Wat€rnomics

Usage case and Exploitation Scenarios

Project Acronym:	**Waternomics**
Project Title:	**ICT for Water Resource Management**
Project Number:	**619660**
Instrument:	**Collaborative project**
Thematic Priority:	**FP7-ICT-2013.11**

D1.1

Work Package:	*WP1*	
Due Date:		31/12/2014
Submission Date:		31/01/2014
Start Date of Project:		01/02/2014
Duration of Project:		36 Months
Organisation Responsible of Deliverable:		NUIG
Version:		1.0
Status:		Draft
Author name(s):	Sander Smit Daniel Coakley Thomas Messervey Christos Kouroupetroglou Edward Curry Riccardo Puglisi	BM-Change NUIG R2M U4 NUIG R2M
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Nature:	☒ R – Report ☐ P – Prototype ☐ D – Demonstrator ☐ O - Other	
Dissemination level:	☒ PU - Public ☐ CO - Confidential, only for members of the consortium (including the Commission) ☐ RE - Restricted to a group specified by the consortium (including the Commission Services)	
Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		

Revision history

Version	Date	Modified by	Comments
0.1	19/05/14	Edward Curry	Initial Version of Document
0.2	02/06/14	Sander Smit	Added methodology
0.3	11/07/14	Sander Smit	Added input from interviews
0.4	19/07/14	Daniel Coakley	Added Public users (Scholars and students) Scenario
0.5	21/07/14	Sander Smit	Added Business Strategies
0.6	22/07/14	Sander Smit	Added ranked feature list
0.6_THM	24/07/14	Thomas Messervey	Document walkthrough, comments for clarification of ambiguous elements
0.6_CK	24/07/14	Christos Kouroupetroglou	Added technical context for scenarios 1 and 2, general comments and document walkthrough;
0.7	29/07/14	Daniel Coakley	Replaced section 4.2.2, Modified section 2 (Introduction), Added further clarification of usage cases and exploitation scenarios
0.8	30/07/14	Daniel Coakley	Added inputs from Irish stakeholder interviews; Added technical context for scenarios;
0.9	31/07/14	Daniel Coakley	Added Scenario 3: Municipalities;
1.0	31/07/14	Daniel Coakley, Edward Curry	Reformatted tables, headers and captioning; Added technical context to Scenario 3: Municipalities; Incorporated comments from v0.6_CK;. Final Review

Executive Summary

This document is an interim submission of D1.1 which will be officially submitted at M12.

Chapter 2 introduces the concepts of usage cases and exploitation scenarios. The scenario construction method is described in detail. These scenarios will form the framework on which the WATERNOMICS platform will be built, including technical features and business exploitation. The roadmap for this document is also presented from Draft (M6) to final deliverable (M12). The final version of this document will include feedback from all relevant stakeholders: internal consortium, pilot sites and external feedback.

Chapter 3 describes the three initial exploitation scenarios: (1) Scholars and students, (2) Fiction Factory, and (3) Municipalities. Each scenario is described from the point of view of an end-user in each case. Various use-cases and functionalities of the WATERNOMICS platform are presented through this users interactions with the system during their daily routine. This is then discussed in a business context, describing each of the stakeholders in the presented scenario, and how they can benefit from the WATERNOMICS platform. Finally, the technical context explains how the presented use-cases link to specific features outlined in the WATERNOMICS feature list (Appendix B).

Chapter 4 presents the business strategies for each of the exploitation scenarios from the point of view of our three target audiences: (1) Corporate users, (2) Municipalities, and (3) Domestic users.

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1 Background

To resolve upcoming shortages in clean drinking water, Waternomics will explore technologies and methodologies needed to successfully reduce water consumption from households, companies and municipalities. Waternomics is a three year, EU-funded project that started in February 2014 and will evaluate its results in three real life experiments in Italy, Greece and Ireland.

The goal of Waternomics is to explore how ICT can help households, businesses and municipalities with reducing their consumption of drinking water. The research will focus on ways to increase the awareness of people about their water consumption and the availability of water. Also scenarios for how to bring these technologies to the market and make them available to a wider audience, will be investigated.

Waternomics is organized in seven different Work Packages as shown in Figure 1.

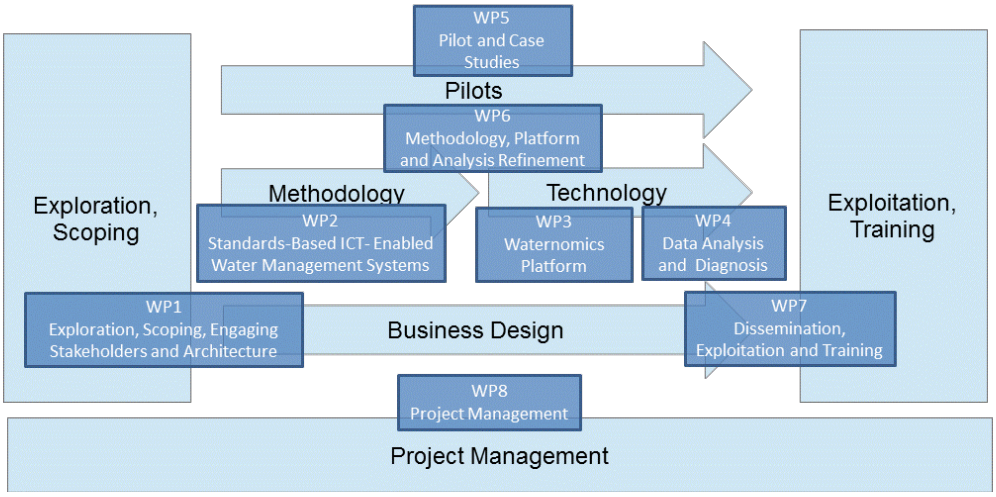


Figure 1 : Waternomics work package structure.

The objective of Work Package 1 is to provide guidance to the other work packages in Waternomics to ensure that project results are a good fit for industrial needs. More specific, work package 1 will identify needs, barriers, opportunities, policies, challenges, collaboration opportunities and solutions for each of the targeted stakeholders and define an overall architecture for the Waternomics Water Information Platform. This document describes the scenarios from which the requirements and system architecture will be derived.

2 Introduction

In this chapter we explain the roadmap for Deliverable 1.1 and summarise the construction method for the set of usage cases and exploitation scenarios that function as the basis for the Waternomics architecture, business models and applications.

In this project, we define usage cases as any potential end-user interaction with the WATERNOMICS platform for a specific purpose (e.g. to check their current monthly water consumption). Exploitation scenarios can be seen as story-boards which tie together multiple usage-cases in a more coherent fashion. For clarity, we have defined scenarios for three clearly identifiable end-users / stakeholders:

1. Scholars and Students (Public users / Education)
2. Fiction Factory (Commercial)
3. Domestic users

Chapter 3 explores these exploitation scenarios from the point of view of real potential end-users from each of the above categories. Chapter 4 explores the business strategies linked to these exploitation scenarios.

The appendices provide further information on requirements gathering activities:

- Appendix A: Feature List Selection Criteria – This section describes the criteria used to filter the features requested during stakeholder interviews and round table discussions.
- Appendix B: Ranked Feature List – Using the above selection criteria (Appendix A), the full set of requested features is ranked based on how well they meet each of the criteria.
- Appendix C: Reports on Interviews and Round Table Sessions – This section contains detailed background information, meeting minutes and follow-up activities from the various interviews and round-table discussions held with WATERNOMICS stakeholders during the first 6 months of the project;
- Appendix D: Interview Checklist – This section contains a checklist of questions used during stakeholder interviews to provide a standard template for interviews and to ensure that all relevant topics are covered.

2.1 Usage case and scenario analysis roadmap

The Waternomics project will develop usage cases and exploitation scenarios during the first year of the project. External stakeholders will play a major role in identifying and prioritising features and functionalities for the different scenarios. The further implementation and validation of the exploitation scenarios will be continued in Task 7.2.

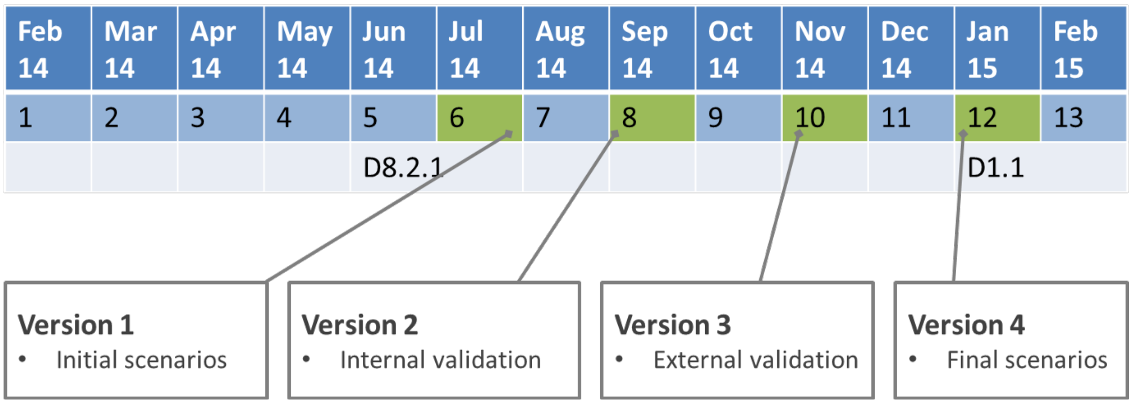


Figure 2 - Roadmap for usage cases and exploitation scenarios

The following roadmap (see Table 2-A), as illustrated in Figure 2, is envisaged for the development of the usage cases and exploitation scenarios.

Version	Due	Description
Initial Usage Case and Exploitation Scenarios	July 2014	Define methodology for scenario development Stakeholder consultation and desk research on features and market demands Define initial usage cases and exploitation scenarios Internal consortium validation
Usage Case and Exploitation Scenarios Version 2	September 2014	Incorporate feedback from Version 1 External stakeholder validation
Usage Case and Exploitation Scenarios Version 3	November 2014	Incorporate feedback from Version 2
Usage Case and Exploitation Scenarios Version 4	January 2015	Final usage cases and exploitation scenarios

Table 2-A - Description of the different document revisions

2.2 Scenario Construction Method

Overall, scenario development has been based on three sets of guidelines and criteria. The set of final scenarios should:

- be based on end-user perceived value,
- be based on business value,
- cover all target functionality of the Waternomics project, i.e., be compatible with the Description of Work (DoW) document,
- be technically innovative.

In the rest of this section, we give an overview of the steps and relations between the steps that have been taken as part of scenario construction methodology.

We used a zoom-in method, and as such the process was mainly bottom-up. By this we mean that we started by collecting a large set of functionalities and features as basis for the Waternomics scenarios. Then we filtered these features, based on the criteria mentioned above, in a step-by-step way. The final results have been integrated in three scenarios that each covers a part of the Waternomics project from a different perspective and together cover the complete scope of the project. In this section we detail the steps that resulted in these three final scenarios.

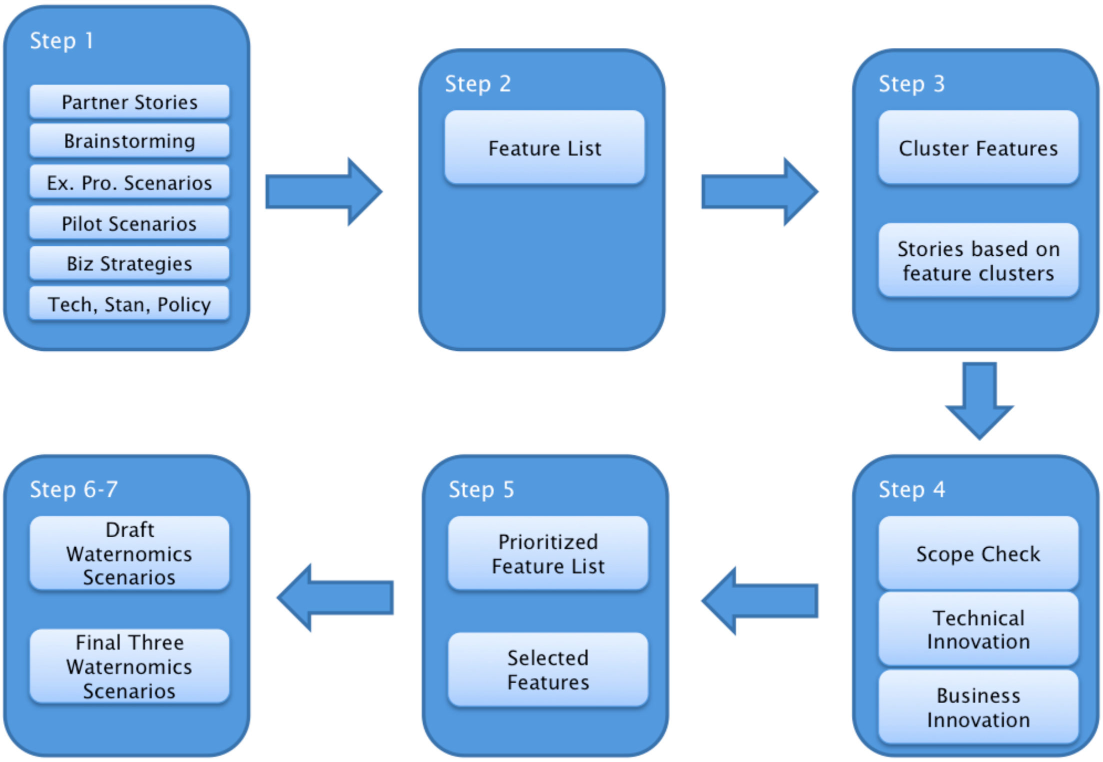


Figure 3: Graphical representation of the scenario construction method

Feature list development

As the scenarios form the basis of the project, we decide to first generate a very broad list of functional and technical features that could be used as the basis for the scenarios (See Appendix B). We did not want to exclude features that might have value at the start of the project.

1. We gathered a list of features. This approach ensured a broad set of features, and thereby a large set of functionalities. These features have been developed by:
    - Project partners
    - Brainstorming Session
    - Pilot Scenarios
    - Business Strategies (Task 1.1)
    - Technologies, Standards, Policy (Task 1.2)
2. A list of features (where a feature is defined as any identifiable block of functionality, be it user-based or technical) has been constructed collaboratively by several project members. The feature lists has a total of 68 features (Appendix B).

