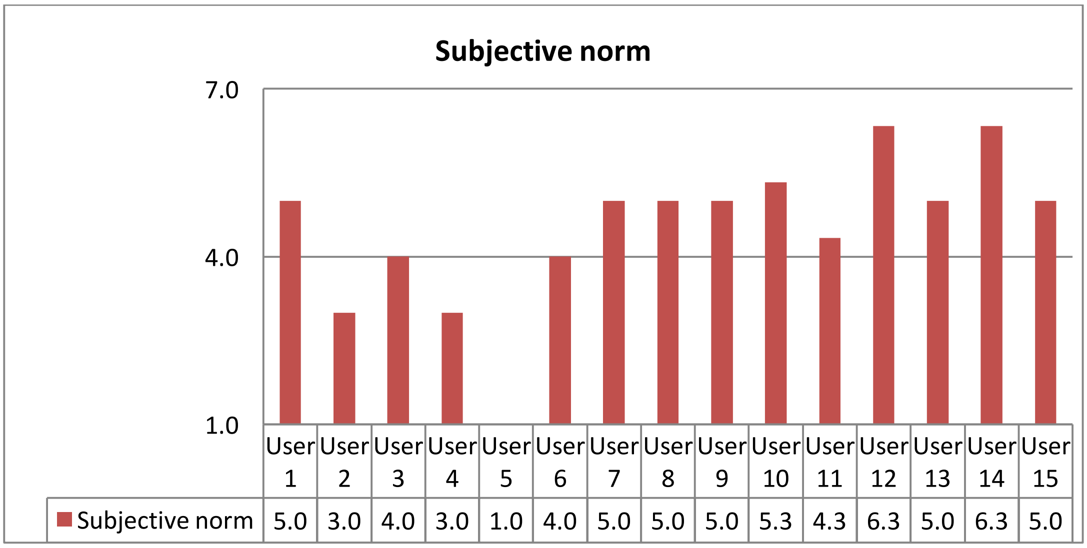


Attitude items
Engaging in everyday actions to save water around the house and garden is: • extremely bad/extremely good; • extremely harmful/extremely beneficial; • extremely worthless/extremely valuable; • extremely unpleasant/ extremely pleasant.

Figure 53. Attitude towards water saving.

Results indicate strongly positive attitudes towards water saving, even though there is some variation between users (s.d.=.9). Particularly #5 and #13 demonstrate less favourable attitudes than the other users. As could be predicted from the TPB model, utilitarian beliefs were positively correlated with attitudes (rho(12)=.06; p=.04).

Three seven-point Likert scale items were included in the questionnaire to assess the subjective norm, with higher values indicating a stronger subjective norm. In Figure 54 the results are displayed.



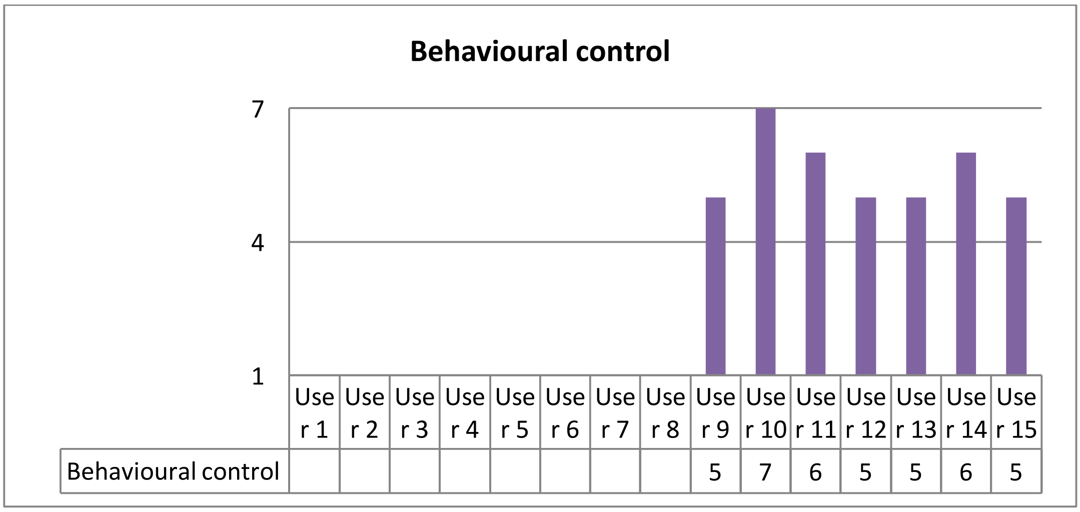
Subjective norm items
• It is expected of me that I save water around the house and garden.
• I feel like there is social pressure to save water around the house and garden.
• People who are important to me want me to save water around the house and garden.

Figure 54. Subjective norm with respect to water saving.

The findings demonstrate a relatively low average score for the subjective norm (m=4.5), with a high standard deviation (sd=1.4). Note that #5 was extremely insensitive to social influences, with a subjective norm average of 1. These results imply that the influence of significant others on water consumption behaviour is smaller than the literature suggests (e.g. [Corral-Verdugo et al., 2002]), to the extent that this can be observed from such a small data sample. Finally, the variability in the results with a standard deviation of 1.4 highlight the importance of offering multiple incentive mechanisms to engage different segments of the user population.

Following [Fielding et al., 2012] a single seven-point Likert scale was used to measure perceived behavioural control. Unfortunately, technical difficulties in the online questionnaire tool have resulted in the loss of data on perceived behavioural control for 8 users. The results of the remaining users are displayed in Figure 55.

As can be seen from perceived behavioural control scores vary between users from five to seven. This shows that users feel moderately confident to save water, but there is room for improvement. This result is consistent with the basic portal evaluation findings on the water saving tips (see Section 5.3.1): the usefulness of the tips was positively evaluated, but users gave lower assessments of the extent to which they were able to put the tips into practice.

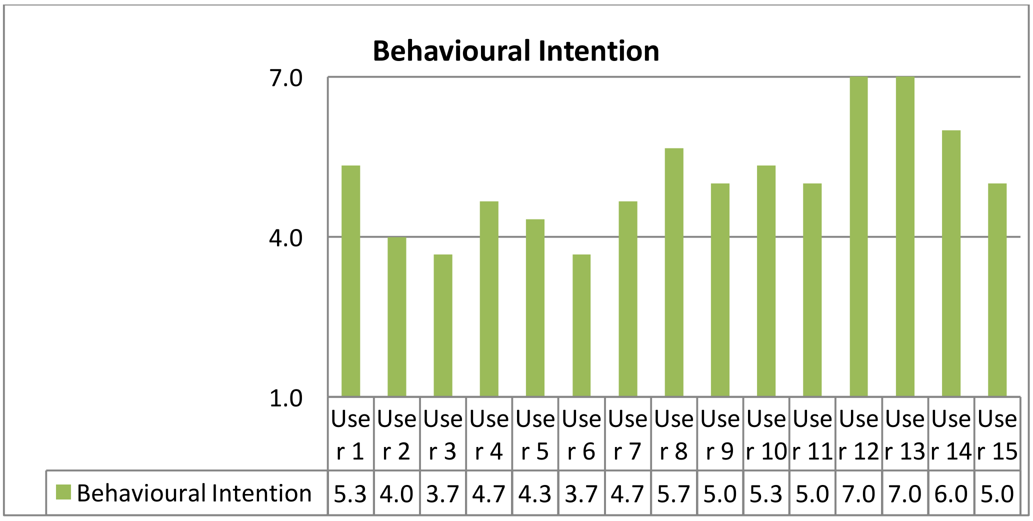


	User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9	User 10	User 11	User 12	User 13	User 14	User 15
Behavioural control									5	7	6	5	5	6	5

Perceived behavioural control item
• I am confident that I could save water around the house and garden if I wanted to.

Figure 55. Perceived behavioural control over water saving actions.

Three seven-point Likert scale items were used to assess the user's behavioural intention. The results are shown in Figure 56.



	User 1	User 2	User 3	User 4	User 5	User 6	User 7	User 8	User 9	User 10	User 11	User 12	User 13	User 14	User 15
Behavioural Intention	5.3	4.0	3.7	4.7	4.3	3.7	4.7	5.7	5.0	5.3	5.0	7.0	7.0	6.0	5.0

Perceived behavioural intention items
• I expect I will engage in everyday actions to save water around the house and garden in the next six months. • I intend to engage in everyday actions to save water around the house and garden in the next six months. • I want to engage in everyday actions to save water around the house and garden in the next six months.

Figure 56. Behavioural intention with respect to water saving.

With an average behavioural intention of 5.1, the results demonstrate that even though most users have favourable attitudes towards water saving, the intention to convert these attitudes into actions is both lower and less equally distributed. Even though the sample is small, this result provides tentative evidence for the assumption in SmartH2O that continuous incentives are needed to close the gap between attitude and behaviour.

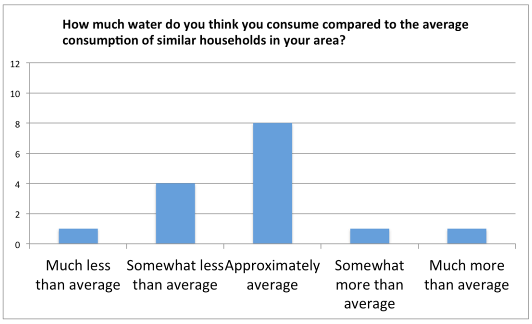


Figure 57. Estimated water consumption difference with similar households.

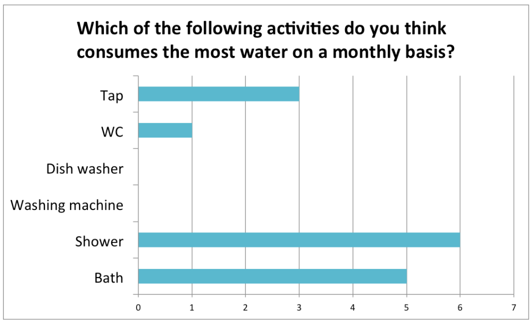


Figure 58. Most water consuming activities.

As shown in Figure 57, the participants' estimation of their water consumption in comparison to other households demonstrates a more or less normal curve, with most participants rating their consumption as average, and few participants rating their consumption above or below average.

A recent Swiss water consumption study [Freiburghaus, 2015] has demonstrated that toilet usage (42 litres per inhabitant per day), and showering consume (37 litres per inhabitant per day) most water, whereas using the tap in the kitchen consumes only 21 litres per inhabitant per day. Compared against the results displayed in Figure 58, participants have correctly estimated the importance of showering for water consumption. Three participants overestimated the importance of the tap, while five participants considered taking a bath as the most water consuming activity. These observed differences highlight the importance of providing factual information about the activities and appliances that consume most water.

Relationship between constructs

Unfortunately the size of the user population and the resulting sample for this questionnaire does not allow us to do structural equation modelling to assess the relationship between constructs and their influence on the eventual water consumption.

5.3.4 User awareness and behaviour baseline for new sign-ups

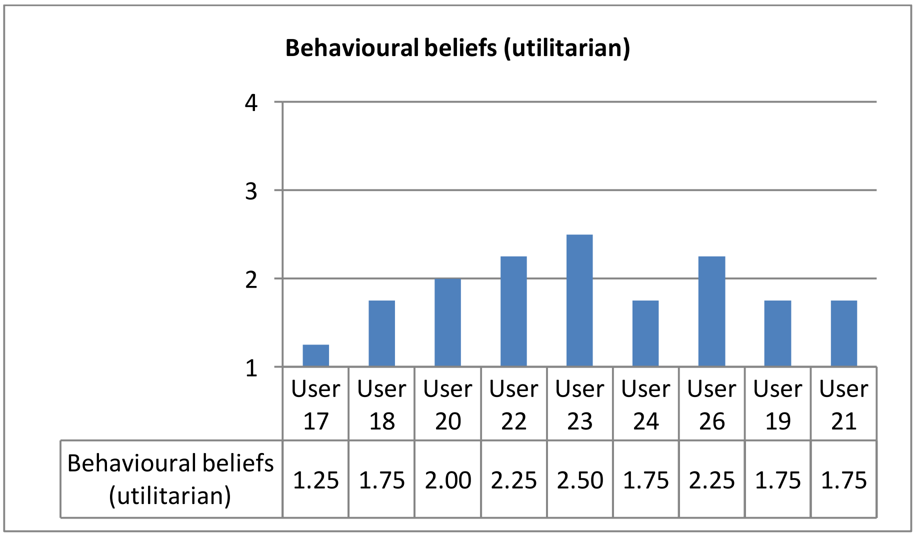
The second version of the basic portal has been released at October 26th. This release included a new sign-up questionnaire that addressed the user's awareness and behaviour baseline according to the Theory of Planned Behaviour. This sub section reports on the behavioural baseline results of the users who have filled out this questionnaire.

In this sub section we describe the social awareness results for the participants who have signed up since the basic portal evaluation. At sign-up, these participants were requested to fill out a questionnaire containing the same Theory of Planned Behaviour questions as reported in the previous sub section. 9 out of the 14 participants filled out this questionnaire. In contrast to the participants from the basic portal evaluation, these participants have not been exposed to e.g. water consumption feedback and tips from the Smart H2O portal.

Thus, these detailed social awareness data constitute a clean social awareness baseline measurement against which the impact of the gamified portal can be assessed. Recruitment actions are planned early in Y3 of the project, to expand the user base and consequently also to get more participants for whom we can assess their awareness on water consumption against both the water consumption and the awareness baseline.

In Figure 59 to Figure 64 we display the results on beliefs, attitude, subjective norm, and perceived behavioural control, and behavioural intention towards water saving. Note that for the belief results lower values represent stronger beliefs about the necessity of saving water.