Features check with business and innovation value and project scope

In addition to the end-user based criterion we gathered three other types of criteria (project scope, business innovation, and technical innovation) in order to balance the final scenarios. These four different types of criteria have been used as selection criteria for the initial list of features.

3. A list of the business criteria has been assembled by the different project partners to be able to score the different features based on business value. The same has been done for technical innovation value (both in Appendix A). The Waternomics project proposal has been used as input to evaluate to what extent a feature fitted within the scope of the project.

4. Based on the four different criteria (user-value, business innovation, technical innovation and description-of-work relevancy) all features have been scored individually and separately for each of the criteria. This has been done by different project members, to ensure an unbiased way of scoring (e.g., project member A from company X scored only based on business innovation, while project member B from company Y scored only based on technical innovation). These scores have been integrated using a weighted average. This resulted in one score per feature that has been used to prioritise the list of features. In a plenary discussion involving all partners a selection of features was made based on this prioritised list. This selection was used to develop the final three scenarios.

Scenario development based on prioritised features
The selected features built the basis for the final three scenarios. These final three scenarios have been constructed such that they span the complete project but each have a defined focus. This focus is described in the introduction of the individual scenario chapters.

5. The selected scenarios have been used to construct three different scenarios that each has a different perspective on the Waternomics project. Three different teams were created and each team worked on one scenario. Each team kept track of which features have been used in the scenario, ensuring full traceability of the scenario back to the first step of collecting features as well as the individual scorings of the features based on the different criteria. These scenarios will be described in detail in the next chapters. For each scenario a short introduction is given of how the scenario reflects the Waternomics project as well as how it is related to the other scenarios.
6. During a face-to-face plenary workshop involving all project partners the draft scenarios have been discussed and fine-tuned resulting in the three final scenarios described in this document.

The scenarios have overlap, but they focus on different aspects. The two dimensions that have been used to focus the scenarios are:

- type of *target user group* involved, and
- type of *information and services* involved.

In the introductory paragraph of each of the scenarios a short description is given on how the scenario relates to the other two scenarios in terms of these two dimensions. Each chapter first presents the scenario as a whole from a user perspective. The scenario is presented as consecutive scenes. Each scene in the scenario is then discussed in terms of technical content (what technological features and innovations are used in a scene). Finally, the scenario is discussed from a business perspective including a description of the main actors in the scenario (such as professional content providers, users paying for services, etc.)

Summary
We have used a structured and traceable method for generating Waternomics scenarios. This resulted in scenarios that (1) complement each other by each presenting a unique view on the Waternomics capabilities, (2) scenarios that are well-balanced with respect to the different criteria involved (user value, business value, innovation value and project scope), and (3) cover the complete Waternomics project so that, together with the list of prioritised features, these scenarios can function as a solid basis, agreed upon by all partners for the rest of the project.

3 Exploitation Scenarios

3.1 Introduction

To guide the development of the Waternomics architecture, applications, methodology and exploitation plan, three scenarios have been developed, describing the usage of a possible Waternomics Water Information Platform in three different settings. Each scenario contains a description from a user perspective, a business perspective and a technological perspective.

3.2 Scenario 1: Domestic and public users

This scenario describes the experiences of ordinary citizens with the WATERNOMICS water information platform. One of the primary aims of the WATERNOMICS project is to strengthen awareness of users about water consumption and conservation. Therefore, the platform aims to integrate seamlessly between domestic and public life. Since many individuals spend a large proportion of their time in public buildings, it is clear that these locations may provide an ideal platform with which to broadcast the Waternomics message to a wider audience.

In this project, we have targeted schools and Universities for deployment of the WATERNOMICS platform for two primary reasons:

1. Public schools and universities are high-traffic areas with a high throughput of users who will be exposed to and have the opportunity to interact with the platform;
2. Typically, moral values and habits are formed and strengthened in children and young adults. These values will inevitably be carried through to adulthood. Therefore, it makes sense to target users at a young age, in order to develop positive attitudes towards water awareness and conservation.

This storyline describes a pair of brothers, Peter and John, as they interact with the WATERNOMCIS platform in their everyday activities at home, at school and at University. Peter is 10 years of age, and attends a local school in his hometown in Ireland. His older brother, John (21) is studying to be an engineer at a University in London, England. Both Peter and John interact with the WATERNOMICS platform on a daily basis.

3.2.1 Scenario Description

Scene 1: Water Conservation Competition
Peter gets up at 8am to get ready for school. He has a quick shower and brushes his teeth, ensuring to turn off the tap when he doesn't need water. He is already nearly top of the class leaderboard for water conservation, so he is making a special effort to ensure he keeps making progress.

Scene 2: Water Awareness Application
Peter is able to log his daily activities using the free WATERNOMICS smart-phone application. In addition, the location-aware life-band on his wrist is able to learn from his inputs in order to automatically log these activities in future. This gives him a good idea of where he is using most water, as well as his improvement over time. In addition, he is able to compete with his family, friends and people from around the world in water awareness and conservation.

Scene 3: Water Awareness Dashboard
Peter arrives at school just before 9am, and is immediately greeted by the water awareness dashboard in the foyer of his school. The screen displays lots of interesting information about water efficiency progress in the school, as well as how the school compares with other schools in the region, as well as nationally and globally. There is also graphical information displayed

about how the schools performance has helped with environmental conservation, by visually displaying the impact of conservation activities. So far this year, the Peter can see that his school has saved the equivalent amount of water that would be needed to produce 80 laptops, or over 1500 t-shirts.

Scene 4: Water Analysis Software
Meanwhile, in London, Peters brother John, has just started his first lecture of the day on Hydrology, and is learning about urban water distribution networks. From his experience growing up, John knows that water scarcity is a major issue for many countries, which is why he decided to study Civil Engineering, and focus on becoming a city engineer in order to improve on the water distribution systems of the future. His first assignment for this class is to design an efficient distribution network for a town in Italy. Using data collected and made available through WATERNOMICS, John is better able to understand the water availability of the region, as well as the typical behaviour of individuals living in that region. Using this data, John is able to simulate water demand for that region, and come up with an optimal system for water distribution.

Scene 5: Appliance Recommendation System
Peter returns home from school for dinner. Afterwards, he helps his parents to load the dishes in their dishwasher. From his experience with the water awareness application, he knows that a lot of the water he uses on a daily basis comes from the appliances in his home, particularly the dishwasher and washing machine. Peter asks his Dad about how they could reduce their consumption so he can improve his performance in the WATERNOMICS competition. His Dad checks the WATERNOMICS website where he has filled in details about the water-consuming devices in their home, and is able to calculate what the effect of changing to more efficient appliances would be. He is immediately presented with a number of options for more efficient appliances available locally, as well as recommendations of which one's would best suit his household based on historic water consumption.

Scene 6: Water Conservation Game
Both Peter and John are part of the WATERNOMICS simulation game, in which people compete globally on virtual household water management. In this game, users can build up their own house, add water conservation devices, adjust behaviours and interact with other users in the virtual environment to trade resources and virtual points.

Scene 7: Water Rewards
At the end of the school year, Peter and his classmates attend the school assembly where the WATERNOMICS awards are to be announced for the local community. These awards provide recognition to local businesses, households and individuals that have made significant improvements in water conservation performance over the past 12 months. Peter's school receives special recognition for reducing their water demand by over 10% for two consecutive years. Peter is also awarded the Neptune prize for best individual improvement in his class. For this, he receives a virtual badge in his WATERNOMICS application profile, and 1000 points to spend in the WATERNOMICS game.

Scene 8: Social Networking
Peter is delighted with his success and decides to inform his brother in the UK. From the WATERNOMICS application, he is able to send a tweet to his brother to share the news of his Neptune award. His Waternomics profile is also updated to reflect his success, and he moves up the global leaderboard, placing him in the top 10% nationally.

3.2.2 Business Context

Different business configurations are possible for this scenario. As an example, one business configuration is first depicted and further on described per actor being involved in the scenario.

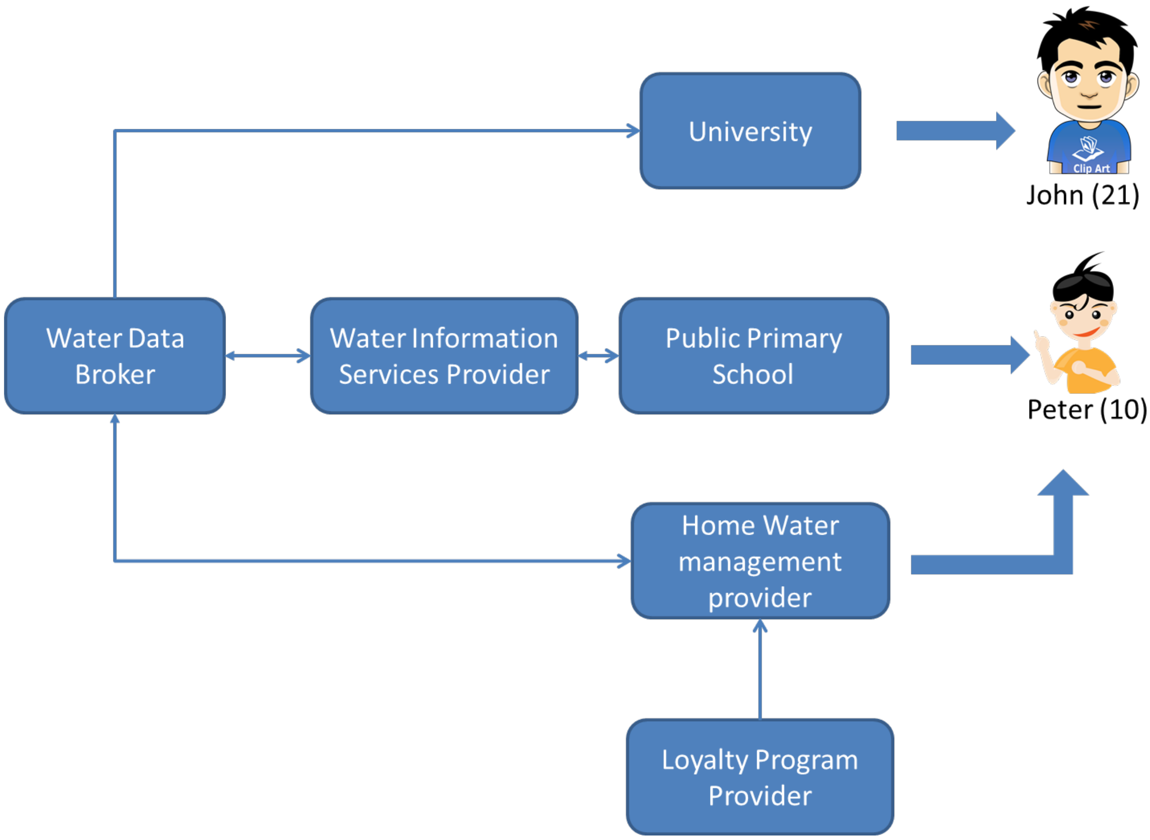


Figure 4 - Business configuration for the Scholars and Students scenario

The **University** can offer their students more realistic case studies when using real-time field data or datasets from real cities or regions. With anonymised network data, forecasted usage data and water availability information based on hydrological information, students can even be challenged to work on real life scenarios and problems.

The provider of such datasets and real-time data is the **Water Data Broker**. As the classic middle man, the Water Data Broker collects and purchases detailed water usage and availability information from various sources such as industries, water companies and households. The Water Data Broker makes sure that data sets cannot be traced back to individual users and offers its data through standardised interfaces.

Another customer of the Water Data Broker is the **Water Information Service Provider** (WISP). WISP offers water monitoring and awareness services to schools, factories and public buildings. It uses various feedback systems to make inhabitants of the buildings aware of their individual and collective water usage. With the data obtained from the Water Data Broker, WISP is capable of benchmarking water usage of its customers and set-up a national water saving competition. The water usage information collected by WISP, can be sold back to the Water Data Broker.

The **Public Primary School** uses the services of WISP to make scholars and staff more aware of the availability and usage of water. The information provided by WISP can be used in combination with the educational material to make water education more tangible.

For domestic users, the **Home Water Management Provider** offers monitoring, simulation and information services with respect to water usage. For benchmarking, it also purchases data from the Water Data Broker.

To enable national water saving competitions and leader boards, a dedicated **Loyalty Program Provider** collects, compares, ranks and publishes the water saving results from multiple Home Water Management Providers and Water Information Service Providers.

3.2.3 Technical context

Here we describe the relation between this scenario and the technology and potential technological innovations.

Scene 1: Water Conservation Competition
Sensors in the bathroom pick up water consumption on each separate tap. The platform has assigned the specific sensors to Peter's family so that they can account for the water they consume. This allows Peter to account for specific amounts of water used and connect it with his account on the platform. Peter can then view performance on the WATERNOMICS leaderboard application [20] [42]. The leaderboard module of the platform uses that information in combination with other user (Peter's classmates in this case that decided to join the game).This builds on the gamification aspect of the WATERNOMICS information platform [18] [26].

Scene 2: Water Awareness Application
Similar to scene 1 Peter can account for his water usage through the smartphone application wherever he uses WATERNOMICS connected water sources. Users can install the WATERNOMICS smart-phone application on any mobile device (smartphone, tablet). Therefore he can even account for water usage in his school which is also WATERNOMICS enabled by having installed sensors in their water distribution network. The application also provides an interface with the WATERNOMICS e-learning platform [26] [34].

Scene 3: Water Awareness Dashboard
A water awareness dashboard [2] is used to display information about building/user performance in public places. One of the strongest points of the WATERNOMICS dashboard application is that it is highly customizable. User can select over a range of diagrams and statistics they want to see and arrange them as they like. Time-series trends [10] [53] are used to illustrate progress. This dashboard is also used to display how this performance compares to other similar buildings in the area, as well as how the performance compares globally. Moreover they can also select over a wide range of metaphors. User can even input metaphors in the system so that it calculates and presents information in the way they like. Illustrative comparisons [49] and colour codes [47] are used to better convey water/energy [59] savings in real terms to building occupants. The personnel is also conducting experiments on what kind of information has the biggest impact by changing the information shown over specific periods and measuring the impact in water consumption.

Scene 4: Water Analysis Software
The data collected through the WATERNOMICS platform can also be made available anonymously [52] through a secure data transmission system [9] [48] to schools and college in order to improve water distribution network design by linking analysis to real performance data, and providing tools for network simulation [12].