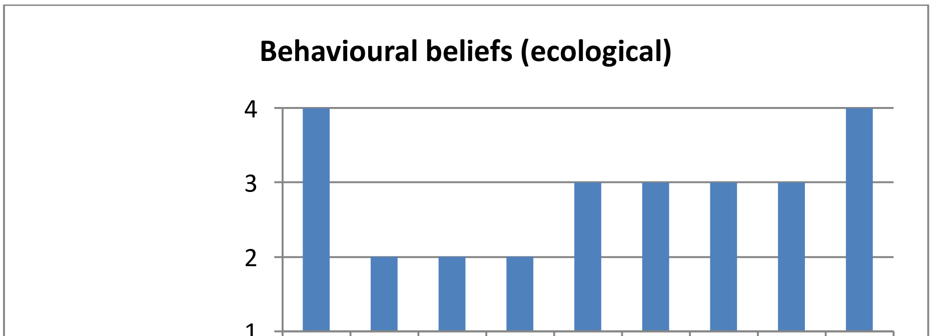
Results demonstrate that all participants responded with values on or below the scale average of 2.5, which indicates positive utilitarian beliefs that acknowledge the importance of water saving. The low score for the utilitarian behavioural beliefs (m= 1,98), with a small sd= 0,4, manifests this initial observation.



Utilitarian beliefs items
• **There is much water in [area name]. We just have to conduct it to our cities.**   • **Science surely will solve the problem of water scarcity.**   • **Drinkable water is an unlimited resource.**   • **Drinkable water will exhaust very soon if we do not save it.**

Figure 59. Sign-up results: utilitarian beliefs.

As can be seen from Figure 60, ecological beliefs paint a more mixed picture. Ecological beliefs were operationalized with an item that addresses if participants think water exhaustion can be prevented by using water when absolutely necessary (following [Corral-Verdugo et al., 2003]). The calculated mean of 2,9 also underlines the higher ecological as compared to utilitarian behavioural beliefs, whereas the relatively high s.d. (0,7) on the 4-point scale reflects that their opinions display a relatively large variety.



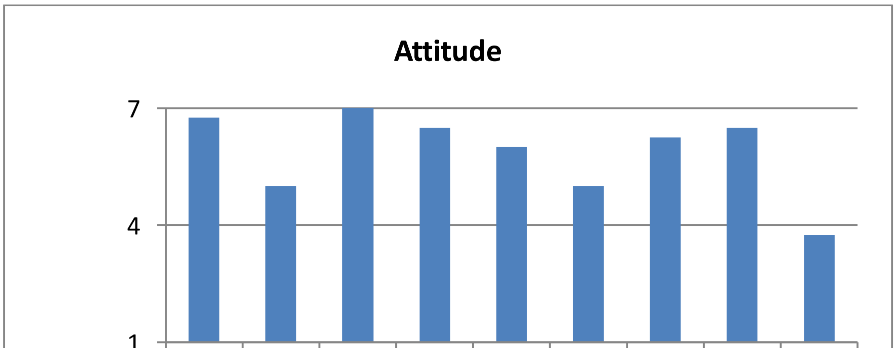
	User 17	User 18	User 20	User 22	User 23	User 24	User 26	User 19	User 21
Behavioural beliefs (ecological)	4.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	4.00

Ecological beliefs item
• **A way of preventing water exhaustion is using it when absolutely necessary.**

Figure 60. Sign-up results: ecological beliefs.

Whereas half of the users agree with this statement, users 18, 20, 22 have reported to (strongly) disagree to the ecological beliefs statements, which suggests that awareness on the necessity of water saving is not omnipresent yet and is in need of improvement.

Figure 61 displays the users' attitudes towards water saving.



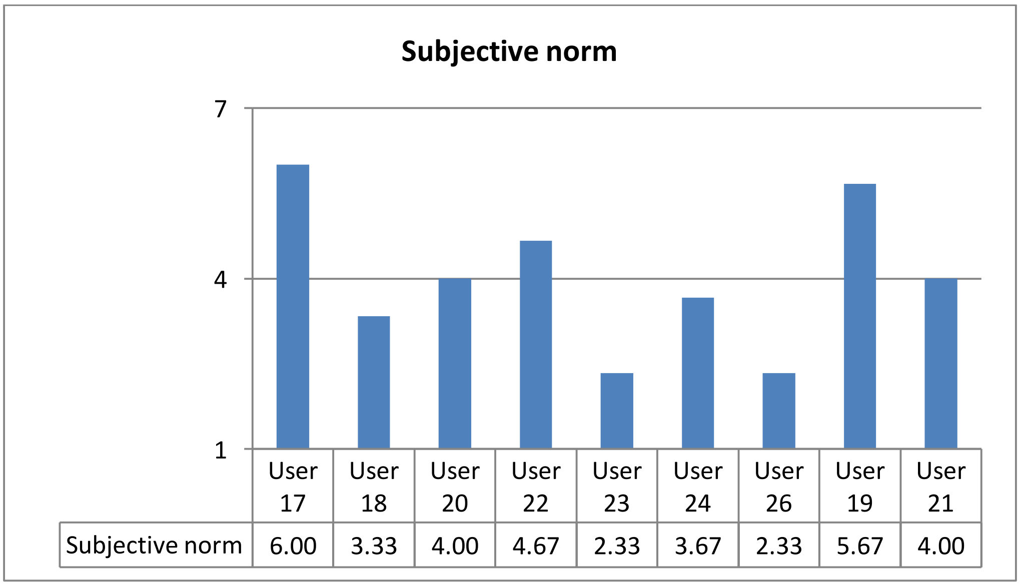
	User 17	User 18	User 20	User 22	User 23	User 24	User 26	User 19	User 21
Attitude	6.75	5.00	7.00	6.50	6.00	5.00	6.25	6.50	3.75

Attitude items
Engaging in everyday actions to save water around the house and garden is: • extremely bad/extremely good; • extremely harmful/extremely beneficial; • extremely worthless/extremely valuable; • extremely unpleasant/ extremely pleasant.

Figure 61. Sign-up results: attitudes.

Users who have signed up proved to have strongly positive attitudes, with an average of 5 or more. This is reflected in the high mean (m= 5,88), with a relatively small standard deviation (sd= 1,0) considering it was measured with a 7-point scale.

In Figure 62 the subjective norm responses are displayed.



Subjective norm items
• It is expected of me that I save water around the house and garden. • I feel like there is social pressure to save water around the house and garden. • People who are important to me want me to save water around the house and garden.

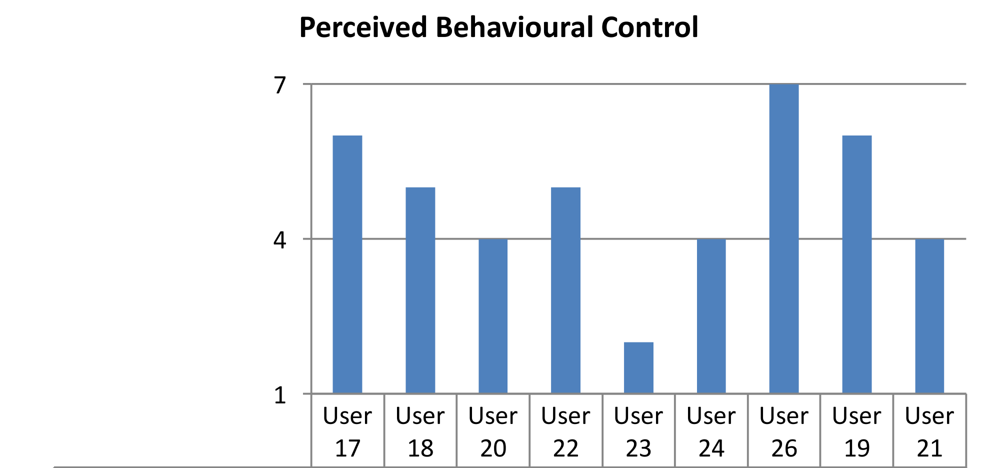
Figure 62. Sign-up results: subjective norm.

Interestingly, compared to the basic portal evaluation the results demonstrate a lower level of social influences (average of 3.8 vs. 4.5 in the basic portal evaluation), and a medium score for the subjective norm (m= 4,03), with sd= 1,2.

In contrast to the strongly positive attitudes and beliefs, perceived behavioural control and behavioural intention are lower for approximately half of the participants, as can be seen from Figure 63 and Figure 64.

This is also reflected when comparing means and standard deviation: a relatively high score for the perceived behavioural control (m= 4,70), but with a relatively high sd= 1,3, and a slightly higher score for the Behavioural intention (m= 5,00), with a much smaller sd= 0,7.

The variability in the perceived behavioural control, with half of the users (#20, #23, #24, #21) on or below the scale average, suggests that practical support to help people save water is needed to improve the perceived behavioural control, and subsequently to reduce water consumption.

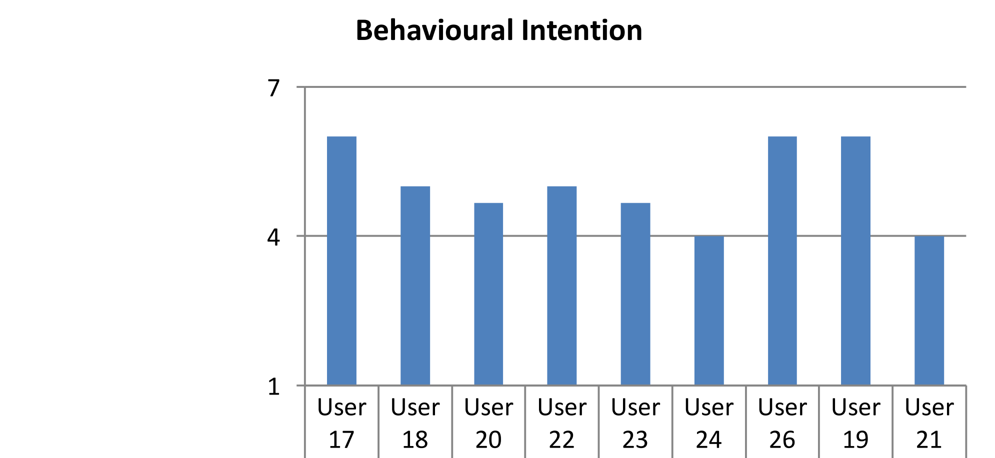


	User 17	User 18	User 20	User 22	User 23	User 24	User 26	User 19	User 21
Perceived Behavioural Control	6.00	5.00	4.00	5.00	2.00	4.00	7.00	6.00	4.00

Perceived behavioural control item
• I am confident that I could save water around the house and garden if I wanted to.

Figure 63. Sign-up results perceived behavioural control.

In Figure 64 the results are shown for behavioural intention.



	User 17	User 18	User 20	User 22	User 23	User 24	User 26	User 19	User 21
Behavioural Intention	6.00	5.00	4.67	5.00	4.67	4.00	6.00	6.00	4.00

Perceived behavioural intention items
• I expect I will engage in everyday actions to save water around the house and garden in the next six months. • I intend to engage in everyday actions to save water around the house and garden in the next six months. • I want to engage in everyday actions to save water around the house and garden in the next six months.

Figure 64. Sign-up results: behavioural intention.

All but two users demonstrate an above-average intention to save water, even before usage of the portal. This is consistent with the largely positive attitudes towards water saving, but inconsistent with the mixed results for behavioural control. The results put emphasis on the importance of supporting users to save water, to avoid the often-found gap between attitudes, intention, and the desired behaviour (e.g. water saving).

5.3.5 Log analysis as outlook on advanced portal usage

From November 2015, user activity in the CH case study has been logged (joint release with basic portal V2 on October 26, 2015). As per February 2016, there were 27 basic users and 16 users of the gamified portal.

As we have discussed in previous sections and also in *D4.3 Incentive models and algorithms*, we consider the Swiss case study a test bed for the bigger case study. Especially in the initial period recruitment efforts had been limited to be able to focus on the technical releases and data infrastructure testing. Now that these aspects have been stabilized, more recruitment campaigns are planned as described in section 4.1, expecting user activity to increase in the upcoming months.

While the set of data on the success criteria for the gamified portal is not yet complete, some positive trends with respect to the defined feature-based success criteria can already be observed at this early evaluation stage. In this sub section we report some of these early results, based on the analysis of the gamified portal activity in general, and the activity and consumption patterns of three identified lead users.

After the launch of the gamified portal in early December a clear difference between basic portal usage and gamified portal usage could be observed: only little basic portal activity occurred with 20 logins of basic portal users (m=0,74; sd=1,9), in comparison to the logged gamified portal usage (292 logins of gamified portal users (m=18,25; sd=42). This could already indicate that the gamification features motivate usage more than the basic version.

The collected logs on the other hand already give tentative evidence about the initial engagement with the gamified portal. Treatment measures on technology acceptance, awareness and water consumption will follow in D7.2 - in comparison to baselines reported in the previous sub sections.

As discussed in more detail in the last chapter of *D4.3 Incentive models and algorithms,* we have found that portal activity peaked after the Christmas letter promotion campaign targeted at existing portal users (see Figure 65), indicating the positive effect of such campaigns for future application in both case studies.

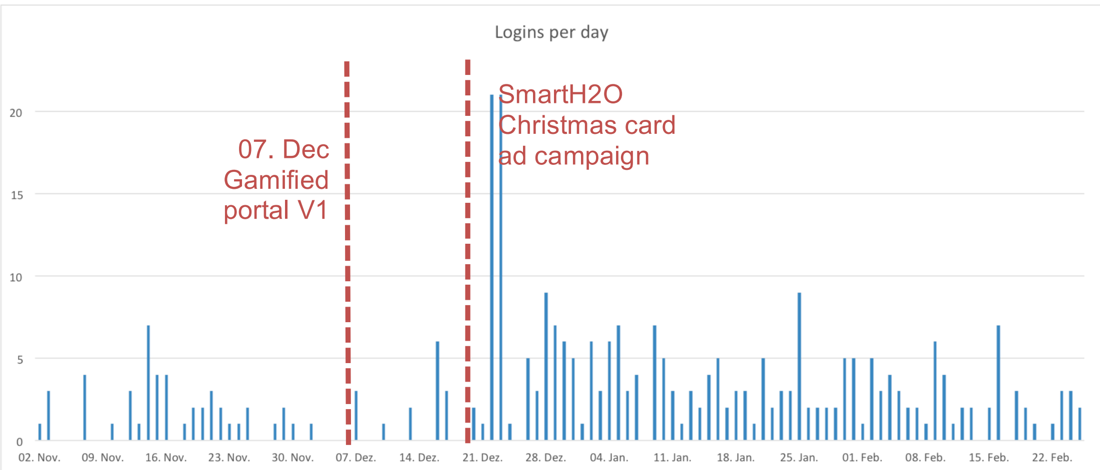


Figure 65. No. of daily logins.

Figure 66 shows how many users viewed the main elements of the gamified portal more than once. It highlights that while the consumption chart has been viewed the most and remains the focal point of the application, other key elements like the profile page, the leaderboard and the achievements and actions panel have also been frequented by over half the users. It means users show interest in additional features beyond their consumption, and interact with the portal on different levels as envisioned in the incentive model that ultimately should lead to awareness and behaviour change (compare D4.3).

The results also show that most users have actually interacted with the consumption visualisation (Figure 67), 13 of the 16 gamified portal users have collected badges and 10 of 16 users have filled out their profile between 60 – 100% (see D4.3 for more details). The fact that most users feel incentivized to fill out their profile information is key to utilities, which until then often know very little about their customers' household characteristics and value this information greatly. It will also be valuable in the project to better analyse and model user behaviour and consumption patterns and gain more informed insights about different consumption groups.

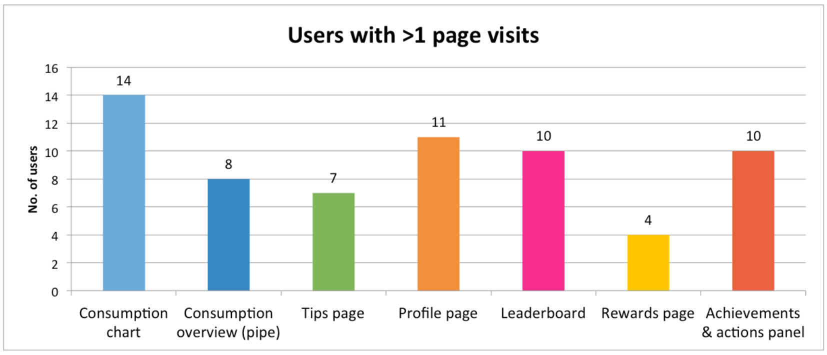


Figure 66. No. of gamified portal users with >1 page views for the main portal pages.

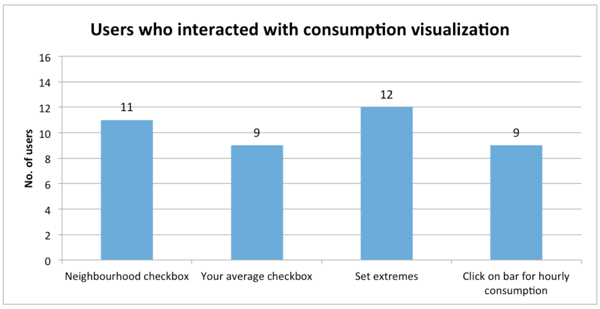


Figure 67. No. of gamified portal users who interacted with consumption chart.

Lead user activity and consumption patterns

The logs also revealed that there are currently three lead users on the portal with significantly higher activity levels compared to the other users (Activity of lead users in Figure 68, Figure 69 and Figure 70).

To better understand the actions and possible motivators of the three lead users, their activity was analysed individually (see D4.3 for details). Findings suggest that the three users responded very differently to the gamified portal incentives (ibid). This corresponds to lessons learned in previous studies about different user and player types as presented in D4.3, which stress the fact that different users can be incentivized by different types of incentives, driven e.g. by extrinsic motivation like competitions, virtual and real rewards, or intrinsic motivation like environmental concern. It highlights the importance of offering different incentive types, and offering different levels of information and interaction, as is the case in the SmartH2O portal. This way, we hope to be able to cater to different user and consumer types and offer them the information and means of interaction they benefit from the most, ultimately attracting many different users to the portal and increasing awareness of a large portion of water consumers.

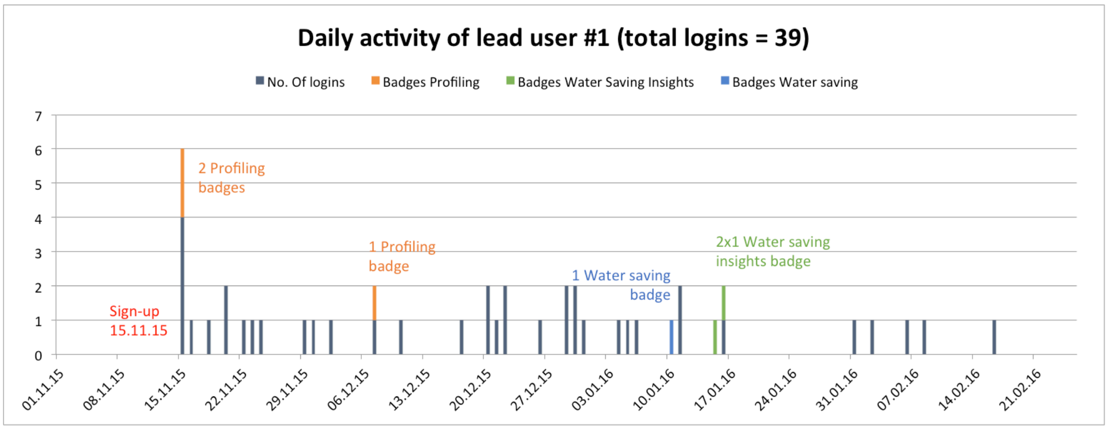


Figure 68. Activity of LU1.

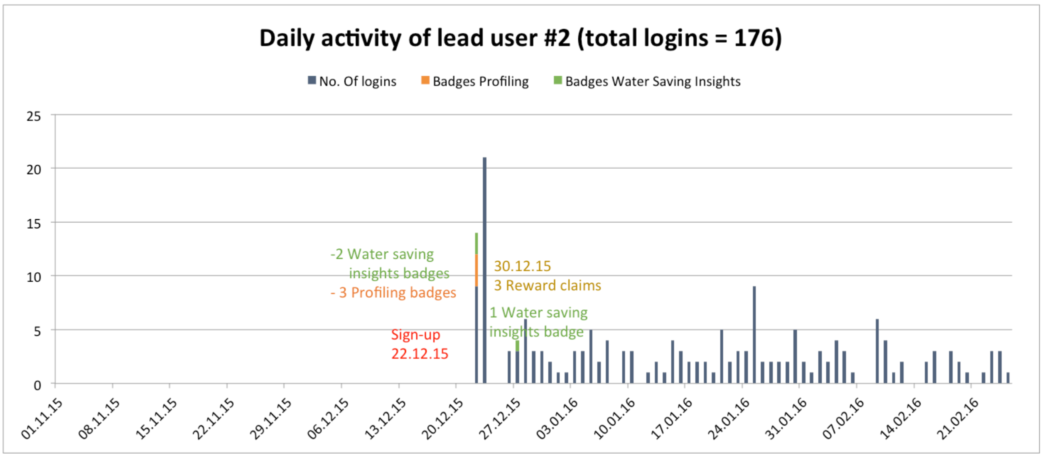


Figure 69. Activity of LU2.

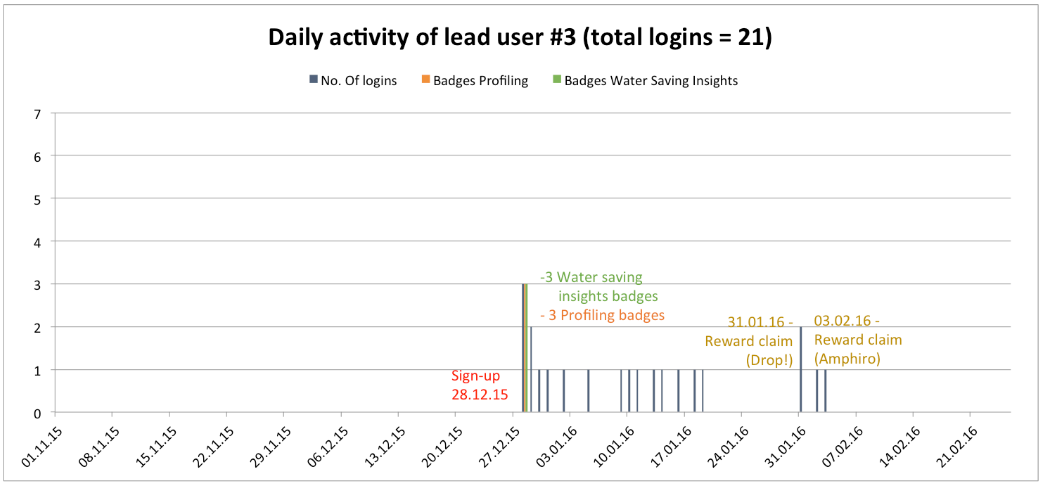


Figure 70. Activity of LU3.

In addition, we considered the consumption patterns of the identified lead users. Overall, LU1 belongs to the low consumption class, while LU2 and LU3 both belong to the low/medium consumption class. Figure 71, Figure 72 and Figure 73 plot the daily consumption of the lead users during the period October 15 2015- February 6 2016.

The consumption pattern of LU1 (Figure 71) is too irregular to draw any conclusions about a possible portal impact at this point. It suggests that the metered household had been unoccupied for longer intervals. Yet, the fact that LU1 still continuously logged in during absence periods could indicate that they used the portal as a remote monitoring tool. For LU2 (Figure 72) and LU3 (Figure 73), we compared the average daily consumption of the last two months before the adoption of the platform to the average consumption value computed over the first month after the adoption of the platform: LU2 shows a reduction of 18.2%, and LU3 a reduction of 52.5% in this period. While we cannot solely attribute these significant consumption reductions to portal usage (there is e.g. an obvious vacation gap in both charts, and other external factors also play a role), the patterns could indicate that the portal usage may have influenced users over the whole period. Especially LU3 has visibly reduced their consumption in January.

While we cannot draw a final conclusion based on this limited data, we will investigate along the same lines in the final evaluation. Once more activity is generated in the Swiss case study, and users have used the gamified portal longer, more elaborate analysis will be done. And in the Spanish case study, we will be able to investigate the effect of the portal on users consumption on a much larger scale, too.

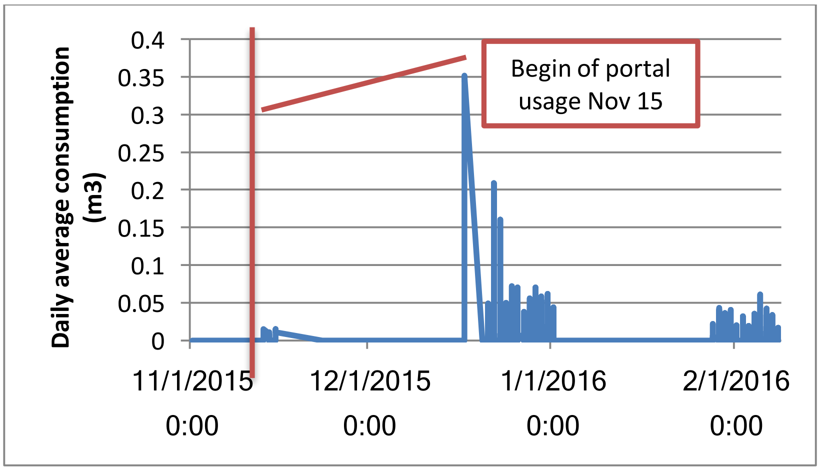


Figure 71. Daily water consumption pattern of user LU1.

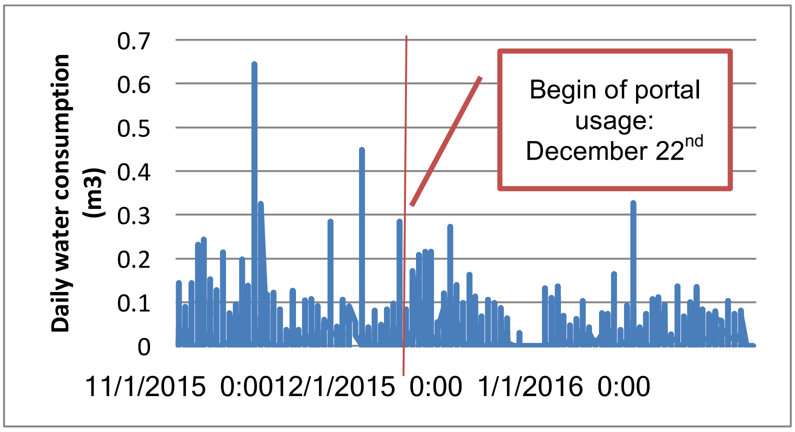


Figure 72. Daily water consumption pattern of user LU2.

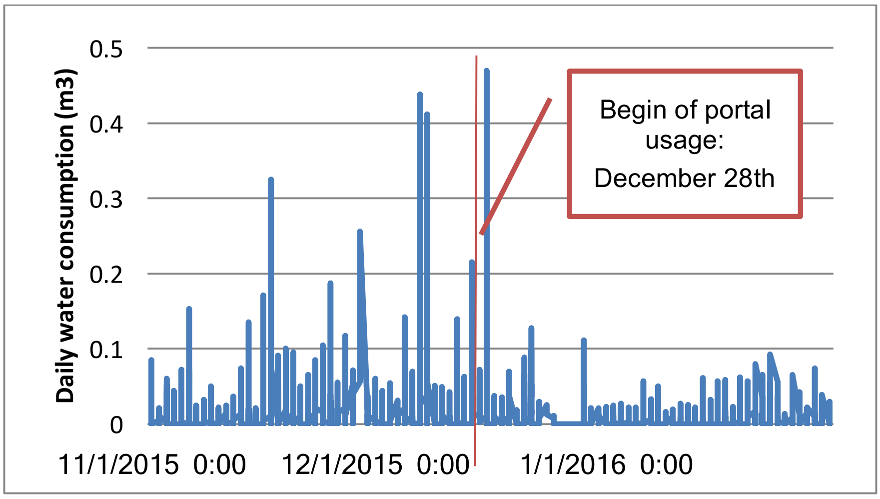


Figure 73. Daily water consumption pattern of user LU3.

The analysis of the lead users' activities suggests that even with a user community that is limited in size and the complete incentive model having only recently been put in place, already three users are highly active. This result also highlights the importance of continuously incentivizing users and attracting their attention towards the portal, and offering different types of incentives, information and means of interaction to stimulate different user and consumer types. These lessons have been taken into account in the adjustment of the incentive model for the Spanish case study (see *D4.3 Incentive models and algorithms*).