A large amount of data gathered from WATERNOMICS enabled households and businesses within a city in Italy enable the simulation application the John is using. The schematics and water distribution network are based on the city itself. However, consumption data is based on historical information and the simulation is not using current usage data. It rather shows a snapshot of the city ware usage in the past allowing John to experiment on the effects that various decisions will have in water consumption. After conducting a number of simulations John is able to compare results and decide which ones are the optimal solutions for the problems the city is facing.

Scene 5: Appliance Recommendation System

The simulations application includes also a simulation of water usage for various appliances such as dish washers and washing machines. Peter and his father can select over a range of predefined appliances (already described in the platform's linked data space) or they can also create their own appliance profile based on specifications of each appliance. By using real performance data, occupancy profiles and these equipment profiles [23] [40] [41], the WATERNOMICS platform is capable of delivering personalised information to the end-user. A product recommendation system [51] uses usage characteristics, location and budgetary conditions to provide recommendations on water-saving product upgrades. The simulation is also helping them to decide by providing some relevant contextual information such as "This device is typical for a 4 members family" or "This appliance is consuming as much energy as a..". Having all this information in hand they can make a much better decision on which washing machine to buy.

Scene 6: Water Conservation Game

A water conservation simulation game is used to further promote the WATERNOMICS message to younger users, by allowing them to manage water usage on a virtual building [25]. This game is used to teach children [26] about the importance of different conservation measures.

The WATERNOMICS virtual water management game, consists of various levels. A player starts by managing water consumption in a household level. Users are awarded for good practices and penalized for bad ones. They can exchange ideas and practices with other players to gain more points. Once a user manages to achieve a specific goal in a level he is moving to the next one where the entity he manages is gradually more complex (SME, big company, campus, city, etc.). Behind the scenes the game can give feedback of good practices and hacks invented by users to save water and inform policy makers. It can also be tweaked and changed by organisations running the game to reflect more realistic situations and data based on information from actual users.

Scene 7: Water Rewards

The WATERNOMICS platform allows for communities to join and include their members in water conservation competitions. Rewards [18] are used to motivate and encourage users to be more pro-active towards water conservation activities. These rewards may be in-game rewards (virtual badge) given to users of the WATERNOMICS application, but it may also be possible to redeem these for real-world rewards, such as store discounts, allowances etc.

Scene 8: Social Networking

By linking the WATERNOMICS application to social networks [3], it is possible to communicate to a much wider audience and encourage further peer participation. WAERNOMICS heavily utilised social networks for communicating and spreading information about water conservation practices. A very crucial aspect however is that all kinds of sharing personal information of a user's achievements is initiated by the user. This measure is taken in order to fulfil privacy concerns of participating users. Moreover, when sharing real data users are notified accordingly and in some cases restrictions might also be applied on sensitive information not to be revealed publicly.

3.3 Scenario 2: Fiction Factory

The Fiction Factory scenario focuses on a medium sized factory that wants to get a better understanding of their water consumption as part of their sustainability program. Factory management not only looks at their own water consumption but considers water consumption of their business partners in other parts of the value chain as well.

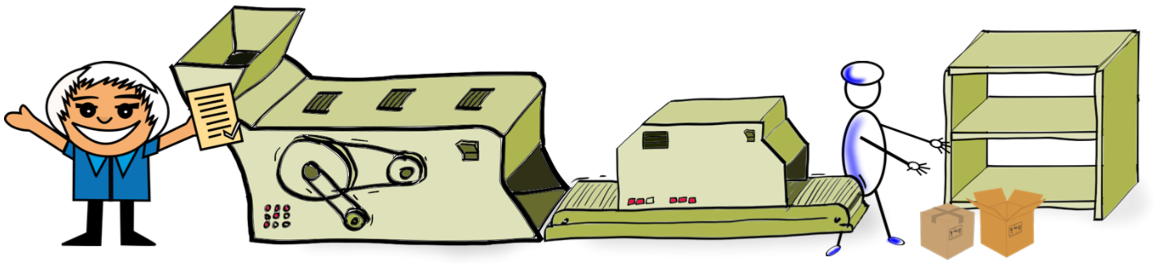


Figure 5: Fiction factory production line

The scenario has a strong focus on collecting water usage related information across organisations as well as providing water usage related information on department, company and value chain level.

3.3.1 Scenario Description

Scene 1: Morning shift
Jim is the leader of the morning shift and he just entered the factory to check out on production line 3, the line Jim and his team are responsible for today. In the meeting room on the work floor his team and the members of the night shift are already waiting. Sorry, he says, entering the room and asks Joanne, the team lead of the night shift, how things were going. Joanne shows the KPI's on the screen in the room and explains that although they produced 10% more items that night, they only used up 5% more water and 6% more energy. The information board also showed that one of the cooling machines was using more water than considered normal. Jim promised to take a look at that later that day.

Scene 2: Cooling machine
The team was working for a couple of hours now and the production line was running nice and stable. Together with his technicians, Jim looked at the historical water and energy usage data of the troubling cooling machine. The machine was already 13 years old but not yet entirely written of. They let the Water Management System make a calculation about the expected additional costs for water during the rest of its expected life time and talked through different scenarios. The Water Management System recommended to replace the cooling machine with a latest generation cooler. Although not entirely written of, the savings on water and energy out weighted the costs for financing this new machine. Jim places the order and schedules replacement of the cooler upon the next maintenance moment.

Scene 3: Leakage
Suddenly the Water Information Display gives a warning that unexpected large amounts of water is being used from tap number 16, near the storage department and that drain number 32 at the same location is receiving unexpected large quantities of water. Edith, who is the member of the morning shift closest nearby this tap, also receives the warning on her smartphone. She immediately goes to the tap to check what is going on there. It turns out that a fallen pallet has damaged the tap beyond repair. With the water management application on her smartphone she indicates that the tap is defect and that water is leaking. The water management application checks if this section of the water network can be shut down without disturbing the primary

production process. This is the case and the valves of the segment with the broken tap are closed. Edith warns maintenance staff to come and fix this tap immediately. Then she starts cleaning up the mess. Most of the water has run into the drain and will be reused.

Scene 4: The Sustainability Manager
Joanne, the sustainability manager of the factory, also received an alert on her smartphone that a water related incident had happened. She checks the Water Information System on the nearest computer terminal and sees that the situation is already under control. While she is in the Water Information System, she checks on the water efficiency of the different units and production lines. Overall, water consumption has dropped with 15% the last 3 years and her water saving strategy seems to pay off. Joanne had created a mix of competition and collaboration to increase awareness of water usage amongst staff. Departments and production lines could earn blue drops when outperforming other units but were also encouraged to share information and best practices by setting common goals for the complete factory. The blue drops were popular and could be exchanged for a wide range of products and services.

Scene 5: Blue Partner meeting
Later that day, Joanne attended the Blue Partner meeting, a monthly meeting with representatives from other companies working in the same value chain. It was their goal to keep the total water footprint of the product they were all making parts for, as low as possible. Joanne was sharing the meeting and she showed last month’s water usage information from all the companies on the screen. Every company shared his water usage information with the water data broker and had strict agreements about sharing of their data. All companies had agreed to share their data with the other partners in the value chain and this way they could easily identify the larger water users. Together they thought about further water reduction measures and they already had started three pilot projects together to investigate the feasibility of specific shared water reduction measures.

Scene 6: Blue label
All this work together did pay-off. Joanne was pleased to announce at the Blue Partner meeting that the Water Footprint Organisation had reviewed their water usage data, which they had obtained from the water data broker, and had benchmarked it with similar industries. Because of their significant progress on reducing water usage and because they now belonged to the top 3 producers that produced in the most water and energy efficient way, they were awarded with the Blue Label award. This award gave them the right to use the Blue Label logo on their products so that consumers could see that their product was produced with minimal impact on the environment.

Scene 7: Energy saving
Back in the meeting room at production line number 3, Jim had told his team the good news of the Blue Label award. They celebrated with cake and already started discussing about how to further improve water and energy efficiency. The team had noticed that specific products caused peaks in the usage of water. In day-shifts enough energy was available from their solar panels and wind mills but at night shifts this costs extra energy. To create a water buffer they planned to place an additional water reservoir which they could fill during day-time, when energy was sufficiently available and costs of energy were low, and could use at night so no extra energy for the pumps was needed. Jim approved the plan and asked the team to work it out in more detail. He was proud that everybody was so involved in reducing use of valuable resources.

3.3.2 Business Context

Different business configurations are possible for this scenario. As an example, one business configuration is first depicted and further on described per actor being involved in the scenario.

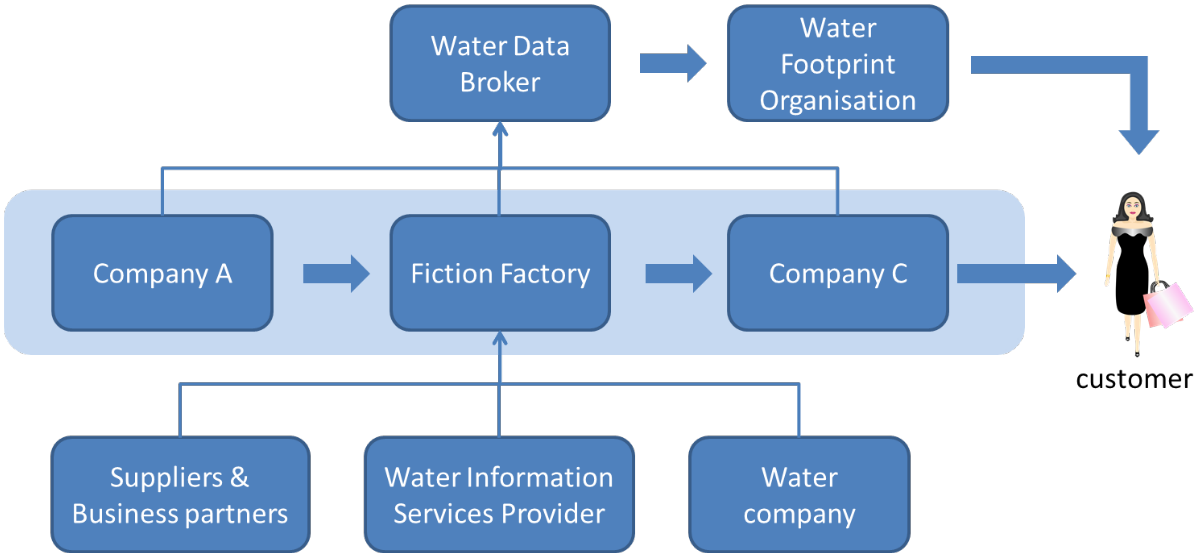


Figure 6 - Business context Fiction Factory scenario

3.3.3 Technical context

Here we describe the relation between this scenario and the technology and potential technological innovations.

Scene 1: Morning shift

The WATERNOMICS water information system (WIS) provides commercial users the ability to monitor how changes in production levels affect water and water-related energy consumption [59] and present this information any way they like. That is how Joanne has already pre-defined the screen that show in the room in order to display the information she wants to highlight. Moreover, the dashboard allows users to conduct comparisons within the same graph in order to visualize anomalies and trends. In addition, by correlating existing production line information with water measurements from the WIP, it is possible to produce relevant KPI's which may be used to inform operators and help pro-actively adjust and improve existing practices. The system will also allow users to identify anomalies in the data [4] which may signify system or equipment malfunction.

Scene 2: Cooling machine

The WATERNOMICS dashboard [2] also provides users the ability to examine historical information [53] at various levels of granularity [22] in order to help root cause any issues as they arise. By running various scenarios [15], it is also possible to determine the cost of equipment deterioration [59] or malfunction as well as the cost of replacement (along with personalised recommendations) [51].

The WATERNOMICS platform Linked Data Space is able to gather information about a variety of machines given that the manufacturers publish their specifications in open data formats. Based on this information the Water Management System used in the factory can conduct simulations of the water usage of the cooling machine over the next years and estimate costs based on the increase in water consumption. Then it combines with water consumption of new machines in the market and their cost and estimates the total cost over the next years using a new cooling machine. This comparison allows the system to suggest that a change in the cooling machine will be more profitable than fixing and continuing to use the old one.

Scene 3: Leakage
By continuously monitoring and recording water flow data in a facility, it is possible to quickly detect and respond to flow anomalies [4] which may indicate a leak or system malfunction. These anomalies may be communicated to relevant personnel via PUSH notifications for a smartphone application, via text message, e-mail, or social media. Using the smartphone application, personnel can also respond to an alarm by indicating the problem, adding a message/attachment, and alerting the relevant technicians needed to fix the problem. The critical notification is also driving users to a specific screen where they can follow the event in real time (real-time graph) presenting also with a number of possible solutions based on the network diagram. The user in place can see a different screen where he/she can confirm the level of damage and the possibility to be repaired easily or not. When the information is entered respective solutions suggested might become disabled on the main office screen so that the action to be taken is actually effective.

Scene 4: The Sustainability Manager
The scene is also presenting a different configuration of the leader board functionality presented in the previous scenario. The scene presents the same a leader board linked with groups of people within a specific community and using a mix of virtual and real rewards configured by the general entity and role (Factory and Sustainability manager). Records of historic water consumption data [53] linked with this leader-board provide a means of verifying the efficacy of water reduction strategies, as well as simulating the potential impact of future strategies. Successful strategies may also be shared across the organisation [52] [9]. Another important aspect pointed out in the scenario is the personalization of information based on the user. Joanne, does get an alert on her smartphone (as Edith also did in the previous scene) but the information presented to her is rather general than the specific options presented to Edith.

Scene 5: Blue Partner meeting
The scene is pointing out the social networking aspect of the platform from another perspective. Users / groups and other entities can collaborate and choose to share information amongst given that they have respective agreements. The formation of communities can be done quite easily within the platform with the creation of groups and the participation in that of other groups or individual users. The exchange of information within a community is strictly about information at the level of participating groups and only after agreement of individual users or smaller groups more detailed information can be shared. Water data can then be shared [9] securely between users or organisations using the WIP secure data transfer network, backed by standard data encryption protocols [48].

Scene 6: Blue label
Once again another instance of the leader board functionality is presented within a higher level of operation. The principles of operation remain the same with participating entities agreeing to share specific data and specific metrics identified as the ones that will determine the ranking. This time the leader board is operated by the Water Footprint Organisation and the rewards have a more official character than the rewards at the school and company level. Companies may receive rewards [18] for good performance in water conservation and efficiency. These may be publicised using social media, and used as a badge of merit for the company in the context of corporate social responsibility (CSR) and public brand image.