And while data is still too sparse to draw conclusions on major consumption reduction as a result of portal usage, the lead user analysis paints a tentatively positive picture, which will be investigated on the large scale in the Spanish case study.

5.3.6 Conclusions and outlook for user-based performance indicators

As introduced in *D2.2 Final requirements*, and revisited in section 5.1, we defined user-based performance indicators to measure users' acceptance of SmartH2O, both on the level of the application as a whole, and on the level of individual use cases.

Already in this initial evaluation round in the Swiss case study, users were asked to assess the basic portal based on these indicators (where they applied), operationalized as individual questionnaire items. On the overall level, users assessed effort expectancy, performance expectancy and attitude towards the technology. Positive attitudes were expressed for the latter two, whereas users were mostly undecided in terms of effort expectancy (first subsection in 5.3.1). We will compare these responses against the feedback on the gamified portal in the next evaluation round, which, offering a lot more interactivity and additional gamification features, is expected to influence users' attitudes stronger.

Users also assessed the qualitative vs. pragmatic quality of the system, and while both aspects were assessed positively, users found the portal more pragmatic, as was also intended by the design of that portal version, due to the basic features it provides (second subsection in 5.3.1).

In addition, the user-centred basic portal use cases that were implemented at the time of the initial evaluation were assessed based on the indicators usefulness, comprehension and perceived incentive, with mostly positive results (see Section 5.3.1). The use cases will be assessed again as part of the evaluation of the gamified portal, in addition to the assessment of the advanced portal use cases. In the meantime, the logs presented in the previous section already provide some preliminary indicators of which gamification elements may be most frequented, such as the leaderboard. For the evaluation of the gamified portal, we will use the updated logs to enrich and further evaluate the self-assessed responses of users in the second evaluation round.

Summarizing, the interim evaluation from the Swiss case study paved the way for the large-scale deployment and evaluation in the Spanish case study. It has already provided some preliminary insights into user behaviour and user attitudes of the basic features, and the evaluation of the gamified portal features will follow soon. Findings already resulted in continuous improvements of the portal, and after the launch in Valencia, user-based performance will also be assessed by a more representative sample, using the same indicators. While a direct comparison will not be possible due to the significantly different case study characteristics and population size, we will still cross-check the main findings for possible common outcomes, or significant obvious expressed in user behaviour and attitudes towards the system.

5.4 Spanish case study baseline results

5.4.1 Water consumption baseline

Even though the Smart H2O platform with all gamification features currently implemented has just been released, we are already able to report the first baseline results for the Spanish case study. We report the baseline results obtained from a sample of approximately 90,000 households (22,5%) in the period between January 1st 2014 and January 1st 2016.

Table 15 provides an excerpt of 20 representative users.

Table 15. Exemplary baseline water consumption results in Valencia.

ID	**Baseline average daily water consumption 2014** (in m^3)	**Baseline average daily water consumption 2015** (in m^3)
1	0.2108	0.2289
2	0.2071	0.1673
3	0.1484	0.1320
4	0.2745	0.3313
5	0.0712	0.0690
6	0.4586	0.6267
7	0.4466	0.4627
8	0.6934	0.5427
9	0.5621	0.5455
10	0.4578	0.4287
11	1.7616	1.7942
12	1.0700	1.2100
13	1.2039	1.2113
14	2.2126	1.8578
15	1.0550	1.2130
16	3.3380	3.6600
17	2.7427	2.6288
18	3.5633	3.1096
19	3.0887	3.1557
20	5.6273	5.7778

Figure 74 reports the distribution of the baseline individual consumptions computed on yearly basis.

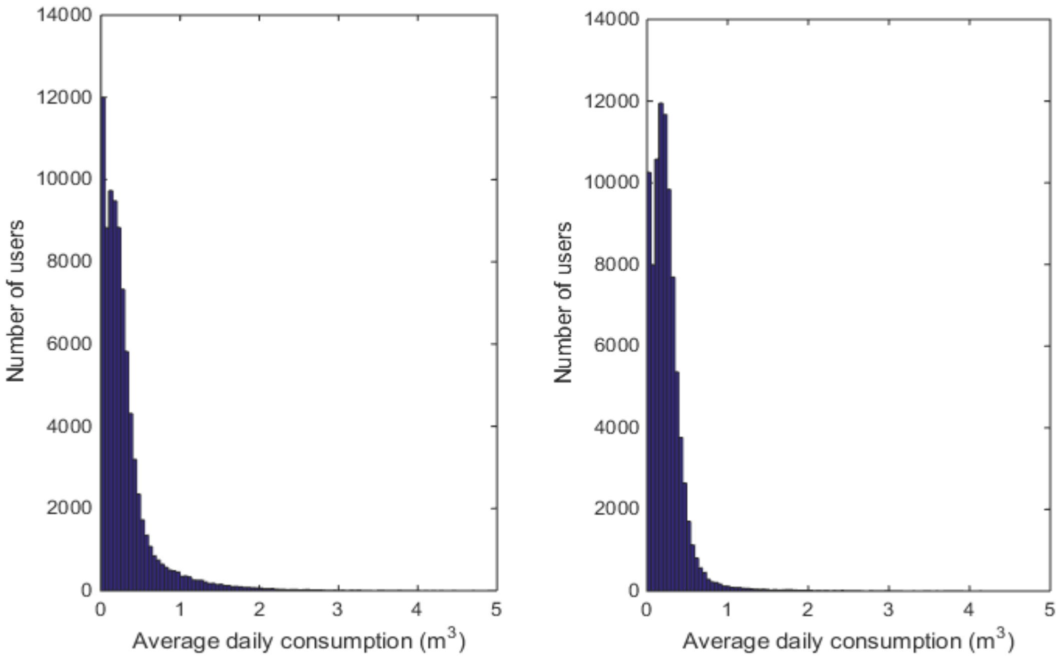


Figure 74. Histogram of average daily consumption in 2014 (left) and 2015 (right).

Additionally, in Figure 75 we report a characterization of a sample of 286 Valencian users registered to the S2HOplatform in terms of their water consumption volumes using smart meter measurements collected from the moment of the smart meter installation up to July 19th 2016. The date of the smart meter installation at the user's premises varies within the range April - December 2015. Moreover, similarly to the Terre di Pedemonte case study, Valencia users have been tentatively clustered into consumption classes. However, differently than the Terre di Pedemonte, most of the readings gathered from the users' smart meters in Valencia exhibit daily or monthly granularity. For this reason, only a simplified version of the algorithm reported in D3.4 have been applied to cluster the users in four consumption classes (low, low/medium, medium/high, high) based on their average daily consumption. As shown in Figure 75 (left), the daily consumption volumes are consistently lower than the ones that characterize the Swiss consumption classes, due to different household and lifestyle conditions. Application of the above mentioned algorithm on a wider number of users will yield more precise results.

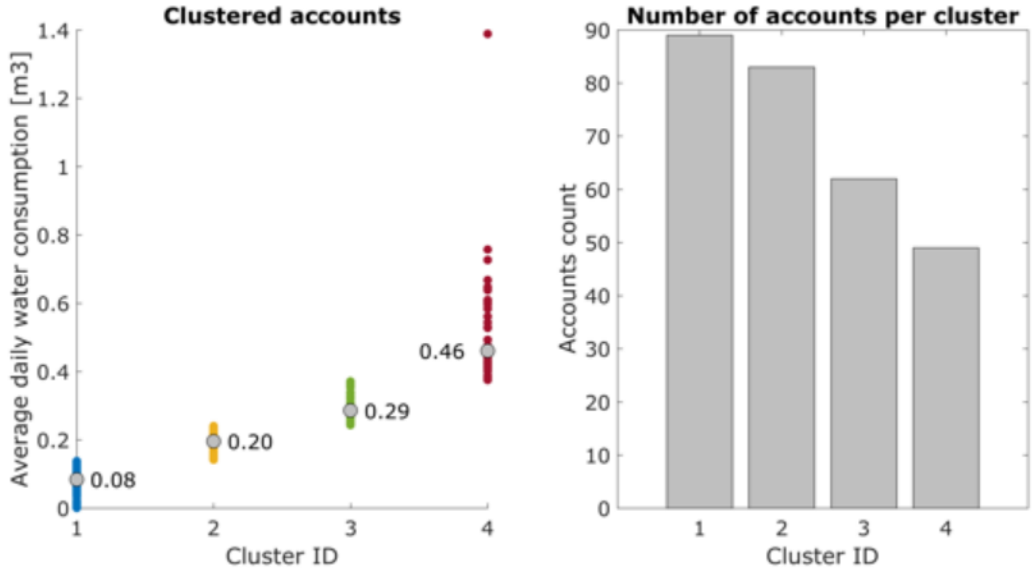


Figure 75. Baseline water consumption of 283 Valencian platform users.

Refinement of the baseline results, comparison of the water consumption levels of Smart H2O users at the end of the trial against the baseline and against the control group, as well as users' assessment of the (gamified) portal will be provided in upcoming deliverable *D7.3 Final overall validation and impact report*.

5.4.2 User awareness and behaviour baseline

User awareness and the behaviour baseline in the Spanish case study were measured among a control group contacted via a call centre, and SmartH2O portal users.

User awareness and behaviour baseline (control group)

Baseline awareness measures have been collected for two conditions in the case study: the control group and the experimental group (users of the SmartH2O system). For the control group, the call centre was able to obtain responses from 203 participants.

The demographics of the control group sample are summarized in Figure 76 and Figure 77, whereas the distribution of participants over different types of houses is depicted in Figure 78.

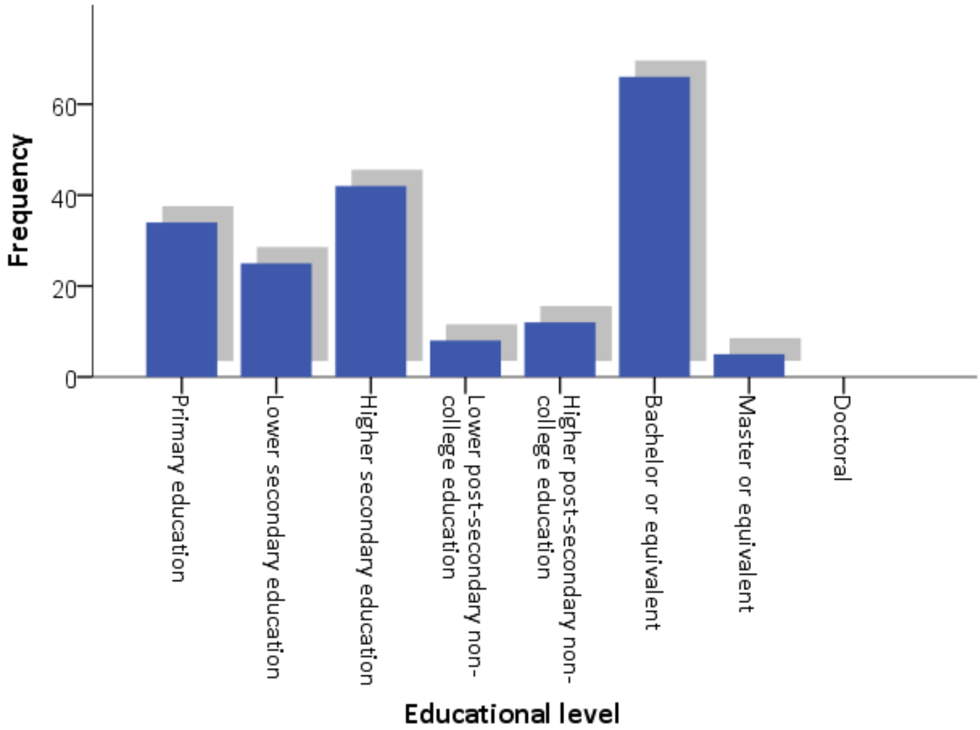


Figure 76 Distribution of educational level in the control group (Spain).

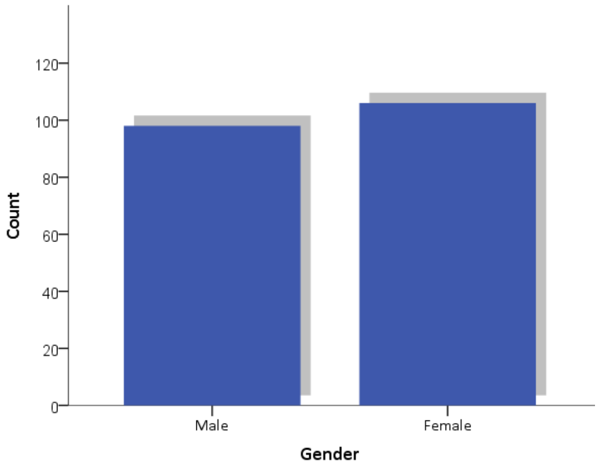


Figure 77. Gender distribution in the control group (Spain).

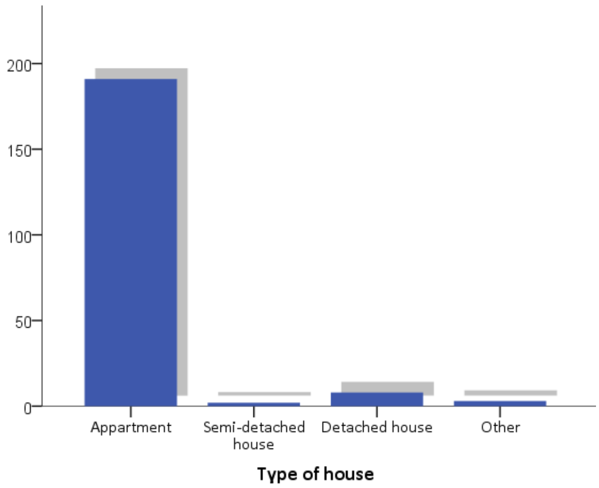


Figure 78. Distribution of house types in the control group (Spain).

Users were asked to estimate how much water they consume in comparison to other similar households. A five-point Likert scale has been used, ranging from much less than average to much more than average. A “Don’t know” option was added to avoid users randomly picking an option, even when they don’t know the answer.