Scene 7: Energy saving
By linking water and energy-use data in the water information system, it is possible to identify flow signatures [40] and energy signatures [41] associated with water-consuming devices. By using a combination of these data sources, it is possible to perform this identification with a higher degree of confidence. By linking peak energy usage times [21] with equipment information, it may be possible to reduce peak load, thus making significant savings in commercial energy-use tariffs (which are generally based primarily on peak load patterns).

The platform can be used to produce a variety of reports over time and identify patterns of lower or higher consumption within specific periods. Once a pattern is recognised it is displayed on relevant dashboards along with a notification of the detection of that pattern. Users can also initialized this pattern discovery process by selecting specific locations, sensors and intervals they want to investigate and respective reports are produced. Even patterns are not identified within the specific interval the users can setup "watchers" on them so that they are followed by the system in the future. This is how Jim's team was able to notice the peaks of water consumption in the specific product lines that required more water than others.

3.4 Scenario 3: Municipalities

This scenario describes how the WATERNOMICS water information system (WIS) may be utilised by water utility companies or municipalities. The transmission and supply of water in large regional networks is a complex task, often involving aging infrastructure, deteriorating equipment and sub-optimal network configuration. By leveraging the analytical power of the WIS, it is possible for utilities to better manage their existing infrastructure, and identify improvement opportunities.

3.4.1 Scenario Description

Scene 1: Water monitoring
Nicholaos is the network manager for a large municipal water distribution network in Greece. Much of the water infrastructure under his management is aging, and shows signs of deterioration. However, capital funding is limited so Nicholaos needs to continuously monitor the existing network to ensure safe secure supply to network consumers at all times. On arrival at work on Monday morning, Nicholaos notes that there was a 14% increase in typical weekend water consumption. An on-screen alert identifies the affected region.

Scene 2: Fault detection and diagnosis
Nicholaos immediately runs a diagnostic on the network and is able to isolate the fault to a 90m section of mains pipe in the North-west quadrant of the city, based on an abnormal energy-use signal from the pumping equipment in that section of the network. He uses the WATERNOMICS platform to send out a notification to customers on the affected section of the network to inform them of possible disruption to their supply in the following hours. He also notifies technical personnel with a work order to respond to the affected area.

Scene 3: Remote control
From the office, Nicholaos is able to remotely switch off supply to the affected region by closing the supply valves to that section of the network and switching off power to the pumping equipment to remove risk to operatives working in the area.

Scene 4: Leak Detection
Michael and Andreas are the technical operatives who receive the work order to respond to the affected region. There is no obvious damage visible during a routine surface examination of the area, as may sometimes be caused during construction works in the area. Therefore, they conclude that the fault probably lies with the pipe itself, which is currently 70 years old and has exhibited multiple fractures over the past 10 years. Michael opens the access point to the network branch and sets up the acoustic leak detection sensors. Using automated signal analysis techniques, they are able to isolate the leak to a 2m section of the pipe approximately 40m downstream. They immediately alert the repair team to perform the required repairs at the specified co-ordinates. They inform Nicholaos of the successful completion of their work order.

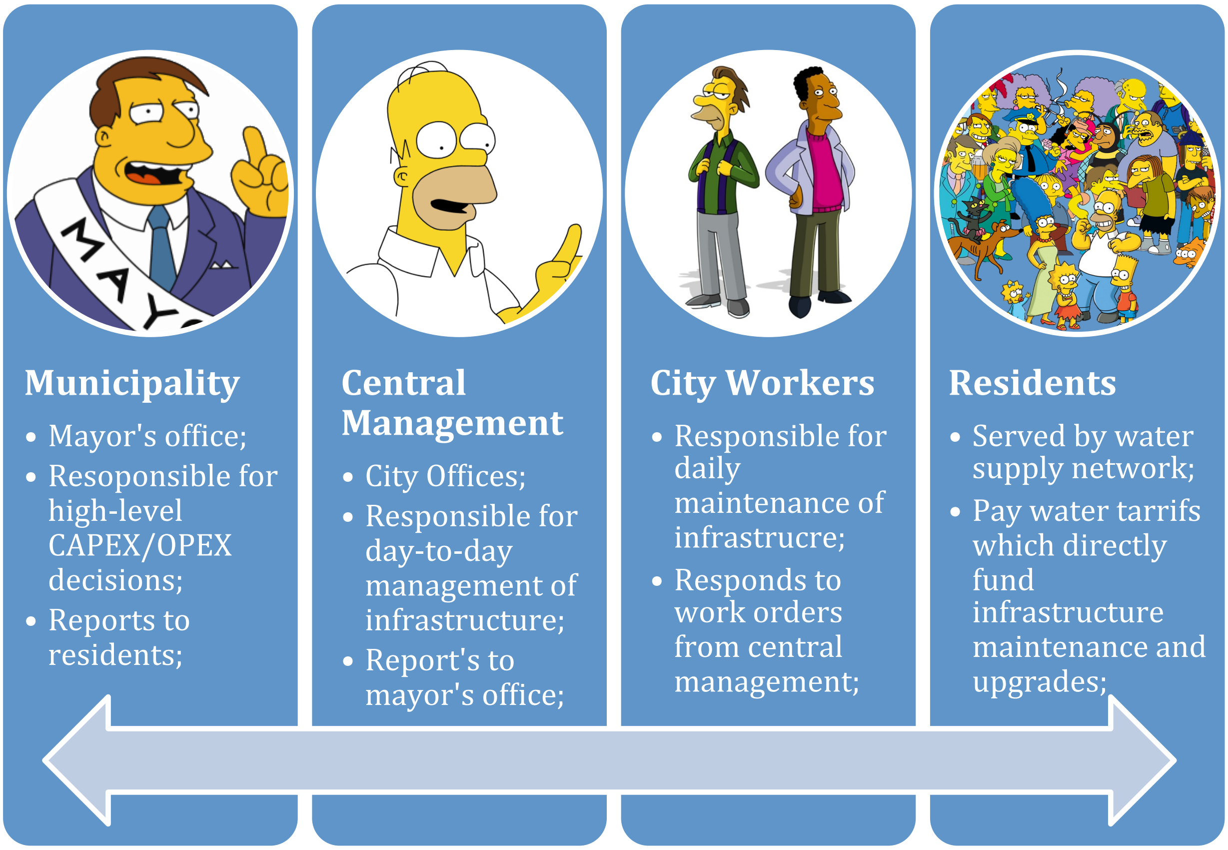
Scene 5: Economic analysis
Once the repairs team have finished their work, Nicholaos is able to remotely restore power and water supply to the affected region. However, based on historic event data he is concerned that this problem has been occurring more frequently recently, particularly in the older NW quadrant of the city. He decides to run an analysis of the CAPEX cost of replacing the oldest sections (>70 years) of pipe vs. the increased OPEX cost associated with the frequent repairs required to maintain the aging network. He is able to determine that the CAPEX cost of replacement will be

offset by the reduced maintenance cost within just 6 years. Based on this analysis, he applies to the Dimitris in the city office for funding to carry out the work.

Scene 6: Pricing mechanisms
Dmitris is concerned that the city will not be able to afford the capital cost of such a large project under the current financial conditions. Therefore, he decides to explore alternative pricing mechanisms for consumers, adjusting peak rates for large commercial consumers and changing the volumetric usage bands for domestic supply. While maintaining pricing structures within a 10% band of existing costs for most consumers, Dimitris is able to find a solution which will allow the works to be carried out with limited financial impact on consumers. He is able to justify the cost with the increased reliability and quality of supply following completion of the works – reducing current annual disruptions from 3 to just 1 for average households.

Scene 7: Drought prediction
Back in the utility office, Nicholaos is notified of his successful application and planning for the major upgrade project. He is also conscious of the fact that Greece is due a period of particularly dry weather in the comings months, and wants to avoid any potential impact to supply during severe drought periods. By analysing historic water usage patterns, in combination with weather data from the local meteorological office, he is able to determine that the weeks of June 11-18 and August 14-21 are particularly high-risk. Therefore, he decides to arrange for works to be carried out outside of these periods, and issues an Orange water conservation alert to households for those dates. While this alert is in effect, households will be subject to a 10% premium on their water price.

3.4.2 Business Context



In this scenario, there are a number of different actors that benefit from the WATERNOMICS water information system (WIS):

Firstly, at the municipal level, the **Mayor's Office** (Dimitris) needs to access relevant water data and financial metrics in order to effectively budget for capital and operating expenditure. Much of the analysis of this data may be performed by central management in order to present a clearer picture to city officials.

Next in the value chain is the **Central Management** (Nicholaos). This office is responsible for the routine maintenance of the regional water infrastructure. The WATERNOMICS platform provides the data needed to carry out this work, as well as the facility to perform analysis, fault detection, leak detection and operational optimisation. This allows the central office to respond quickly and effectively to problems as they arise, and issue work orders to the relevant personnel.

The **City Workers** (Michael and Andreas) respond to work orders received from central management through the WATERNOMICS platform. The platform is also pivotal to their daily routine, allowing for remote checking of status on various nodes in the water distribution network (flow, pressure etc.) as well as the ability to remotely configure this equipment in the event of a fault.

Finally, the **Residents** benefit from the WATERNOMICS platform due to the ability for it to help deliver a safer, more reliable water supply. They also can benefit from more flexible water tariffing which allows for a fairer distribution of the financial burden of maintenance and upgrades in an ageing water infrastructure. It also helps to provide transparency over the decisions of their elected officials.

3.4.3 Technical context

Here we describe the relation between this scenario and the technology and potential technological innovations.

Scene 1: Water monitoring
Live data [17] collected from sensor points and nodes on the water distribution network allows managers to continuously monitor [2] the status of the water distribution network. On-screen colour-coded alerts [47] are used to indicate the presence and severity of faults / anomalies [4] [6] [21] in the system.

Scene 2: Fault detection and diagnosis
Sensor-level alarms [6] may be used to indicate faults on any single component in the system due to anomalous performance (e.g. pressure > Baseline+20%). Notifications of this fault may then be sent automatically to relevant personnel via standard communication channels (E-mail, SMS, PUSH notifications, social media etc.) along with the severity status (Yellow, Orange, Red).

Scene 3: Remote control
Remote telemetry [7] and control [36] allows pumps and valves to be configured and/or switched off remotely.

Scene 4: Leak Detection
Work orders may be send to operatives in the field via the WATERNOMICS platform. Operatives may then respond to the work orders with notes, attachments or requests for

additional information. In the event of a leak, novel acoustic leak detection sensors are used to locate the position of suspected leaks I branches of the water distribution network.

Scene 5: Economic analysis
Using historic data [53] combined with physical and economic data for the water distribution network, it is possible to perform details analysis of different strategies for operation, maintenance or upgrades. For example, the replacement cost of network sections is fixed (labour + materials) while the operating expenditure offset due to upgrades (labour + network disruption) is a function of probability which needs to be analysed in order to make informed decisions on capital expenditure.

Scene 6: Pricing mechanisms
Using past data [53] along with usage pattern data for domestic and commercial consumers, it is also possible to investigate the impact of flexible tariff options and different pricing structures [37]

Scene 7: Drought prediction
Weather data and usage pattern data may be combined in order to provide a more accurate prediction of water availability [1] and possible periods of expected drought [35]

4 Business Strategies

This chapter describes the strategic options for a Waternomics Water Information Platform. The strategic options are based on the results of market consultation and desk research from which the results are described in paragraph 0.

4.1 Waternomics strategic options

From a business model perspective, the Waternomics Water Information Platform can be either positioned as a key resource that enables specific products or services or as a value proposition in itself. For the description and visualisation of a business model, the Business Model Canvas from Osterwalder is used. Figure 10 shows the nine building blocks of the Business Model Canvas.

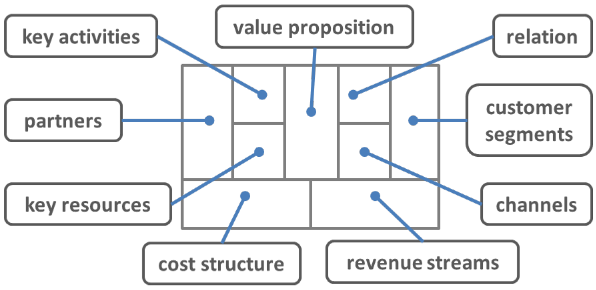


Figure 7: Business Model Canvas

Before a viable business option for this platform can be selected, a rich set of options need to be created. In order to do so, various value proposition – customer segment combinations have been developed which are enabled by the Waternomics Water Information Platform.

For the description of the various options, the Value Proposition Canvas (VP-Canvas) from Osterwalder is used. The VP-Canvas focusses on two elements of the Business Model Canvas, namely 'Value Proposition' and 'Customer Segment'. The VP-Canvas links customer needs explicitly to the value proposition and allows more detailed analysis of their relation and fit.

The VP-Canvas focusses on three drivers in a customer segment, being:

1. What is the job the customer is trying to be done?
2. What are the customer's pains, e.g. what gives him a headache?
3. What are the customer's gains, e.g. what makes him happy?

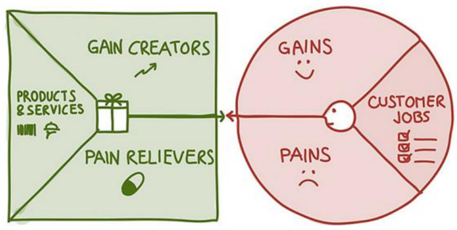


Figure 8 - Value Proposition Canvas

The value proposition should address these three drivers in order to be of interest or the customer.

For each of the Waternomics' target groups, a set of strategic options has been developed. The options are structured in tables, representing the elements of the VP-Canvas. To limit the number of options, differences in geographical locations of customer segments have not been considered. The focus has been on the variations in customer's needs and fears for the different types of customer segments since these variations have a large impact the way a Water Information Platform is designed and presented to a customer.

It is important to note that at this stage every strategic option is based on assumptions about customer's drivers, needs and fears. Development of the Water Information Platform in an incremental way and validating these assumptions in the process, is key for a successful market introduction of the Water Information Platform.

4.2 Value Propositions

This section introduces the business value propositions for each of the target users:

- Corporate users
- Municipalities
- Domestic users

4.2.1 Corporate users

Value Proposition	Water Host		Hotels	Customer Segment
Product/service	Water dashboard. Alerts on abnormal water usage per room. Non-intrusive anonymous feedback to guests.	← --- →	Accommodate travellers	Job to be done
Pain reliever	Offered as a service. Early warning on increased water usage.		Higher costs	Fears
Gain creator	Results link to sustainability index		Improved reputation	Gains

Value Proposition	Water Management Centre		Airports	Customer Segment
Product/service	Water dashboard. Overview and analysis per logical unit (store, department…)	← --- →	Facilitate passengers and airliners	Job to be done
Pain reliever	Transparency of water usage		Reputational damage	Fears
Gain creator	Ability to charge large-scale consumers. Early leakage detection.		Lower costs	Gains

Value Proposition	Sustainable Factory System		Factories (light water users)	Customer Segment
Product/service	Combined monitoring of water and energy usage per production		Produce goods	Job to be done

	line.			
Pain reliever	Early warnings on leakages or low availability of water	← --- →	Decreased production capacity	Fears
Gain creator	Combined water usage information per product over value chain		Improved sustainability	Gains

Value Proposition	Virtual building		Owners office buildings	Customer Segment
Product/service	Building water and energy management		Rent office space	Job to be done
Pain reliever	Predictable and lower water and energy costs	← --- →	Empty offices	Fears
Gain creator	Water information service and game for building inhabitants		Sustainable reputation	Gains

Value Proposition	Water4Care		Health practices (dentist, doctor, physiotherapist)	Customer Segment
Product/service	Water monitoring and leakage detection system		Provide medical care	Job to be done
Pain reliever	Controlled water quality	← --- →	Health security incidents	Fears
Gain creator	Controlled water usage		Reduced costs	Gains

Value Proposition	Shared Water Info System		Owners of multiple user buildings (hospitals, shopping malls)	Customer Segment
Product/service	Multi-user water information system, showing individual and shared usage.		Rent space and coordinate co-user ship	Job to be done
Pain reliever	Identification of large-scale consumers and early leakage detection	← --- →	Flaws in service delivery	Fears
Gain creator	Transparent information of individual and shared		Less complaints from users	Gains

	water usage			

4.2.2 Municipalities

Value Proposition	Open Water Assistant		Municipalities with public buildings (schools, libraries)	Customer Segment
Product/service	Collect and display water usage information. Provides tips and feedback on water measures.	← --- →	Provide public services	Job to be done
Pain reliever	Water management as a service. Insight in savings on water and energy.		Higher costs	Fears
Gain creator	Water usage information used for information and educational purposes		Increased environmental awareness	Gains

Value Proposition	Water Partner Dashboard		Municipalities with outsourced water services	Customer Segment
Product/service	Water Management Dashboard, showing KPI's water company	← --- →	Manage the partner water company	Job to be done
Pain reliever	Provide detailed information about network and leakages		Partner does not invest in infrastructure	Fears
Gain creator	Provide insight in operational costs		Reduced price of water	Gains

Value Proposition	Mini Water Management System		Small municipalities with own water utility	Customer Segment
Product/service	Modular water management system	← --- →	Provide sufficient and safe water to citizens	Job to be done
Pain reliever	Standard modules for basic functionality at low costs		High costs	Fears
Gain creator	Standardised interfaces to systems of other utilities		Sharing costs and infrastructure	Gains

Value Proposition	Maxi Water Management System		Large municipalities with own water utility	Customer Segment
Product/service	Complete water management system including analysis, prediction and optimisation modules	← --- →	Provide sufficient and safe water to citizens	Job to be done
Pain reliever	Offered as a service, price per customer		High costs	Fears
Gain creator	Subset of services, billing, planning, can be offered to other utilities		Additional revenues	Gains

4.2.3 Domestic users

Value Proposition	Where's Our Water Platform		Environmental aware families owning a house	Customer Segment
Product/service	Information about water availability, water saving measures and their effects in real time	← --- →	Reduce environmental footprint and influence friends and family to be more eco-friendly	Job to be done
Pain reliever	Real-time water information		Not be taken seriously	Fears
Gain creator	Quantified measures and effects		Show impact of ecological measures	Gains

Value Proposition	Sustainable Home Monitor		Concerned consumers owning a detached house	Customer Segment
Product/service	Home water and energy management system		Reduce water and energy usage around the house	Job to be done
Pain reliever	In-home display showing water and energy savings	← --- →	Bad reputation	Fears
Gain creator	In-home display showing water and energy savings		Reduced costs	Gains
Value	Home water saver plug-in		Ignorant consumers	Customer

Proposition				Segment
Product/service	Installation of automated water saving measures	← --- →	Want to take pro-environment measures but are not pro-active	Job to be done
Pain reliever	Installation by experts, fixed price		It will cost time and money	Fears
Gain creator	Display of saved water and costs		Improved self-esteem	Gains

Value Proposition	Water break down unit		Single households living in attached multiple units	Customer Segment
Product/service	Break down overview of water usage		Get a grip on personal water and energy usage	Job to be done
Pain reliever	Display of single unit and aggregated total usage and costs of water	← --- →	Paying for other units	Fears
Gain creator	Display of results of water saving measures on single unit level		Reduced costs	Gains

4.3 Strategic analysis of Waternomics target markets

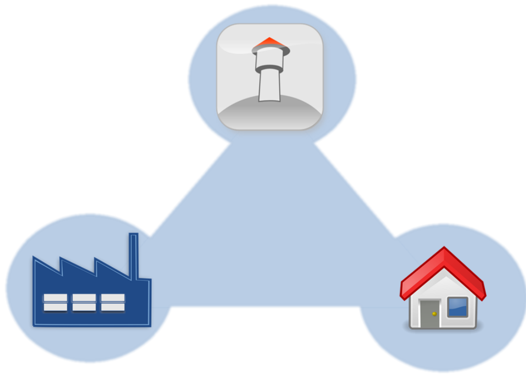


Figure 9 - Waternomics target groups

To gain understanding about the current needs, barriers and opportunities with respect to water information systems, a market consultation and desk research have been executed in multiple European countries. Through interviews with practitioners and policy makers, two roundtable sessions and the study of publications and reports, business configurations and drivers have been investigated from the perspective of three different target groups, being municipalities, corporate users and domestic users. For a better understanding of the impact of our findings, Osterwalders Business Model Canvas is used for displaying the elements of the target group business model who are most affected by water management.

The results of the interviews, workshops and desk research have been fed back into the project as recommendations for the architectural team and as features in the scenarios described in the previous chapter. The following paragraphs describe the results for each of the target groups in more detail.

4.3.1 Corporate users

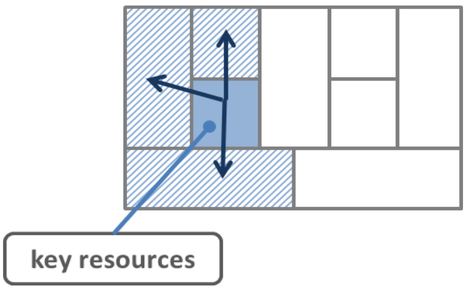


Figure 10: Business Model Canvas

Every industry needs water, whether it is in the core process for the preparation of food or heating and cooling, or in the facilitating processes like cleaning and sanitation. But some industries are more depended on water than others. From a business model perspective, water and a water information system are positioned in the building block "Key Resources". The importance of water within an industry and the way water management is implemented, impacts the cost structure, key activities and key partners of a business' business model.

Differences in attitude towards management is also reflected in the way various businesses execute water management. Differences have been found in the following areas:

- Water management as a key activity
- Monitoring water usage
- Publishing water usage information
- Innovation strategy

The next paragraphs describe our findings for each of these areas.

4.3.1.1 Water management as a key activity

Roughly we can identify two kinds of businesses: those who consider the management of water as a key activity of their business and those who rely on external partners for the delivery and quality of the water used in their business.

As an example, interviews and desk research of two major food companies, Mars and Aviko, show interesting similarities and differences with respect to water management. Both companies are leading in their sector and have factories in the Netherlands and across Europe. The following table gives an overview of the characteristics of both companies.

	Mars (Chocolate)	Aviko
Product	Candy bars	Potato products
Litres water per ton product	466 (2012)	Unknown (water usage for one ton French fries = 1,040,000 litres[1])
Target water reduction	25% reduction in 2015, baseline 2007. Reduction 2007-2012 = 18%	Unknown, 17% reduction in the past 5 years
Water sources	90% drinking water, 10% surface water for cooling	75% ground water, 25% drinking water
Main water usage	Steam production, cooling towers	Production process (blanching, transport), steam production, cooling towers
Metering level	Entry and exit meters + meters on major water usage systems	Fully metered factory
Certification	ISO-14001:2004	ISO-14001:2004

Table 4-A Comparison of water management in two major food companies

Striking is the difference in needed water for the production of their products. This has resulted in a different business model with respect to water management, water extraction and water treatment. Where Mars obtains almost all of its water from an external water provider, Aviko has installed their own water facilities, extracting ground water from local wells. Also the water usage monitoring process show differences. Aviko has installed automatic telemonitoring of water usage in every part of their production process which enables them to respond directly to abnormalities in their water usage. Mars measures water usage not in real-time and at a less detailed level, being at the entry and exit of the factory and upon installations consuming large quantities of water, like cooling installations.

When water management is considered a key activity, as in the case of Aviko, businesses expect to gain competitive advantage in controlling and managing their complete water system. These advantages can be of a strategic nature, having exclusive access to scarce water sources, or operational, being able to produce in the most efficient and cost effective way. To establish an autonomous water system, investments in systems for water extraction, treatment, distribution and quality control have to be made, which effects the cost structure of a business.

When water is not a differentiating element in one's business model, the management of water can be delegated to third parties. Especially SME's who use small quantities of water rely on their water provider to deliver water and manage the quality, measurement and distribution of their water. Water companies often offer additional services like alerts when abnormalities in their usage pattern are being detected or information on water saving measures.

[1] Source: Water Footprint Network, Virtual Water and Comprehensive Assessment of Water Management in Agriculture.

4.3.1.2 Monitoring water usage

Water usage can be measured at multiple levels. Looking at the aviation industry, water usage is typically measured as unit per passenger. In the food industry water is measured as unit per ton product produced. This approach makes it possible to compare water usage of different companies within an industry domain. For example, the performances of various airports in Europe regarding drink water usage are easy to compare, as shown in table xx. Unfortunately, not all companies report about their water consumption. From the three investigated railway companies, DB, Thalys and NS, none of them published water consumption figures, making it impossible to compare across various transport industries.

Airport	Movements	Passengers	Water consumption (m3)	Water usage per passenger (m3/pax)
Frankfurt Airport City	472,692	58,036,948	783,498	0.0135
Amsterdam Airport Schiphol	425,565	52,569,000	714,938	0.0136
Aeroporti di Roma	351,000	41,021,000	2,056,964	0.0501
Milano Malpensa airport	170,747	18,329,205	2,440,218	0.1331
Athens International Airport	140,448	12,536,057	544,000	0.0420
Milano Linate airport	96,186	9,175,619	2,032,589	0.2200
Eindhoven Airport	26,508	3,397,000	20,800	0.0061

Table 4-B: Comparison of water consumption of various European airports

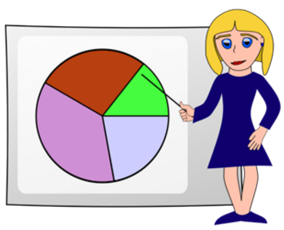
Also the granularity of water measurements differs across industries. Every business measures its water consumption on a company level but not all companies differentiate between different departments or usages. The “logical units” of measurement differ per company. In factories water consumption is measured per production plant, production line or on machine level. In a theme park water usage is measured on or on the level of individual attractions. Each industry can define its own set of logical units but the units should be on such a scale that it provides useful information for the definition and selection of water saving measures.

At Mars, product quality is managed on a value stream level, where a value stream spans the incoming of the raw materials until the packaging department where the finished products are being packed, for a single product. Through various KPI’s for product quality and process efficiency the complete production process is being monitored. In line with Lean manufacturing guidelines, the responsible production shifts can make improvements in the production process and discuss results and deviations with the other shifts. Currently there are no KPI’s for energy and water usage defined on value stream level but there are plans to start experiments with water and energy reduction on value stream level. In this case the logical unit is a value stream.

Water usage is measured at different time intervals, ranging from once a year in the case of the family hotel to real-time in the case of Aviko. Due to the low price of water, especially compared to the price of energy, and the lack of environmental damage in the case of leakages, the interviewed SME’s declared that checking water consumption patterns once a year is enough. Only leakages that are detected by visual inspection or which disturb operations are repaired immediately.

4.3.1.3 Publication of water usage information

The different stakeholders in a corporate setting all have different needs and uses with respect to corporate water usage information. These different needs affect the way information is presented, the moment information is presented and the context information that is combined with the water usage information to come to actionable information. The following table provides an overview of the most common stakeholders and their needs.

 Maintenance staff /operator	Maintenance staff needs information about water related incidents in real time and presented at the location they are currently working. For staff with a fixed working place information can be presented on a computer or fixed display. For staff who work at different locations or in wide areas, information can be presented on mobile devices such as mobile phones, tablets or portable readers, as separate applications or embedded in existing dashboard applications. Requirement is that the information is actionable, meaning providing information about location and urgency of the incident.
 Operational management	Operational management needs information about performance indicators for water. In industry domains where water is part of the core process this information should be presented in real time so that actions can be taken if water related KPI's cross predefined thresholds. In less water consuming industry domains, aggregated water related information can be published on a daily, weekly or monthly basis in order to identify trends in water usage. Real-time information on water related incidents, e.g. leakages, should be presented to enable immediate action. Water usage data should be combined with operational context data to come to meaningful information. For example, when water usage in a hotel suddenly increases it might be caused by a leakage or by an increased occupation level. Only in the first case, an alarm is needed.
 Senior management	Senior management needs aggregated water usage information together with bench-mark data and market data in order to make decisions on corporate water strategy, for corporate water risk management and for reporting to shareholders and other external stakeholders. On a corporate level, water risk management is not only about reducing water usage but also about issues like water pricing, water availability, policies, regulation, water usage in the supply chain, water quality and reputation. To create actionable information, corporate water usage data should be combined with business context data.
 Staff / guests / customers	To inform the actual consumers of water about their consumption pattern, water usage information should be presented in a non-intrusive personalised way. In the case of guests or customers, water usage information might be made available upon request only in order to serve the needs of environmental aware people and not alienating customers who care less about their water usage. Gamification techniques can be used to inform certain customer groups, like children or staff, about their water usage. In any case, immediate feedback should be provided about the results of water saving measures

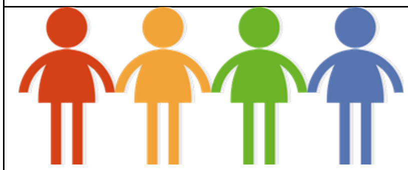
	taken by staff and customers.
 External stakeholders	External stakeholders such as local citizens, investors, business partners, policy makers or environmentalists, have a need for corporate water usage information to determine if their interests are being threatened. Providing them that information might help companies to get in a cooperative mode with their stakeholders and improve understanding of shared interests. As part of their risk assessment, investors will want to know the water related risks for a specific company or industry. By publishing corporate water usage information in the form of sustainability reports or as open data, external stakeholders can decide on actions to take or be involved in the further development of the corporate water strategy.