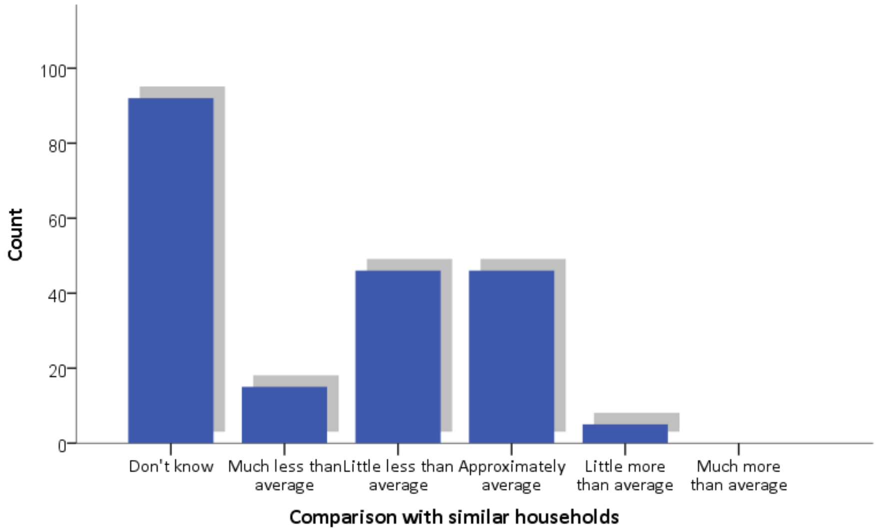


Figure 79. Distribution of consumption estimates compared to similar households.

As can be seen from Figure 79, a significant share (45,1%; *f*=92) of the consumers does not know how their water consumption compares against the consumption of similar households.

Utilitarian and ecological beliefs were measured on a four-point scale, ranging from strongly disagree to strongly agree. For the two utilitarian beliefs items the average values were 2.6 (s.d. 1.0) and 1.7 (s.d. 1.1) respectively. The distribution is displayed in Figure 80.

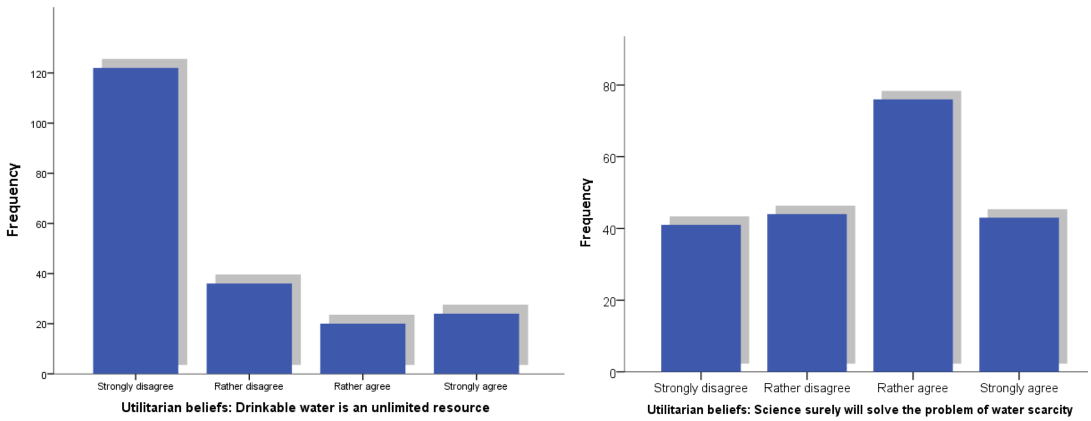


Figure 80. Distribution of utilitarian beliefs

Interestingly, even though the vast majority disagrees with that statement, still 21.8% of the control group participants believe that water is an unlimited resource.

Ecological beliefs were also measured with two four-point scale items. Results are depicted in Figure 81.

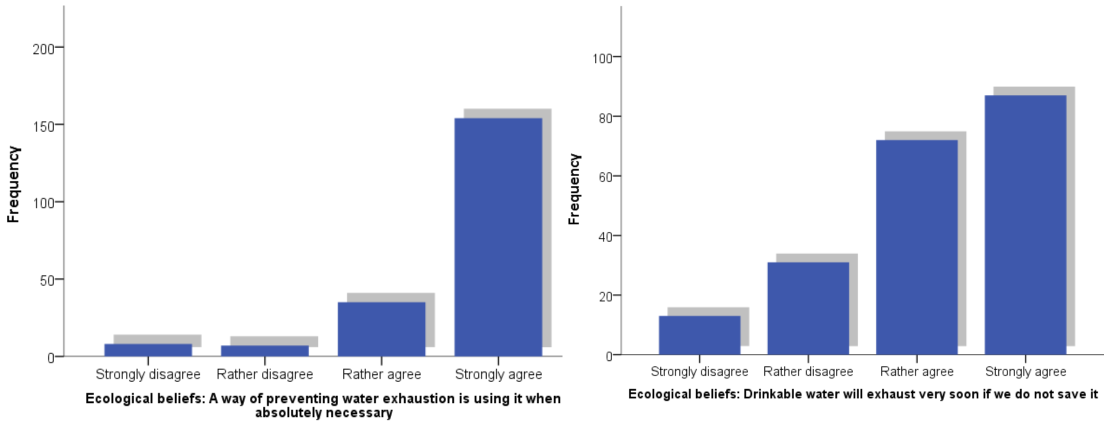


Figure 81. Distribution of ecological beliefs.

For the ecological beliefs, average values were 3.2 (s.d. .9) and 3.7 (s.d. .7) respectively. The results demonstrate that a large share of the participants are convinced of the necessity of saving water. However, 7.4% is not convinced of the necessity to use water only if necessary, while 21.7% does not expect water to exhaust when no water saving actions are taken.

Attitudes towards saving water were measured with four five-point bipolar scales. Results are shown in Figure 82.

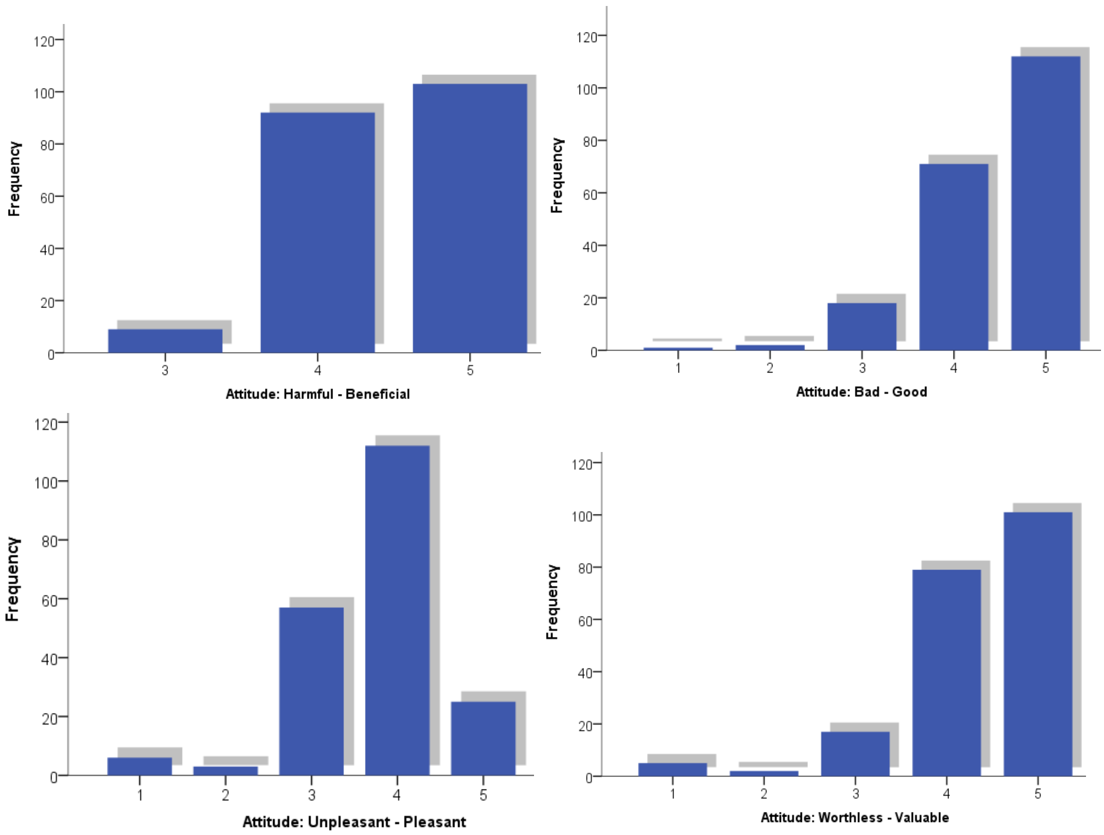


Figure 82. Distribution of attitudes: I consider that "Engaging in everyday actions to save water is... ".

The results demonstrate that users think of water consumption as something that is good, beneficial, and valuable, considering the high frequencies for the 4 and 5 values on these scales. The unpleasant-pleasant item demonstrates similar results, but shifted slightly towards the neutral point of the scale. This is not surprising, since water saving can potentially reduce comfort levels.

In Table 16 the average values for the individual items and for the scale as a whole are depicted.

Table 16. Averages for attitudes towards saving water

Item	Average	S.d.
Bad – good	4.4	.7
Pleasant – unpleasant	3.7	.8
Harmful – beneficial	4.5	.6
Worthless – valuable	4.3	.9
Scale	*4.3*	*.5*

In Figure 83 and Table 17 the results of the three subjective norm questions are displayed. The perceived social pressure was on a five-point scale on average 2.6 (s.d. 1.6), whereas the two questions about other people's expectations for the respondent to saver water yielded an average of 4.3 and 3.6 respectively. Results demonstrate that even though participants do not perceive that there is social pressure to save water, there is a strong social norm to actually do so.

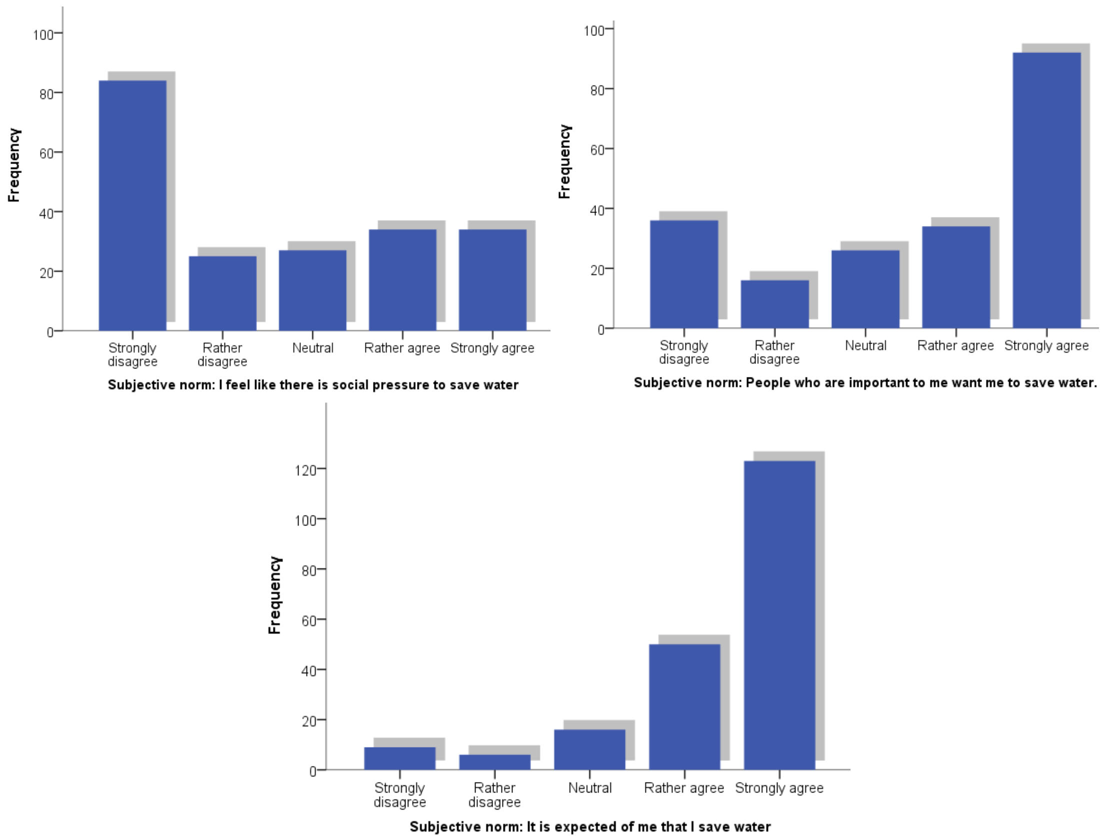


Figure 83. Distribution of subjective norm items.

Table 17. Averages of subjective norm items.

Item	Average	S.d.
It is expected from me that I save water	4.3	1.0
I feel like there is social pressure to save water	2.6	1.6
People who are important to me want me to save water	3.6	1.5

Perceived behavioural control was measured with a single five-point Likert item, as shown in Figure 84. Results demonstrate that users are confident in their ability to save water.

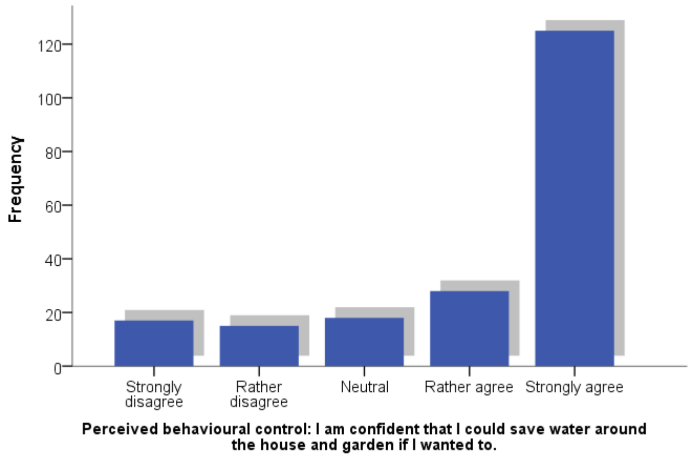


Figure 84. Distribution of perceived behavioural control.