Table 4-C: Overview of stakeholder needs for corporate water information

4.3.1.4 Innovation strategy

Companies with multiple production plants in different countries tend to have a dual approach for trying out new water saving measures.

Generic innovations: One factory typically serves as a flagship factory where all new technologies and measures are being tested before, if the results are positive, they are being deployed to the other factories. This mostly involves innovations in the core production process since circumstances for production lines are similar in the various production plants.

Local innovations: For location dependent innovations, each time a business case is set-up to determine for which location the impact would be the highest.

The companies interviewed consider a pay-back time of five years or less appropriate for investments made in water saving products or measures. An exception is made for projects which fall under a sustainability program. In the case of Mars, the expected pay-back time may increase up until 50 years.

Another outcome of the interviews is that companies who use large quantities of water often have their water management at a high level. Instead of trying to gain small improvements in an already well performing water management system, they put their efforts at other parts of the supply chain where investments in innovations have a higher impact on the water footprint of their end products. So is Aviko investing in research for less water intensive potato cultivation techniques?

Companies who are less water intensive seem to have a more passive innovation policy for water consumption reducing activities. They include measures for water reduction in their regular maintenance activities.

Based on the importance of water within an industry and the maturity of the existing water information system (WIS), we can distinguish four different types of approaches companies use with respect to innovation in corporate water management. The four different approaches are:

Basic WIS: Companies with no or minimal water information system and where water is a minor resource are mainly interested in being informed when abnormalities in their water consumption occur. Since the costs of water for these kind of companies is typically very low, no large investments in water information systems will be made.

Integrated WIS: Companies for which water is not a key resource but who do have a more sophisticated water information system available focus on combining different resource management systems, such as energy management, water management or management of raw materials.

Optimised WIS: Companies for who water is a key resource but who lack a mature water management system, the focus is on establishing a water information system in their corporate environment. This means adding more sensors and meters to get more detailed information about the water consumption of individual parts of their production process.

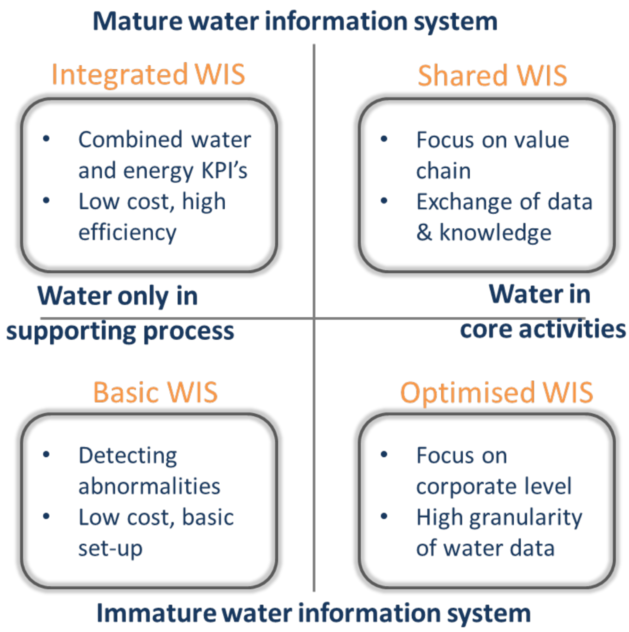


Figure 11: Innovation approaches

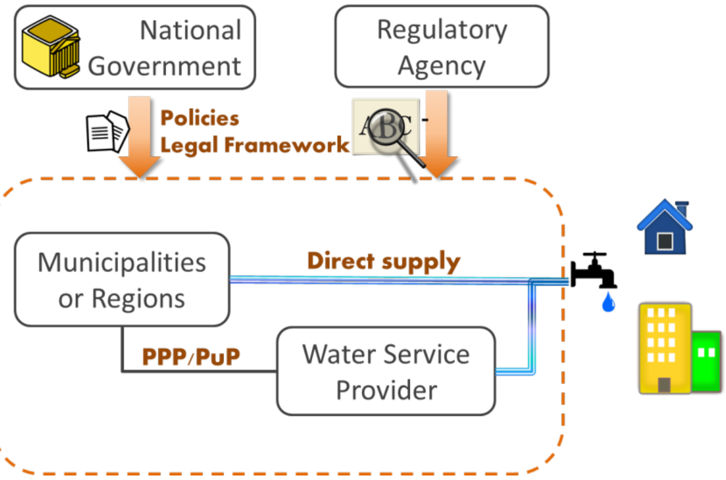
Shared WIS: Companies for who water is a key resource and already have a mature water information system, focus on improving water management in other parts of the supply chain. They take a leading role in water consumption related innovations and work closely together with partners from the supply chain.

4.3.2 Municipalities

Municipalities have the obligation to ensure that their citizens have access to sufficient water of good quality. Municipalities can either choose, within their national legal framework, to either manage their own water provisioning or subcontract it to a third, mostly commercial, party. In this paragraph we look into the pros and cons of privatisation of water utilities, investigate the various pricing structures used by European water utilities and take a closer look at how utilities ensure accessibility of water also for the economic weaker citizens.

4.3.2.1 Public or private water utilities

From an economic point of view there is scarcity and demand for water, so there can be a profitable market for water services. Most water services are provided by public utilities. Historically, the reason for this institutional setup is that water is considered as a necessity, which must be provided by the public sector. The privatisation trend that started in the late seventies has also affected the water sector. In some countries, like France and UK, private companies deliver water services. Two main forms of privatisation can be distinguished:

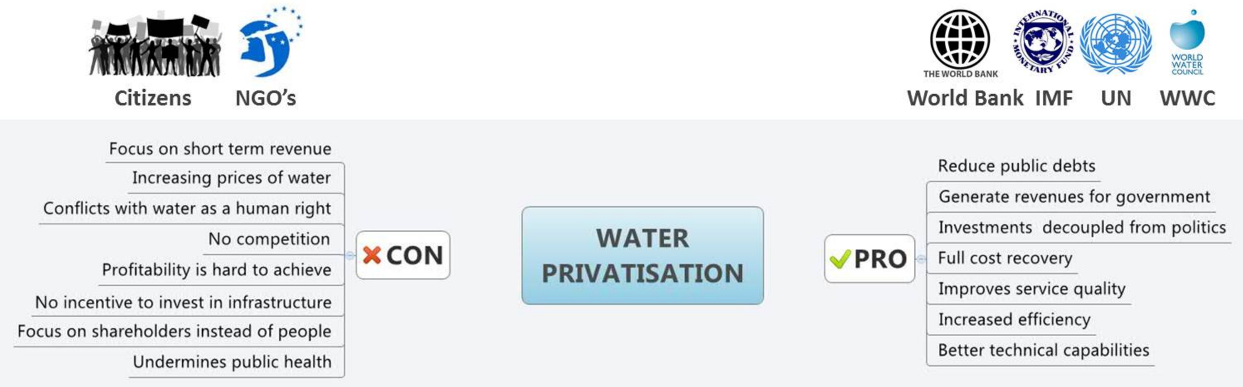


- Privatising water resources, services and operations
- Public water resources and privatised services and operations

Most private water companies work through concession contracts.

4.3.2.2 Privatisation of water utilities

Organisations like IMF, the World Bank, WWC and parts of the UN are in favour of privatisation of public services, and view it as a necessary step to both fixing public finances and increasing productive efficiency. Thus, privatisation of public services, including water, is often set as a requirement for getting a (conditional) loan to countries with macroeconomic imbalances.
Opponents of privatisation are concerned citizens, NGOs, political parties and environmentalists who claim that privatisation will increase prices, increase poverty and exclude people from access to clean drinking water.



In Europe there are recent signs of a trend to re-municipalising water services as private contracts expire, following the examples of Paris and Berlin. Major private water companies like Veolia and Suez are repositioning and focusing on long-term outsourcing contracts of functions like billing, operations management, treatment or desalination by public sector water companies.
There are examples of excellent managed public as well as private water companies, making it impossible to define one unifying model. Performance also depends on local conditions such as

the strength of a nation's government and the legal framework in which water companies operate.

4.3.2.3 Utility segmentation

Utilities range in size and level of technological capabilities. Merging municipalities causes more work to integrate different systems and investments to make sure that all involved locations are at the same technological level. Here the basic infrastructure needs to be set-up first.
Larger utilities have more resources and the economies of scale to implement a telemetric system and integrate the various IT systems, like Skada, GIS and ERP systems.

4.3.2.4 Pricing structures

Of course, establishing the rational, "right" price for water is important for consumers as well as for water companies. The price should be based on supply costs, willingness to pay on the demand side, but should also take care of equity concerns, i.e. it should not be a barrier for lower income consumers to accessing water. There is large variation in water prices across European countries, as they range from €0,40 per m³ (Italy) to over €6,- per m³ (Denmark & Germany).

In Europe a variety of pricing structures are in place for water. Most European water companies use a combination of fixed fee with volumetric pricing. The table below shows an overview of the most commonly used pricing mechanisms.

Price mechanism	Description	Metering required	Stimulates conservation
Free	No fee for water services	No	No
Fixed fee	Single fee regardless water use	No	No
Volumetric pricing	Constant per unit price	Yes	Yes
Decreasing block tariffs	Lower unit rates of succeeding blocks of usage	Yes	No
Increasing block tariffs	Higher unit rates of succeeding blocks of usage	Yes	Yes
Adjusted increasing block tariffs	Variable block of usage size or varying volumetric rates per block of usage	Yes	Yes
Seasonal rates	Peak rates in fixed time periods	Yes	Yes
Drought rates	Peak rates in dry periods	Yes	Yes
Collective rate	Rate based on average usage in group of users, e.g. block of apartments	Yes	No
Zonal rates	Rates based on regional availability of water	If combined with volumetric pricing	No
User class differentiation	Rates based on characteristics of user, (domestic/industrial)	If combined with volumetric pricing	No

4.3.2.5 A fair water price

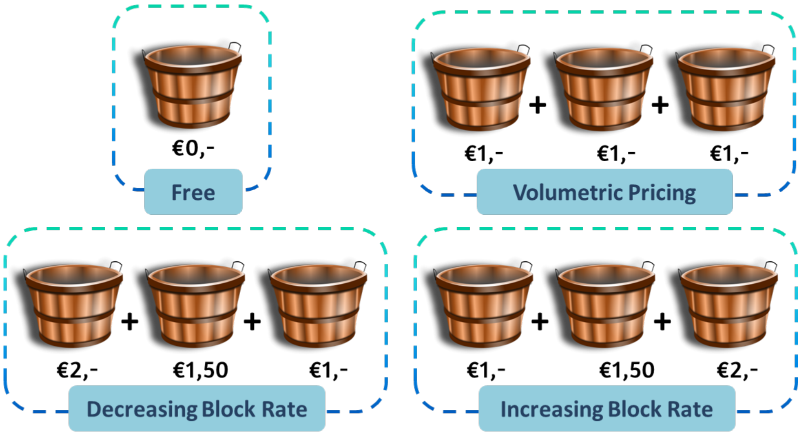


Figure 12: Various water pricing options

Water companies face a tricky dilemma. Their cost structure shows that 75% of their costs are fixed, mainly because of the infrastructure, and only 25% is variable. When water saving programs are successful, water companies need to increase the water unit price to in order to recover all their costs. However if prices are raised as less water is consumed this can negatively impact conservation efforts and the incentive for users to save water. Price setting is also a challenge in rural areas where municipalities act as water suppliers. In stakeholder workshops with rural municipality leaders it was cited repeatedly that citizens repeatedly rejected over time any proposition to increase water prices and that efforts to do so were politically damaging. In such cases, municipalities lose money on their water operations and recover those costs through other revenue generation (or financing) measures.

Other aspects that need to be taken into account when determining the water unit price are the service levels of the water company, what do customers get for their money in terms of quality, education, source of water and availability, and the operational efficiency of the water company, should the customers pay for badly managed companies. In other terms both supply and demand side factors must be taken into account.

The EC promotes full cost recovery for setting the price of water. Full cost recovery might not always be feasible, especially in thinly populated areas. It is also unclear which costs should be taken into account, like environmental costs or resource costs. To ensure universal access to water, most governments subsidise water companies. Question is how to prevent the badly managed companies from getting more subsidies than better managed ones. Subsidies also distort the price effect for reducing water consumption, since they hide the real total cost of water for users.