Behavioural intention was measured with two Likert scale items. The results are shown in Figure 85 and Table 18.

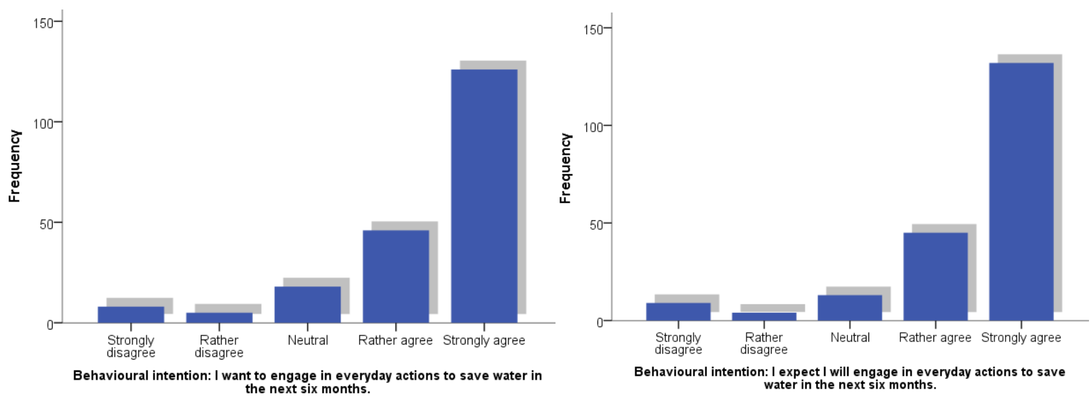


Figure 85. Distribution of behavioural intention.

Table 18. Averages of behavioural intention.

Item	Average	S.d.
I expect I will engage in everyday actions to save water in the next six months.	4.4	1.0
I want to engage in everyday actions to save water in the next six months.	4.4	1.0
Scale	*4.4*	*1.0*

Results demonstrate that most control group participants have a strong intention to save water. Users responded with a score of on average 4.4 (s.d. 1.0) on both items. 12.8% (*f*=26) of users did not have a favourable intention to save water, with neutral or lower scores.

While overlooking the control group results as a whole, it can be concluded that control group participants have favourable attitudes and intentions towards saving water.

User awareness and behaviour baseline (SmartH2O users group)

As recruitment of users is an on-going process, the baseline results need to be calculated for a predetermined period of time since the release of the portal. The cut date that was used was the date of the second year review (June 16th 2016). At that moment, 295 users have filled out the questionnaire, whereas 341 users have signed up for the portal. The response rate was 86,5%.

The age and gender distribution is displayed in Figure 86. The educational level of the participants is depicted in Figure y.

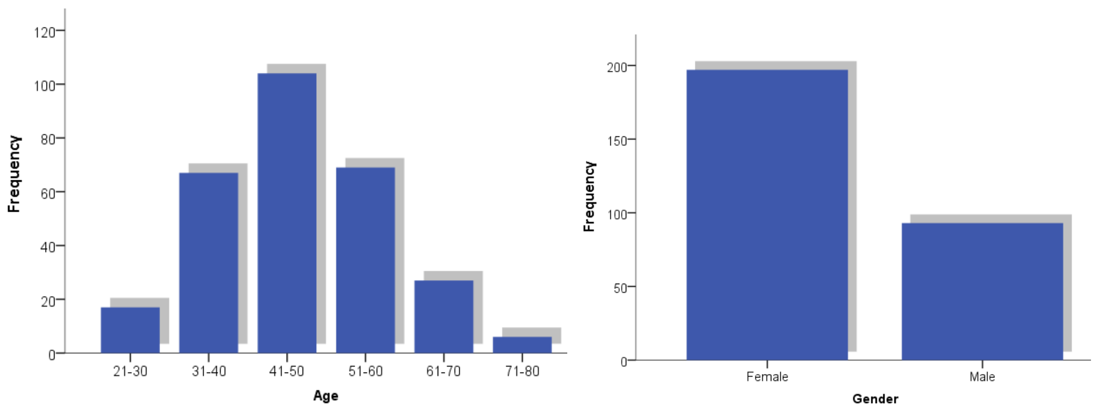


Figure 86. Distribution of age and gender of the SmartH2O user group.

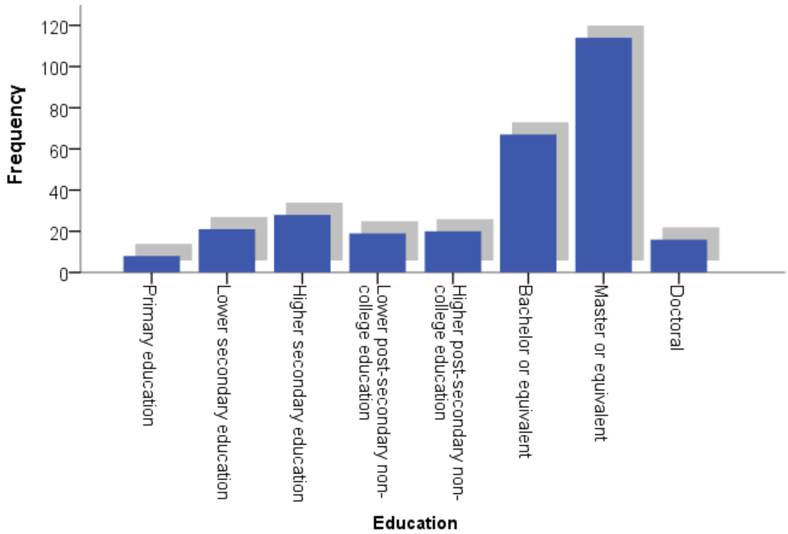


Figure 87. Distribution of educational level of the SmartH2O user group.

The demographics suggest an even distribution of age groups, an underrepresentation of male users, and a tendency towards more highly educated people joining the platform.

Personal innovativeness, the willingness of people to try out new information technology [Lu et al., 2005], was measured using four seven-point Likert scale items. The scale average was 5.4 (1.3). The distribution is displayed in Figure 88.

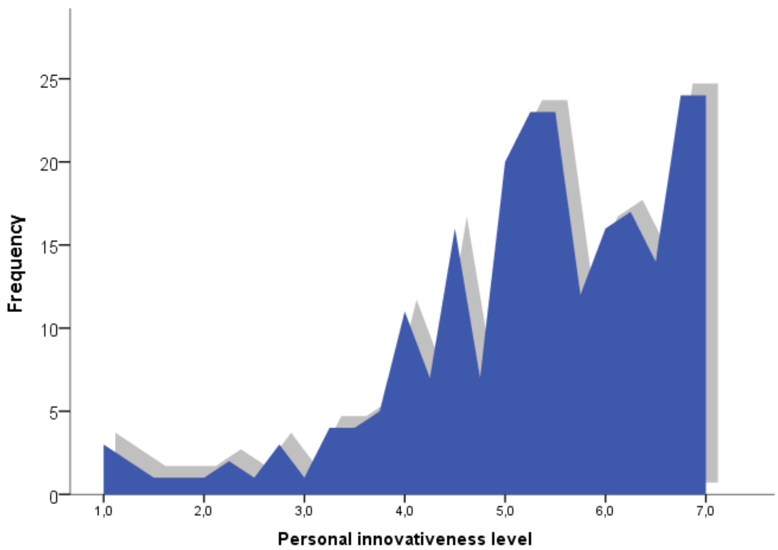


Figure 88. Distribution of personal innovativeness.

Similar to the control group, SmartH2O users were asked to report whether they think their water consumption level is below, similar to, or above the level of similar households. The distribution is displayed in Figure 89.

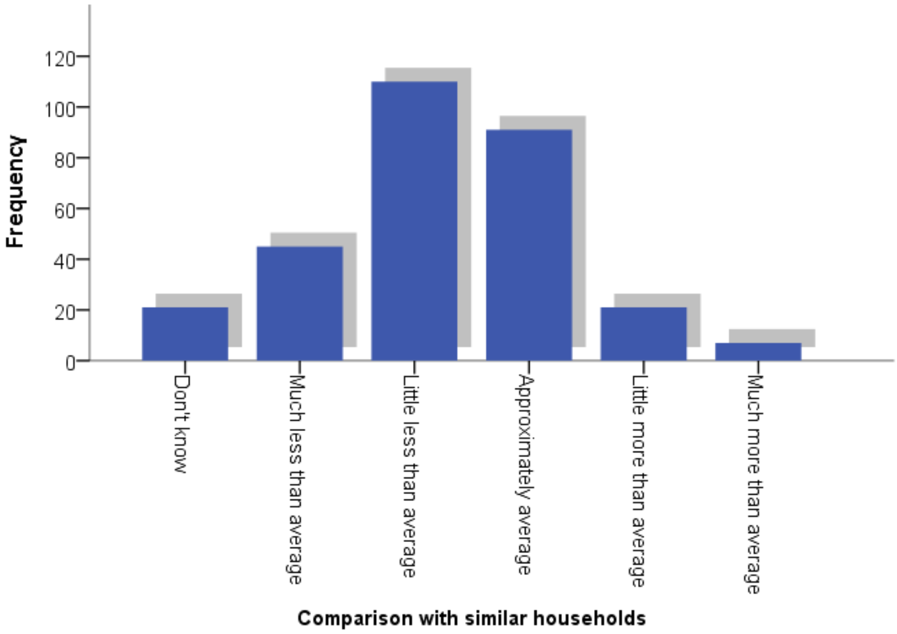


Figure 89. Distribution of consumption estimates compared to similar households.

The results display a distribution that is slightly shifted towards the less than average side of the scale. With much less than average coded as 1, and much more than average coded as 5, the average score was 2.4 (s.d. .9). Of the 295 SmartH2O users, 7.1% (*f*=21) indicated that they did not know how much water they consume in comparison to similar households.

Below the results of the Theory of Planned Behaviour constructs are presented, which have been measured in a similar way as for the control group. Ecological and utilitarian beliefs were elicited with two four-point Likert scales each, similar to the control group. Results are displayed in Figure 90 and Figure 91.

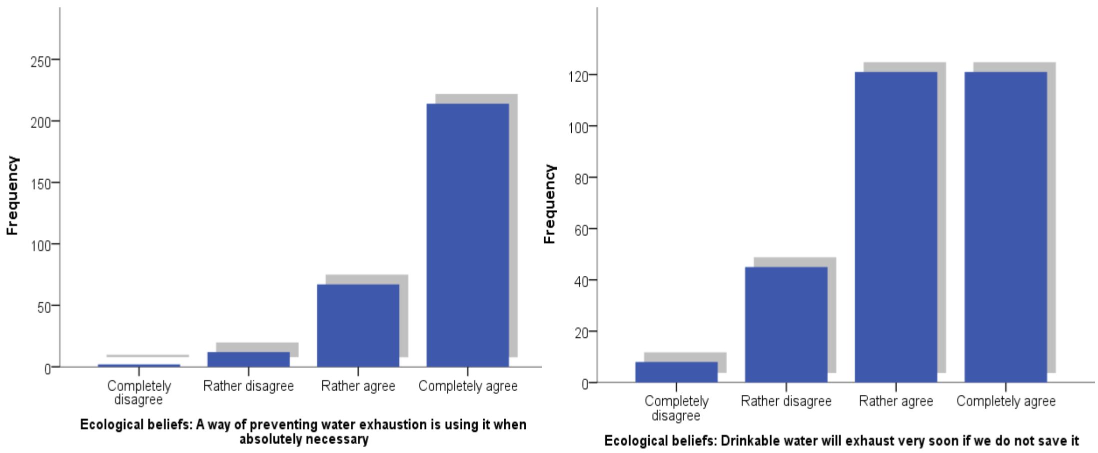
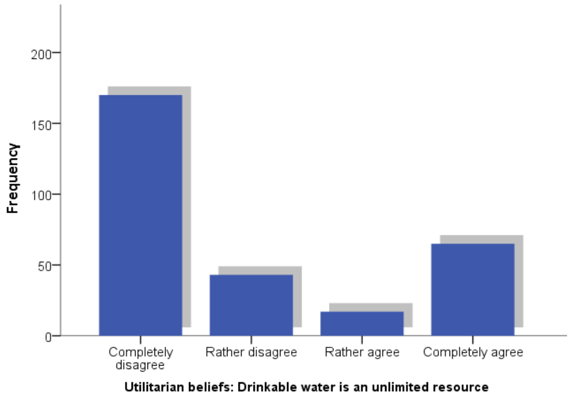


Figure 90. Distribution of ecological beliefs.



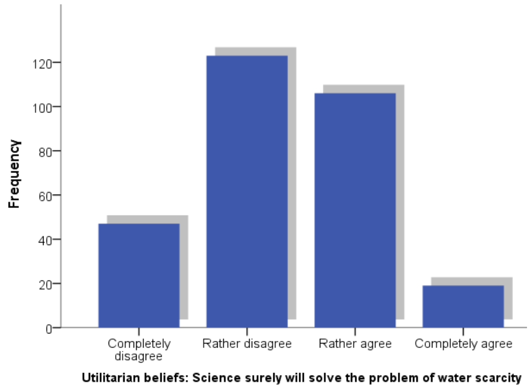


Figure 91. Distribution of utilitarian beliefs.

The means and standard deviations for the beliefs are displayed in Table 19.

Table 19. Averages of ecological and utilitarian beliefs.

Item	Mean	S.d.
Ecological beliefs		
Drinkable water will exhaust very soon if we do not save it	3.2	.8
A way of preventing water exhaustion is to use it when absolutely necessary	3.7	.6
Utilitarian beliefs		
Drinkable water is an unlimited resource	1.9	1.2
Science surely will solve the problem of water scarcity	2.3	.8

The averages for utilitarian beliefs demonstrate that people differ in terms of how the availability of water now and in the future. The high values for ecological beliefs demonstrate that the perceived need of saving water is moderately strong (the first item) to very strong (the second item). In Table 20 and Figure 92 the results of the attitudes towards saving water are displayed.

Table 20. Averages of attitudes towards saving water.