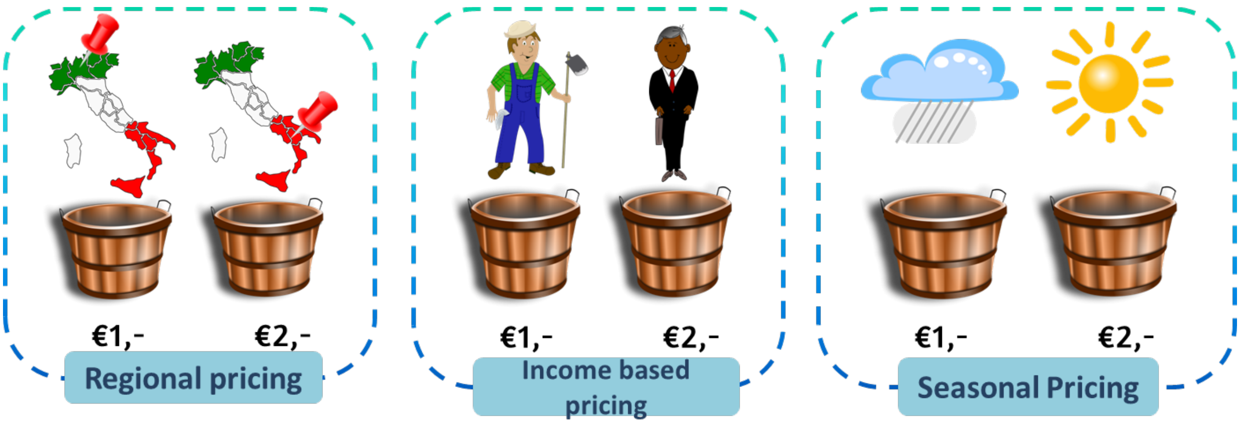


Figure 13: Geographical and socio-economic water pricing options

4.3.2.6 Pricing structures from the energy market

Both the theoretical and empirical literature on public utilities and regulation have been more focused on the energy market, especially the electricity market. It is also the case that the energy market has two pricing mechanisms that are not used in the water sector:

1. Flexible tariffs (Electricity market): Different prices for different times of the day, depending on the availability of electricity.
2. Fixed term tariff (Gas market): Fixed unit price for a longer period of time, e.g. 2-3 years.

The most important difference with energy is that water is a storable commodity, which dampens fluctuations in supply and demand. Fluctuations, especially in availability of water, show a strong seasonal component, and therefore, water prices will most likely change over weeks instead of in real-time.

Most utilities target for full cost recovery. Prices can only be increased in a limited fashion, so that measures are taken on the cost side, such as staff reduction or postponed maintenance.

4.3.2.7 Accessibility to water

Water is often relatively cheap. Governments want their citizens to have access to drinking water since water is one of the basic needs. To keep it affordable various mechanisms exist. In Belgium every individual has the right to 15 m^3 of drinking water per year at no charge. In Thermi the first 35 m^3 are charged at a low rate, with higher rates for households that use more water (increasing block tariff). Household customers are split in single person households and families. This is done on a statistical basis since it is not known exactly how many persons live in a specific house or building. Low income households can get a 50% discount on the first 35 m^3 of their water bill.

Charges for wastewater treatment are based on the usage of drinking. E.g. assumption is that 70% of the obtained drinking water is wastewater. This algorithm does not take into account re-use of water and collection of rain water.

One utility reported after installing smart water meters that they were able to detect football matches and earthquakes. In both cases many people use the toilet at the same time.

Information about availability and quality of water should be presented in an unambiguous way to customers to avoid panic. Direct publication of water quality data might show fluctuations in the level of water quality at the water basin that does not affect water quality at customers' dwellings but could cause people to stop using the water and make (unnecessary) calls to the utilities.

During long dry periods the Athens government published water availability information in the form of "we have water for x days". This seemed to work well and was well received by the public.

People expect a constant, and high, pressure level on their taps. When the pressure level drops, people start to make calls to the utilities service centre. So energy saving measures resulting in pressure drops should consider this effect.

The period of time between the detection of an abnormality in water usage of a customer and the reporting of it to the customer herself is too long when linked to the water bill. There is a need for an early warning system for customers so they can act immediately when water usage increases unexpectedly.

4.3.2.8 Technological infrastructure

Measurements at the customers place are done on a 2-4 monthly basis. In Greece, maintenance staff visits the households and use a handheld device with RFID to read-out the meter. In Thermi, this device has access to the water usage history of the customer and when it detects abnormalities in the usage, the employee can immediately discuss with the customer the changes in usage.

Utilities are not only interested in average usage but also in expected peak usage on an hourly basis. This is useful for efficiently dimensioning of the water network. Levels of water sources are being monitored in real-time. Sometimes, in drills, measurements are not reliable because of defects or inaccuracies in the used sensors.

One utility set-up a pilot with 150 smart water meters to validate the technological aspects of the telemetric system. When all technological issues were resolved, the pilot was extended to 650 household to check whether the introduction of smart meters was business wise feasible. To be able to detect abnormalities in water usage, historical usage information and information on water levels has to be build up and be made available.

4.3.3 Domestic users

When looking from a domestic perspective to the water management market, the focus is on house owners and house users. Basically, there are two ways for home users to save water. First, by introducing more water efficient equipment in their home so that less water is used with the same behaviour. The second option is by changing habits and behaviour with respect to water consumption so that less water is used in daily life.

In this paragraph we look at the different stakeholders around houses and the motivation of these different stakeholders for taking water saving measures. We also look at existing water saving products and services and the channels through which they are being offered.

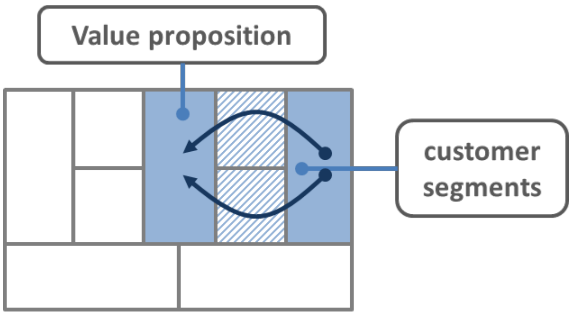


Figure 14: Value proposition for different customer segments

4.3.3.1 Customer segments

Because every household needs water for their basic needs like cooking and washing, the domestic market for water services is highly heterogeneous. In order to create some kind of customer segmentation that can be used to create focus and guidance for the development of the Water Information Platform, four views on the domestic market have been combined to identify clusters of customers sharing similar needs and demands. The four segmentations considered are:

- House ownership
- Housing type
- Family household

- Willingness and ability to act

Ideally, segmentation based on the water efficiency of a building would be taken into account as well. Unlike for energy efficiency, where the directive on the Energy Performance of Buildings (EPBD) has resulted in the energy efficiency index for buildings, no such directive or index for water efficiency has been found.

Table 5 provides an overview of the subsets of customers within each segmentation methodology.

House ownership	Housing type	Family household	Willingness & Ability to act
Private owner & user	Single family detached	Single person	Positive Greens
Private owner & non-user	Semi-detached	Group	Waste Watchers
Corporation	Attached single unit	Couple with dependent children	Concerned Consumers
Non-owner and user	Attached multiple unit	Couple with independent children	Sideline Supporters
	Moveable	Couple without children	Cautions Participants
		Single parent with dependent children	Stalled Starters
		Single parent with independent children	Honestly Disengaged

Table 4-D - Four types of customer segmentation

4.3.3.2 House ownership

A house can be privately owned or belong to the stock of a housing corporation. If the house owner is also the user of the house, the owner benefits directly from water saving measures taken but in general has less money to spend. This opposed to housing corporations who do not receive all the benefits from water saving measures but can install measures more cost-effective because of their economy of scale. Some housing corporations actively promote water saving initiatives like water reuse, rainwater harvesting, and efficient water use and onsite wastewater management but in general, water management does not have top priority from western housing corporations. Smart home initiatives where housing corporations are involved, mainly focus on applications for telecare and energy efficiency.

4.3.3.3 Housing type

The type of house users live in largely determine the kind of measures that can be taken to reduce water consumption.

4.3.3.4 Family household

The composition of a family household has a direct relation with the level of water consumption. Not only does the total number of family members affect water consumption, also the characteristics of the individual members and the relationship between the family members have an effect on water consumption. For this study, the classification of family and household types of the Australian Institute of Family Studies (2013) is used.

4.3.3.5 Willingness and ability to change

To support policy development and implementation in UK's Department for Environment, Food and Rural Affairs (Defra), a framework for pro-environmental behaviours was developed. This framework segmented the population into seven distinct and independent groups based on pro-environmental behaviours. Table 6 provides a short explanation for each of the segments.

Segment	Description
Positive Greens	Positive pro-environmental beliefs and attitudes. Acting in more environmentally friendly ways than any other segment does.
Waste Watchers	Have a slightly more pro-environmental than the average ecological worldview. Urge to avoid waste. Sceptical about the scale and urgency of environmental problems.
Concerned Consumers	Sympathetic to the concept of 'climate change', acknowledging their personal impact and seeing taking action as important. Reject the idea that we are reaching our limits to growth. Focus on environmental behaviours in the home.
Sideline Supporters	Generally pro-environmental worldview, although these beliefs are held relatively weakly. They recognise the environmental issues, are willing to learn and do more – they appear receptive though are unlikely to be proactive in acquiring information or adapting their behaviours.
Cautions Participants	Agree there is a pressing crisis, and that there are limits to growth. They are pessimistic about our ability to tackle climate change, but recognise their impacts. Environmentally friendly behaviours are not a natural fit with their self-identity.
Stalled Starters	Strongly negative environmental view. Say that their behaviour does not contribute to climate change, and that the environment is a low priority for them personally. Have a lot of serious life priorities to address before they consider the environment.
Honestly Disengaged	Ecological worldview is predominantly shaped by a lack of interest and concern. They do not seek excuses for their lifestyles. Debates about the environment and climate change do not touch their lives.

Table 4-E - Population segmentation based on willingness and ability to change

Combining the four segmentations results in 4*5*7*7=980 Waternomics customer subsets. From an information perspective, clusters of customer subsets can be defined. Taking the willingness and ability to change as the starting parameter, three categories show distinct information needs, being:

1. *Positive Greens*: They most likely want to have information on what they can do more. Furthermore, they are most likely to seek to influence friends, family and the workplace to be more environmentally friendly and they need the information to do so.

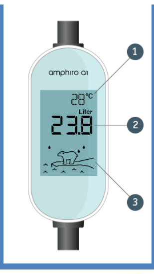
2. *Sideline Supporters*: In this group their green beliefs have not yet been translated to their behaviours.
3. *Stalled Starters*: Although highly sceptical about environmental issues, this is also the least informed group and they do recognise that (water) resources are limited and that humans are damaging nature.

4.3.3.6 Available water saving products and services

Different kinds of water saving products are available for house owners. Most well-known examples are low-flow shower heads, low-flush toilets and low flow aerators. Once installed, users automatically use less water. Other measures target at behavioural change, like shower timers or rain water tanks.
In both cases the effect on water use is not immediately visible. Water saving products can be bought on the Internet, in regular builder's merchants, through utilities and in special "eco-stores" together with other energy saving devices. Prices range from €1 for a low flow aerator to hundreds of euros for a dual flush toilet. The table below shows an overview of the most popular water saving products and price indications.

Table 4-F: Popular water saving products, providers and pricing

	Product/service	Providers	Price	Channels
	Low flow aerator	Sustainability stores Plumbers Home improvement stores Water companies Energy providers	€1 to €6	Web shop DIY Shop
	Low flow shower head	Department stores Water companies Sustainability stores Bathroom stores Home improvement stores	€10 to €50	Web shop Store DIY Shop
	Low flush toilet	Home improvement stores Bathroom stores Sanitary stores Building contractor	€30 to €500 for a dual flush reservoir	Web shop DIY store
	Shower timer	Sustainability stores Home improvement stores Water companies Energy providers	€5 to €10	Web shop

	Shower water meter	Amphiro	€60	Web shop (http://amphiro.com/products/a1/)
	Trigger nozzle	Sustainability stores Home improvement stores Garden stores	€5 to €50	Web shop Garden store DIY store
	Toilet tank bag	Sustainability stores Home improvement stores	€3	Web shop DIY store
	Rainwater tank (overground)	Garden stores	€50 to €250	Web shop DIY store Garden store
	Rainwater tank (underground)	Building contractor Garden stores	€1,000 to €5,000	Web shop Contractor

Products are sold either separately or bundles as Water Eco-kits. Smart water meters are usually not sold to consumers directly but can be obtained through water utilities.

More sophisticated solutions come from Home Energy Management (HEM) products or services. A HEM is any product or service that monitors, controls, or analyses energy in the home. This includes residential utility demand response programs, home automation services, personal energy management, data analysis and visualization, auditing, and related security services. HEM systems can be purchased by the home owner or being offered by utilities. HEM systems costs between €400 and €3000 with monthly subscriptions of €15 – €60 combining energy management, automation and security services. Comcast, Verizon,

Figure 15: Home energy management (HEM) system

Telecom Italia and Swisscom are some the major HEM service providers. Currently, the focus of HEM's is on energy and security but water management systems can easily be integrated in a HEM's network.
Industry technology standards used in HEM's are ZigBee, Z-Wave, HomePlug and Wi-Fi. HEM applications are available for a broad range of devices, like smartphones and tablets, in-home displays, smart thermostats, web portals or dedicated displays.
Dutch water utility Delta, links conventional water meters to smart energy meters to share infrastructure. According to Delta, copying procedures and data-structures from the gas domain to the water domain is relatively easy. Competing with smart home products is more challenging since these products read measures at a higher frequency and can present more precise information to the user.

5 Summary

In this report, we have highlighted the main usage cases and exploitation scenarios for the WATERNOMICS platform from the point of view of real end-users from our various target groups:

- Domestic and public users
- Corporate users
- Municipalities

A novel scenario construction method was used to convey the information gathered and features requested during the first 6 months of requirements gathering. Features were ranked according to three equally weighted categories: (1) Technology, (2) Innovation and (3) Business. This allowed us to filter out features which are not relevant or cannot be implemented within the project time-line. It also allowed us to identify which features should be prioritised for implementation in the first version of the WATERNOMICS platform.

5.1 Future Work

The next phase of Work Package 1 (M6-M12) will involve gathering feedback from the consortium and internal stakeholders on the initial exploitation scenarios presented in this document. The timeline for this activity is presented in Section 2.1. The report will also be made available to external stakeholders in order to gather feedback and inputs from a wider audience.

These requirements will be aggregated and assimilated into the final version of the usage case and exploitation scenarios document, due in M12 of the project.

Appendix A: Feature List Selection Criteria

Terminology

The MoSCoW rules have been used for defining the priority of the criteria.
Must have: Fundamental to the project's success
Should have: Important but the project's success does not rely on this
Could have: Can easily be left out without impacting on the project
Won't have: This time round can be left out this time and done on a later date

Business criteria

#	Description
1	The scenario must be attractive for the end user and/or other business actors or stakeholders
2	The scenario description should be targeted at least one of the three customer segments, being corporate, domestic and municipalities
3	The scenario should not conflict with data privacy legislation
4	The question 'why has this not been built already' must be clearly answered
5	The described services and devices must resolve one or more business issues for the end-user
6	The described services and devices must be easy to use by the end-user
7	The scenario should explain the social gains for the end-user
8	The scenario should explain which savings it produces (time, money…)
9	The scenario must outperform current solutions or products in the market

Technical Criteria

#	Description
1	Existing standards must be adopted as much as possible and existing channels should be used to enhance the standard
2	Should be technologically feasible with 1-3 years development time
3	Technical functionalities mentioned in DoW should be met
4	Scenario should enable exchange of information between two or more stakeholders
5	The scenario should allow personalised and interactive water related services

Innovation criteria

#	Description
1	The scenario must be related to new and working standards and, where possible, contribute to new standards (e.g. Water ontology)
2	Favour leading edge technologies where possible
3	Considerably improve existing solutions
4	Build on existing technology development strand in ICT for Water cluster

A summary of how these selection criteria are quantitatively ranked is provided in Table A-1.