Item	Average	S.d.
Bad-Good	4.8	.6
Unpleasant-Pleasant	3.8	1.3
Worthless-Valuable	4.7	.8
Harmful-Beneficial	4.7	.8
Scale	*4.5*	*.7*

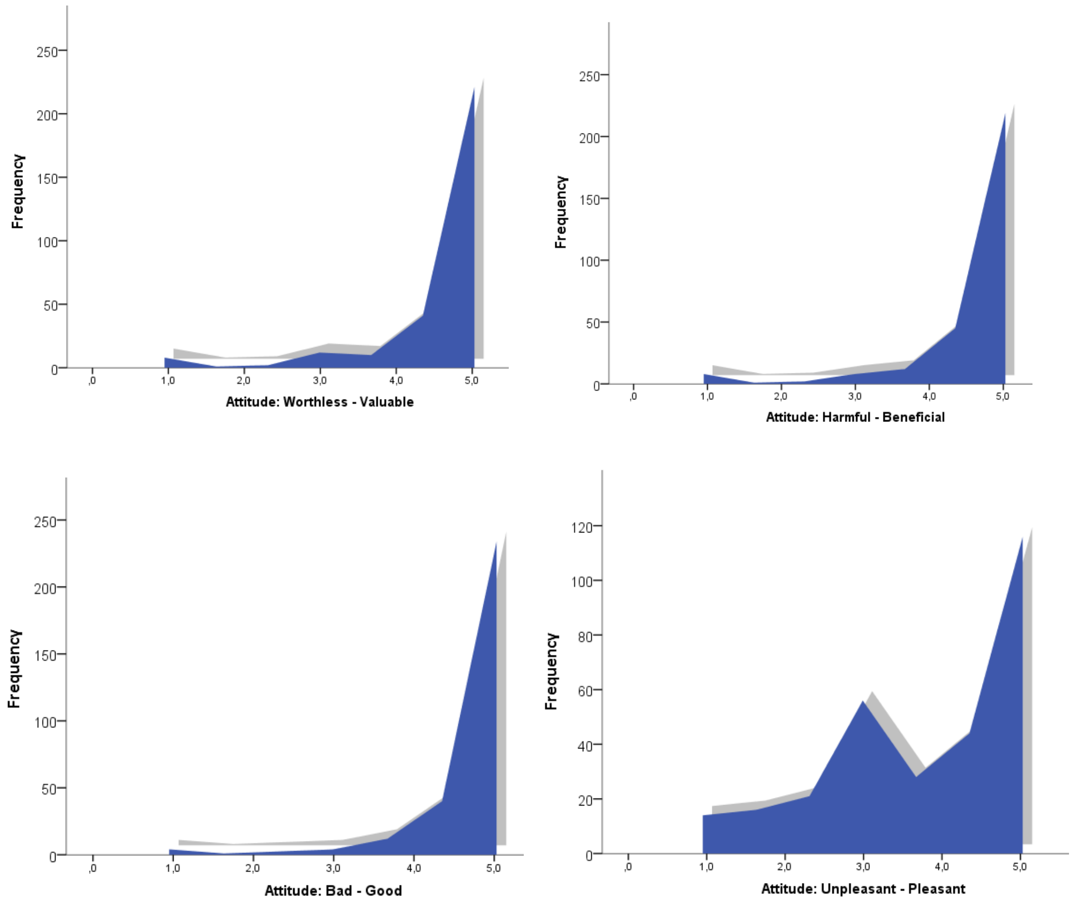


Figure 92. Distribution of attitudes towards saving water.

The results demonstrate strongly positive attitudes, with somewhat lower values for unpleasant-pleasant, which was expected since water saving could result in lower comfort levels, for example when showering for a shorter time.

In

Figure 93 the results for the three subjective norm items are displayed, whereas Table 21 displays the averages and standard deviations for these items.

Table 21. Averages of subjective norm items.

Subjective norm item	Average	S.d.
It is expected of me that I save water	4.4	.9
I feel like there is social pressure to save water	2.8	1.3
People who are important to me want me to save water.	3.8	1.3

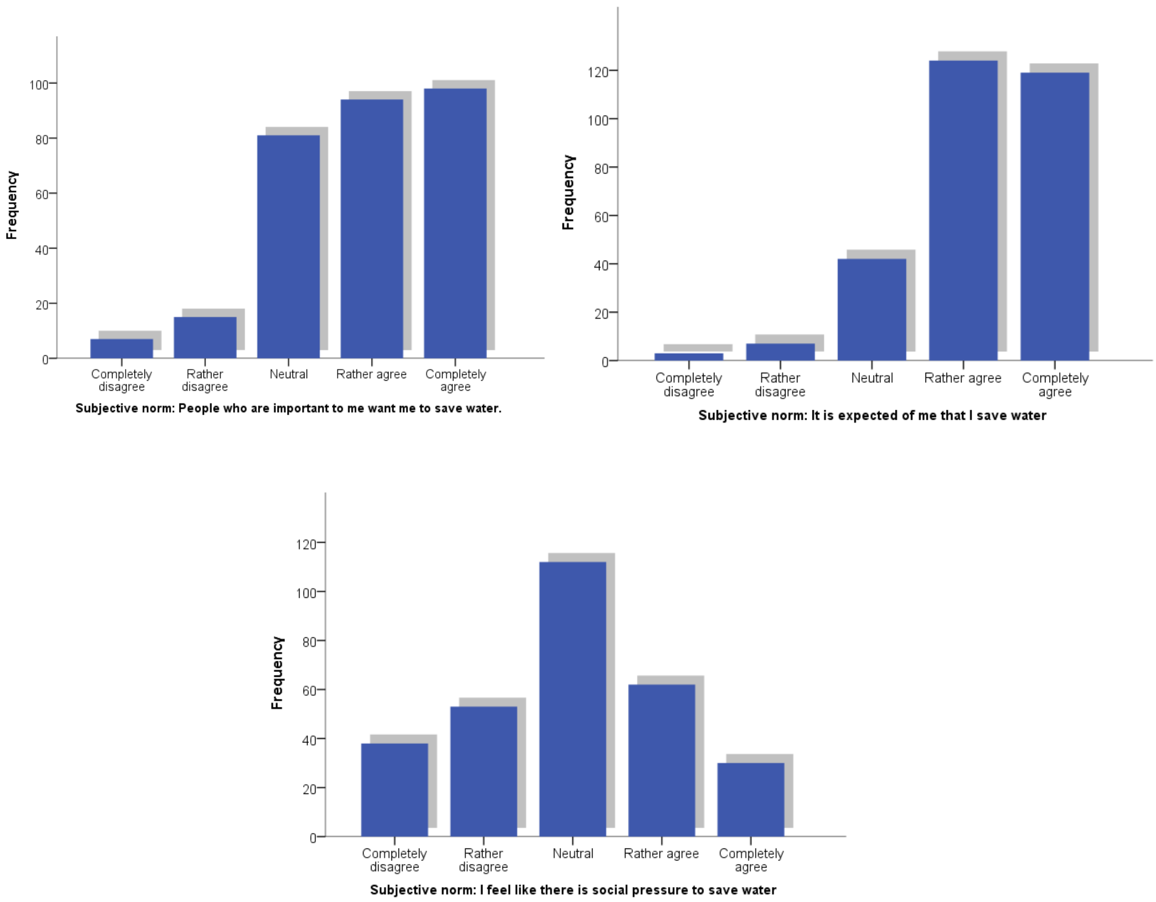


Figure 93. Distribution of subjective norm items.

Similar to the control group, the values for the social pressure item were lower than for the other two items. Thus, even though participants indicated that other people expect them to save water, they do not experience these expectations as social pressure.

Results for the single-item measure for perceived behavioural control are displayed in Figure 94. The average of 4.3 (s.d. .9) suggests that users are confident in their ability to save water. Still, 14.6% (*f*=30) were less confident about their ability to save water, responding either neutral or in (strong) disagreement to the perceived behavioural control item.

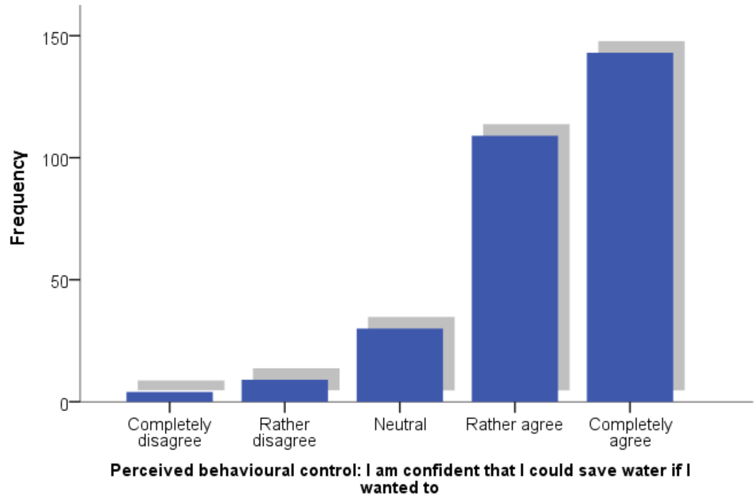


Figure 94. Distribution of perceived behavioural control.

Behavioural intention was measured with two items. The results are shown in Figure 95 and Table 22.

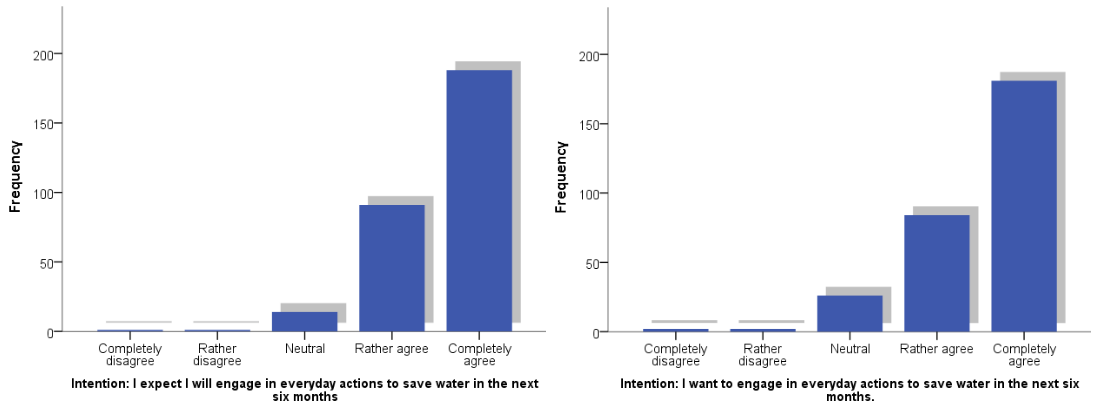


Figure 95. Distribution of behavioural intention.

Table 22. Averages of behavioural intention.

Item	**Average**	**S.d.**
I expect I will engage in everyday actions to save water in the next six months	4.6	.6
I want to engage in everyday actions to save water in the next six months	4.5	.7
Behavioural intention scale	*4.5*	*.6*

The results indicate a strong favourable intention to save water, with low variability between users, as evidenced from the low standard deviations.

6. Conclusions

Real-world deployment and validation of the SmartH2O approach is a crucial part of the project. This deliverable has detailed the deployment of the social awareness apps in the Swiss and Spanish case study, their associated promotion campaigns, and the first validation results: the evaluation of the basic portal for the Swiss case study, as well as the baseline collection results for both case studies.

In the Swiss pilot, SmartH2O recruited a core user group of 42 users (in a rather conservative population). Based on this a larger active user base will be built in the pilot continuation. Users in the Swiss case study positively assessed the basic portal on the level of the application as a whole, as well as on the level of individual features, while tentative evidence for a reduced water consumption points out the potential impact of the basic version of the SmartH2O portal. In Section 5.3.2 the initial results of the analysis display how after the deployment of SmartH2O platform a sensible reduction in water consumption has been observed (about 28%). These first results suggest that, even taking into consideration seasonality effects in water consumption, the KPI's and target levels that have been defined in *D7.1 Validation methodology* are feasible to achieve, and more importantly, this type of stimuli do affect the user behaviour. However, the size of the pilot population and the duration of the data collection do not allow us yet to draw final conclusions, which need support from a larger population size, as it is the case in the Spanish case study.

In terms of user acceptance, participants in this evaluation positively evaluated the utilitarian value of the SmartH2O portal (e.g. performance expectancy; [Venkatesh et al., 2003]) and stated a positive attitude towards the technology in general. Also most success criteria that were introduced during the requirements process (see *D2.2 Final requirements*) received positive ratings, including usefulness of water saving tips and water consumption visualisations, and the extent to which users are encouraged to think more about their water consumption by inspecting consumption feedback.

Increased user activity with the introduction of the gamified portal in the Swiss case study suggests that the gamification features make the portal more attractive to users and that the designed incentive model for behavioural change is suitable in this pilot. As different types of lead users could be identified, the model also appears to be versatile enough to appeal to different user types.

The observed positive effects on water consumption and user attitudes will be more closely assessed in the continuation of the Swiss pilot and in the large-scale Spanish pilot. There, the expansion of the Spanish case study to a full-scale roll-out of the SmartH2O portal as a new customer service for the entire population base served by the water utility in Valencia (ca. 800.000 inhabitants) provides the opportunity to achieve impact on water consumption and water consumption awareness on a scale that exceeds what is commonly found in the literature. In addition to the Swiss results, this deliverable has outlined the actions that have been undertaken to recruit users for usage and validation of the SmartH2O portal in the Valencia area as well as the collected awareness and behaviour baseline measurements. Already in the first 8 weeks, 341 users signed up for the portal 295 users, out of which 295 filled out the awareness baseline questionnaire (response rate was 86,5%). Additionally, a control group of 203 users was established via a call centre. Finally, the acquired baseline water consumption data have been reported.

In the upcoming trial particular emphasis will be placed on the validation of the gamified approach, as a way to incentivize users to engage with water consumption feedback, and to start contemplating their water consumption. For this purpose, in this deliverable we have extended the methodological groundwork provided in *D7.1 Validation methodology* by operationalizing the concept of awareness into measurable determinants of water consumption, in line with *D4.3 Incentive models and algorithms*. Measurements of these determinants (e.g. beliefs, attitudes, perceived behavioural control) have been collected and reported for the Switzerland case study. The upcoming large-scale trial in Spain, as well as the smaller scale Switzerland trial will yield valuable insights into the effectiveness of the gamified approach, and its impact on the associated KPI's on water consumption and water consumption awareness.

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Appendix A Measurement instruments

A.1 Valencia control group script

[Introduction]

Hello, my name is ________ and the reason I'm calling you is about water. Universitat Politècnica de Valéncia and your water utility, EMIVASA, are conducting an academic study on water consumption for a European research project. We would like to ask you some questions about what you think of water as a resource and ways to save water.

The survey today will only take approximately 5 minutes, and if you participate, you can win 2 Tickets to the Oceanogràfic Valencia .

Do you want to participate? [wait for response, only continue with consent]

Please note that all data you provide will be treated confidentially. As this survey is part of an academic research project, the data will only be used for academic, non-commercial purposes. EMIVASA will only receive the aggregated, anonymized results.

You are free to skip questions if you feel uncomfortable answering, and you can stop your participation at all times.

[Part 1- About you and water]

The questions we are going to ask you are about water. Note that there are no right or wrong answers.

1. *First, I'm going to read a couple of statements to you. Please indicate to what extent you agree with them. You can answer with a number from 1 to 7. "1" stands for completely disagree, "4" for neutral, and "7" for completely agree. Please pick any number between 1 and 7 that best reflects your opinion.* [SHORT PAUSE after each statement to note response]
    - It is expected of me that I save water around the house and garden.
    - I feel like there is social pressure to save water around the house and garden.
    - People who are important to me want me to save water around the house and garden.
    - I am confident that I could save water around the house and garden if I wanted to.
    - I expect I will engage in everyday actions to save water around the house and garden in the next six months.
    - I want to engage in everyday actions to save water around the house and garden in the next six months.

2. Next, I would like to know what you think about engaging in everyday actions to save water around the house and garden. For that purpose, I am going to read you some word pairs.

You can answer with a number from 1 to 7. "1" stands for extremely bad, and "7" for extremely good. Again, please pick any number that best reflects your opinion.

Do you find this:

- 1-Extremely bad, 7-extremely good, or somewhere in between
- 1-Extremely harmful, 7-extremely beneficial

- 1-Extremely worthless, 7-extremely valuable
- 1-Extremely pleasant, 7-extremely unpleasant

3. *I'm going to read a few more statements to you. Please tell me to what extent you agree with each statement.*
   For each statement, I would like to know if you:
   - completely disagree,
   - rather disagree,
   - rather agree, or
   - completely agree

   [SHORT PAUSE, also after each statement]

- Science surely will solve the problem of water scarcity
  To what extent you agree or disagree with this statement?

  [repeat the answer alternatives <u>only</u> if people get stuck]

  - Drinkable water is an unlimited resource
  - Drinkable water will exhaust very soon if we do not save it
  - A way of preventing water exhaustion is using it when absolutely necessary

4. *How much water do you think your household consumes compared to the average consumption of other households in your area? Please pick one of the following options:*

Do you consume

- Much less than average,
- Somewhat less than average,
- Approximately average,
- Somewhat more than average, or
- Much more than average ?
- You don't know

5. *I will list 6 water-consuming activities now. Which activity do you think consumes the most water every month? Is it…*

- Taking a bath,
- Taking a shower,
- Using the washing machine,
- Using the dishwasher,
- Flushing the toilet, or
- Running the tap ? [provide example only if respondent is confused]

6. *Can you name 3 actions that you could perform to reduce your water consumption?*
   [note answers below]

- *…*
- *…*
- *…*

<u>[If respondents get stuck or indicate that they don't have more ideas, move on to the next question.]</u>

7. *In the last three months, did you hear, read, or see media campaigns on water saving? For example, government messages on the radio, or the TV, or in newspaper ads. Please pick one of the following options:*
    - *Have you encountered such campaigns*
        - Very often,
        - Often,
        - Sometimes,
        - Seldom, or
        - Never

[Some last questions about you]

The final questions are about yourself. In any case you feel uncomfortable answering them, please let us know, as you are not obliged to answer them. We are only collecting these data for statistical purposes.

8. How many adults are in your household? …

9. How many children are in your household? …

10. *What kind of house do you live in? Please pick one of the following options:*
    - Apartment
    - Semi-detached house
    - Detached house
    - Other.
        - [if the respondent chose "other"]
          Can you specify, please?

11. *What is the highest level of education you have successfully completed?*

[don't read the options, tick category that the respondent said/meant]

- I'd rather not say
- Early childhood education
- Primary education
- Lower secondary education
- Upper secondary education
- Post-secondary non-college education (e.g. professional training, vocational education)
- Bachelor's or equivalent level
- Master's or equivalent level
- Doctoral or equivalent level

12. *Do you work for a water utility?* [don't read the options, tick what the respondent said]
    - yes
    - no

13. *What is your gender?* [don't read the options, tick what the respondent said]
    - Male
    - Female

    Other / rather not say

14. *What is your age?* [don't read the options, tick what the respondent said]
    - I'd rather not say
    - < 20
    - 21-30
    - 31-40
    - 41-50
    - 51-60
    - 61-70
    - 71-80
    - More than 80

[end of questionnaire]

[Outro]

On behalf of Universitat Politècnica de Valéncia and EMIVASA, I thank you so much for participating in today's water survey.

As promised, you can now enter our lottery to win 2 Oceanografic tickets.

EMIVASA will draw the lucky winners in March and inform you if you are one of them. Would you like to enter the lottery? [Wait for response].

[If yes to lottery] *How would you like us to contact you if you win the Oceanogràfic tickets? Can we call you or would you like to provide an email address or your home address?*

____

Can we contact you again at the end of the research project? If you respond to our second phone survey, you will have the chance to win an iPad mini 2. [Wait for response]

Thank you so much, we will make sure to call you again for our second survey then. Have a nice day.

[If no to lottery]

Can we contact you again at the end of the research project for another short survey? [Wait for response]

*Thank you so much for your time today, [*if yes *we will make sure to call you again for our second survey then]. Have a nice day.*

[End of Outro]

A.2 Questionnaire items

In the table below the items are catalogued that were used for the different questionnaires in the validation. The Emivasa sign-up questionnaire contains the same items as were used for Terre di Pedemonte, supplemented with pricing and incentive-related questions (WP5).

Construct	Item no.	Item	Measurement	Source	Basic portal questionnaire	Sign-up questionnaire	Upgrade Questionnaire
UTAUT – Performance expectancy	1	I find the Smart H20 portal useful in my daily life.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Venkatesh et al., 2003]	Y	N	N
UTAUT – Performance expectancy	2	Using the Smart H20 portal increases my chances of achieving things that are important to me.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
UTAUT – Effort expectancy	1	Learning how to use the SmartH2O portal is easy for me.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Venkatesh et al., 2003]	Y	N	N
UTAUT – Effort expectancy	2	My interaction with the Smart H20 portal is clear and understandable.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
UTAUT – Effort expectancy	3	I find the Smart H20 portal easy to use.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
UTAUT – Effort expectancy	4	It is easy for me to become skilful at using the SmartH2O portal.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
UTAUT-Attitude towards technology	1	Using the Smart H2O portal is a bad/good idea	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Venkatesh et al., 2003]	Y	N	Y
UTAUT-Attitude towards technology	2	The system makes work more interesting.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				

UTAUT-Attitude towards technology	3	Working with the system is fun.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
UTAUT-Attitude towards technology	4	I like working with the system.	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
Hedonic quality (stimulation)	1	Typical—original	7-point semantical differential	[Hassenzahl, 2004]	Y	N	N
Hedonic quality (stimulation)	2	Standard—creative	7-point semantical differential				
Hedonic quality (stimulation)	3	Cautious—courageous	7-point semantical differential				
Hedonic quality (stimulation)	4	Conservative—innovative	7-point semantical differential				
Hedonic quality (stimulation)	5	Lame—exciting	7-point semantical differential				
Hedonic quality (stimulation)	6	Easy—challenging	7-point semantical differential				
Hedonic quality (stimulation)	7	Commonplace—new	7-point semantical differential				
Pragmatic quality	1	Technical—human	7-point semantical differential	[Hassenzahl, 2004]	Y	N	N
Pragmatic quality	2	Complicated—simple	7-point semantical differential				
Pragmatic quality	3	Impractical—practical	7-point semantical differential				
Pragmatic quality	4	Cumbersome – direct	7-point semantical differential				

Pragmatic quality	5	Unpredictable—predictable	7-point semantical differential				
Pragmatic quality	6	Confusing—clear	7-point semantical differential				
Pragmatic quality	7	Unruly—manageable	7-point semantical differential				
TPB: Attitude towards water saving		Engaging in everyday actions to save water around the house and garden is:	7-point semantical differential	[Fielding et al., 2012]	Y	Y	N
	1	extremely bad/extremely good;					
	2	extremely harmful/extremely beneficial;					
	3	extremely worthless/extremely valuable;					
	4	extremely unpleasant/ extremely pleasant					
TPB: subjective norm	1	It is expected of me that I save water around the house and garden	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Fielding et al., 2012]	Y	Y	N
TPB: subjective norm	2	I feel like there is social pressure to save water around the house and garden	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
TPB: subjective norm	3	People who are important to me want me to save water around the house	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				

		and garden					
TPB: perc. beh. control	1	I am confident that I could save water around the house and garden if I wanted to,	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Fielding et al., 2012]	Y	Y	N
TPB: behavioural intention to save water	1	I expect I will engage in everyday actions to save water around the house and garden in the next six months	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Fielding et al., 2012]	Y	Y	N
TPB: behavioural intention to save water	2	I intend to engage in everyday actions to save water around the house and garden in the next six months,	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
TPB: behavioural intention to save water	3	I want to engage in everyday actions to save water around the house and garden in the next six months	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)				
TPB: behavioural beliefs (utilitarian)	1	There is much water in [area name]. We just have to conduct it to our cities	Four-point Likert scale (1= completely disagree; 4=completely agree)	[Corral-Verdugo et al., 2002]	Y	Y	N
TPB: behavioural beliefs (utilitarian)	2	Science surely will solve the problem of water scarcity	Four-point Likert scale (1= completely disagree; 4=completely agree)				
TPB: behavioural beliefs (utilitarian)	3	Drinkable water is an unlimited resource	Four-point Likert scale (1= completely disagree; 4=completely agree)				

TPB: behavioural beliefs (utilitarian)	4	Drinkable water will exhaust very soon if we do not save it	Four-point Likert scale (1= completely disagree; 4=completely agree)				
TPB: beh. Beliefs (ecological)	5	A way of preventing water exhaustion is using it when absolutely necessary	Four-point Likert scale (1= completely disagree; 4=completely agree)				
Usefulness	-	How useful or useless is the water consumption chart/the water consumption overview for you? How useful are the water saving tips for you?	Five-point Likert scale (1=complete disagree; 5=completely agree) Five-point Likert scale (1=very useless; 5=very useful)	Success criteria	Y (basis: basic portal v1)	N	Y (basis: basic portal v2)
Comprehension	-	I can understand from the chart/from the overview how much water my household consumes over time How clear are the following options to adjust the display of the water consumption chart? • Possibility to adjust the displayed data to days, weeks, or months • Possibility to display your own daily average • Possibility to display	Seven-point Likert scale (1=complete disagree; 7=completely agree) Five-point Likert scale (1=very unclear; 5=very clear + ‘Did not use this option (yet)’)		Y (basis: basic portal v1)	N	(basis: basic portal v2)

		neighbourhood average • Opening hourly water consumption charts • Sliders to adjust the timespan of the displayed data					
Ease of use	-	How easy or difficult was it for you to use the water consumption chart? How easy or difficult was it for you to take notice of the water saving tips?	Five-point Likert scale (1=complete disagree; 5=completely agree) Five-point Likert scale (1=very difficult; 5=very easy)		(basis: basic portal v1)	N	(basis: basic portal v2)
Perception of awareness increase	-	Please indicate to what extent you agree with the following statement: "The water conservation tips make me think about water consumption more often than before." To what extent were you able to put the water saving tips in practice?	Seven-point Likert scale (1=complete disagree; 7=completely agree) Five-point Likert scale (1=to a very small extent; 5=to a very large extent)		(basis: basic portal v1)	N	(basis: basic portal v2)
-	-	User reference ID (for tracking purposes)			Y	Y	Y
Awareness	1	How much water do you think you consume compared to the average consumption of similar	a. Much more b. Somewhat more c. Same as average	Pricing questionnaire	Y	Y	N

		households in your area:	d. Somewhat less e. Much less				
Awareness	2	Which of the following activities do you think consumes the most water on a monthly basis?	a. Bath b. Shower c. Washing machine d. WC e. Garden irrigation f. Dishwasher a. Tab		Y	Y	N
-	-	Since when do you have an account for the Smart H20 portal?	Five-points scale		Y	N	Y
-	-	How many adults are in your household?	Number		Y	Y	N
-	-	How many children are in your household?	Number		Y	Y	N
-	-	What kind of house do you live in?	House / Apartment / other		Y	Y	N
-	-	Educational level		International Standard Classification of Education	Y	Y	N
Personal innovativeness	1	If I heard about a new information technology, I would look for ways to experiment with it.	Seven-point Likert scale (1=Strongly disagree; 7=strongly agree)	[Lu et al. , 2005)	Y	Y	N
	2	Among my peers, I am usually the first to explore	Seven-point Likert scale (1=Strongly disagree;				

		new information technologies.	7=strongly agree)				
	3	I like to experiment with new information technologies.	Seven-point Likert scale (1=Strongly disagree; 7=strongly agree)				
	4	In general, I am hesitant to try out new information technologies.	Seven-point Likert scale (1=Strongly disagree; 7=strongly agree)				

UTAUT2 Modifications

Discarded items (Performance expectancy):

- Using mobile Internet helps me accomplish things more quickly. (irrelevant)
- Using mobile Internet increases my productivity. (irrelevant)

TPB: behavioural beliefs (modifications)

Adapted from Corral-Verdugo et al. (2003):

- Water is the cheapest natural resource. That is why the government should charge no cost

  Adaptation: excluded; cultural bias towards US
- Humans have the right to use all the water they want because they are the kings of Creation

  Adaptation: excluded; cultural bias towards US
- "Water scarcity is a lie produced by politicians"
  Adaptation: excluded; cultural bias towards US