Table A-1: Feature selection criteria

	Feature Selection Criteria	Definition	
		Low	High
T	Technical Criteria		
1	Existing standards must be adopted as much as possible and existing channels should be used to enhance the standard	Does not relate to any existing or standard commercial technology available today	Based heavily on standard commercial technologies with track record of reliability and persistence
2	Should be technologically feasible with 1-3 years development time	Requires extensive development and/or expertise outside of core consortium	Easily achievable using standard tools/practices within experience of core consortium
3	Technical functionalities mentioned in DoW should be met	Does not fit any of the functional requirements specified in the DoW	Specifically mentioned as part of programme of work
4	Scenario should enable exchange of information between two or more stakeholders	Does not enable new means of exchanging information between stakeholders	Allows ease of information exchange which was not previously available to stakeholders
5	The scenario should allow personalised and interactive water related services	Provides no personalised information to end-user	Provides the means or functionality to display or present user-centric information
B	Business Criteria		
1	The scenario must be attractive for the end user and/or other business actors or stakeholders	Is not a commercially attractive or viable scenario for business consumers	Highly desirable business prospect
2	The scenario description should be targeted at least one of the three customer segments, being corporate, domestic and municipalities	Does not address any customer segments	Addresses all customer segments
3	The scenario should not conflict with data privacy legislation	Conflicts with existing data privacy laws	Does not conflict with data privacy laws
4	The question 'why has this not been built already' must be clearly answered	Development may be inhibited by technological / economic constraints	Development is technologically viable and attractive to market
5	The described services and devices must resolve one or more business issues for the end-user	Address no current business need	Addresses one or more current problems for business

6	The described services and devices must be easy to use by the end-user	Complex or difficult to understand/use	Easy to use - uses familiar interface, system or UI
7	The scenario should explain the social gains for the end-user	Difficult to identify social gain	Social gains / impact is clearly identifiable for end-user
8	The scenario should explain which savings it produces (time, money…)	Does not help to identify savings	Clearly identifies / links with business savings
9	The scenario must outperform current solutions or products in the market	Worse than or equal to already available products	Outperforms existing commercial products
I	**Innovation Criteria**		
1	The scenario must be related to new and working standards and, where possible, contribute to new standards (e.g. Water ontology)	Does not relate to or build upon existing technological standards	Builds on existing standards in an innovative way
2	Favour leading edge technologies where possible	Uses old or pre-existing technology	Uses modern or leading-edge technology
3	Considerably improve existing solutions	Does not improve the existing solutions	Significantly improves on existing solutions
4	Build on existing technology development strand in ICT for Water cluster	Does not build upon existing work in ICT for water sector	Uses one or more developments being used in ICT for Water cluster

Appendix B: Ranked Feature List

#	Feature Name	Category	Further Description	Score
1	Availability prediction on the main dashboard	Communication	Availability could also be present on the dashboard using a gauge with colour codes to signal water scarce and water abundant periods	4.6
2	Water awareness dashboard	Communication	Water awareness dashboard showing monthly water consumption for past 12 months, and year-on-year comparison to show where improvements have occurred	4.2
3	Using personal social stream to attract attention of user	Communication	The platform could use personal social streams to post information visible only to the user (e.g. Congratulations! You managed to reduce your average daily water consumption by 3% since last month!)	4.1
4	Flow Anomaly Alarm	Alerts / Alarms	Alarm which triggers when water flow exceeds a specific percentage of baseline flow rate (e.g. 10% above typical baseline flow)	4.1
5	Virtual building management	Gamification	For children the game could be based on the management of a virtual entity such as a house a business or a city moving from simple to more complex scenarios and more difficult goals.	4.0
6	Leak detection alarms on sensor devices	Communication	Alarm for leakage detection connected with specific sensors if possible Even better if the BBB module could include a functionality to alarm for leakages with a beeping noise or flashing light so that you get notified even without logging to the platform ATTENTION! Alarms on the sensors should not be annoying and should be triggered in most critical cases only! They should also have a mechanism for turning them off.	3.9
7	Remote Telemetry	Access	Wireless data acquisition from water meters (Bluetooth, Wi-Fi etc.) to enable automated access and analysis of water network data	3.9
8	Availability prediction metaphors	Communication	Availability prediction should be presented using metaphors (e.g. enough water for 2 months)	3.9

9	Information sharing transparency and control	Communication	Sharing of water usage information should always be initiated by the user The user should always know who is he sharing information with	3.9
10	Monthly water data visualisation	Communication	Plots of previous monthly water consumption and year on year comparison. Include % improvement indicator	3.8
11	Water consumption production line breakdown	Communication	Display of water usage per production line in a factory. This information is to be used for improving water and energy usage by the various production shifts.	3.7
12	Water network simulation	Analysis	Simulation of current usage and pressure across water network, in order to identify opportunities for flow/pressure optimisation	3.7
13	Simulations triggered by advices	Communication	Simulations could be started by an advice appearing to a user	3.7
14	Gamification aspects	Communication	Gamification of water usage, comparison to peers, display associated energy costs and carbon emissions with various usage of water. Games to increase water and user awareness. Bank of knowledge on which gamification is based.	3.7
15	Simulations tied with appliance specs	Analysis	Simulations could also use technical specification of appliances to help in decision making when a user wants to buy a new appliance	3.7
16	Water awareness and enforcement	Communication	Community education on water scarcity, backed up by water network data. Procedures to identify water theft through illegal pumping	3.7
17	Live (real-time) flow monitoring	Access	Real-time data acquisition from water meters to enable water network simulation and real-time remote control (see water network simulation, remote control)	3.7
18	Game rewards	Gamification	Reward through publicity (local news! social media post from the municipality! a specific section with the users of the months in municipalities web site! etc.)	3.7
19	Fault detection diagnosis	Alerts / Alarms	Fault detection on mechanical and electronic equipment (e.g. pumps, valves, sensor anomalies)	3.6

20	Leader board of good consumers	Gamification	An idea for sharing information is a leader board of good consumers which could be tied with benefits (e.g. the consumer of the month… similar to the employee of the month)	3.6
21	Peak notifications	Alerts / Alarms	Alarms for peak consumption could also be used if water consumed within a large period (1 / 3 / 6 hours) was mainly consumed in a very small period (e.g. 5 minutes)	3.6
22	Timeline granularity levels	Metering	Measurements could be taken every minute Presentation of consumption is better to be done on an hourly basis (or every 3 or 6 hours).	3.6
23	Water consuming device breakdown	Communication	Visual breakdown (pie-chart) of each water consuming device, based on flow signature and/or energy analysis. This could be displayed on a visual dashboard in the home, office or business in order to convey the relative impact of each device on water consumption: Residential (showers, dishwashers, washing machines), Commercial/Business (Toilets, Sanitation, Irrigation, Conditioning etc.)...	3.6
24	Pressure monitoring	Access	Capturing pressure information from the network at different time scales (similar to flow)	3.6
25	Virtual billing as a game	Gamification	Virtual billing with alternative pricing could be a game	3.6
26	Education linked with game	Gamification	Educational material could also be linked with the game, especially a virtual house game where the child selects a number of interventions and installations given a specific time or amount of time and is rewarded with appropriate rewards… going to the next level…. Managing a bigger house… managing a small business… managing an airport! etc.	3.6
27	Multi-tenant metering	Metering	Extension of sub-metering to site tenants in order to (1) accurately record usage breakdown for water users on the network, (2) provide adjusted tariffs, and (3) reduce overall consumption	3.6

28	Non-revenue water (leak) detection	Alerts / Alarms	Detection and location of leaks based on flow measurement, leak detection sensors or water network modelling	3.5
29	Meter USB Data logging	Access	Integration of USB dataport in physical water meters where wired/wireless solutions may not be appropriate (underground, expensive to run cables, high moisture environment)	3.5
30	Daily Flow Measurement	Metering	Capturing daily water consumption	3.5
31	Monthly Flow Measurement	Metering	Capturing monthly water consumption	3.5
32	Annual Flow Measurement	Metering	Capturing annual water consumption	3.5
33	Water availability overview	Communication	Water reserves and forecasted water displayed in number of days of available water based on actual level of consumption	3.5
34	News for educational material	Communication	Educational material could be presented in the form of news (especially for adults) and separated in local and worldwide. Local news could be using local language only.	3.5
35	Drought Monitoring	Metering	Monitoring of precipitation data and weather forecasts in order to predict drought risk periods. This may be used in a feedback loop with adjustable tariffing to disincentivise water consumption during high risk, or peak-load periods.	3.5
36	Remote Control	Access	Remote control of water network (i.e. two-way interaction of water information system). Read data from meter points and respond accordingly to optimise flow/pressure across the network	3.5
37	Pricing Structures	Business/Finance	Adjusted water pricing structures for residential consumers based on (monthly) water consumption. Also, investigate possibility of 'load-levelling' approach as used in energy domain to reduce peak demand, or flatten load profile by incentivising water use during periods of low demand.	3.4
38	Metaphors for simulations too	Communication	Simulations should use meaningful metaphors to present results of the suggested changes	3.4

39	Link telemetric systems and meters	Analysis	Integration of telemetric systems and residential water meters to be able to compare flows	3.4
40	Flow Signatures	Analysis	Analysis of water consumption usage profile in order to determine consuming device (e.g. washing machine, shower, dishwasher etc.)	3.4
41	Energy Signatures	Analysis	Comparison of water consumption profile with energy profile in order to increase confidence about water/energy consuming device signatures (see work from Wattics, Ireland)	3.4
42	Game connection with real information (gamification)	Communication	The leaderboard feature could be part of a game	3.4
43	Simulations connection with availability prediction	Analysis	Simulations should also be connected with availability prediction	3.4
44	Presentation granularity levels	Communication	Emphasis on generic measurements and ability to drill down in time and sensors	3.3
45	Billable period Flow Measurement	Metering	Capturing water consumption data from billing periods	3.3
46	Peak forecasting	Analysis	Predict peak levels in water usage so utilities can make preparations	3.3
47	Colour codes	Communication	Use of colour codes to communicate positive and negative messages	3.3
48	Data security	Communication	Extensive data will inevitably lead to increased knowledge of individual's privacy. Encryption etc. Security of both data and communication channels.	3.3
49	Metaphors for measurements	Communication	Monitoring application should be heavily dependent on metaphors to put measurements into perspective for the users. Possible metaphors are • Amount of rains needed to cover the usage • Comparison with daily activities such as (cooking, dishwashing, washing machine uses, bottles of water, number of showers, etc.) • Comparison with average usage of typical household types. (e.g. "You are consuming as much as a 4 members family") • Comparison with needs in water stressed areas (e.g. "This amount of water could be used for such use in water stressed areas")	3.3

50	Water meter fraud detection	Alerts / Alarms	Alarm which triggers when a user is tempering with the water meter	3.3
51	Product Recommendation	Analysis	Provide recommendation for new water/energy saving equipment based on current consumption pattern and user equipment profile	3.3
52	Water information sharing	Communication	Exchange of information about water usage, available water, network status, etc. between municipalities	3.2
53	Historical information	Analysis	Historic usage information and water availability information should be available for detecting abnormalities	3.1
54	Non-intrusive feedback system	Communication	In the leisure domain, communication about water consumption and water saving should be done in a non-intrusive way	3.1
55	Carbon Emissions	Analysis	Calculation for carbon emissions / environmental impact associated with water consumption for specific period (e.g. CO_2 emissions per Litre water consumed, or total CO_2 emissions per month). On the flip-side, this calculation may be used to display the positive impact of water conservation on environmental footprint.	3.1
56	Multiple Languages for educational material	Communication	Main language for educational material could be in English and auto translation could be used for translating in local languages if needed.	3.0
57	Compatibility with existing home energy management systems	Access	Integration of smart water meters with HEM systems so that energy and water usage can be managed from a single device by the end-user	3.0
58	Support legacy systems	Access	An information platform should be able to interface with existing GIS, ERP and SCADA systems	2.9
59	Cost of Electricity Calc.	Analysis	Calculation for cost of electricity associated with water consumption for specific period (e.g. energy cost associated with water consuming devices for past week)	2.9
60	Water quality monitoring	Alerts / Alarms	Monitoring of water quality for contaminants (e.g. fertilisers, agro-chemicals)	2.9

61	Outsourcing of core functions	Business/Finance	It should be able to outsource specific functionality like billing, network monitoring etc. to a third party.	2.9
62	Short courses	Communication	Educational material could be in the form of short courses / seminars for schools (accompanied with appropriate infrastructure for running them)	2.8
63	Full cost recovery	Business/Finance	Cost and revenue structure should be balanced in such a way that full costs are recovered	2.6
64	Constant (high) pressure on taps	Alerts / Alarms	Drops in pressure or low pressure result in an increase in calls to the service centre of the utility	2.6
65	ROI of 5 years or less	Business/Finance	Investments in water management systems in corporate environments should have a pay-back time of 5 years max	1.7
66	Required staff	Business/Finance	Staff for operating and maintaining water information platform should be available in terms of people and budget	1.2
67	Access to water for everyone	Business/Finance	Minimum amount of water, e.g. 15 m3 per year, available for each individual at a price level that everyone can afford.	1.0
68	Support different customer groups	Business/Finance	Different user groups should be supported like single-households, families with small children, etc.	0.8

Appendix C: Reports of interviews and round table sessions

For the collection of field data, two round table sessions and multiple interviews with stakeholders have been organised. The next table shows an overview of the interviews conducted and round table sessions organised. Reports of the sessions and interviews can be found in the next paragraphs.

#	Stakeholder	Domain	Format
1	Linate Airport	Corporate and municipalities	Round table session
2	Thermi	Municipalities	Round table session
3	Mars	Food industry	Interview
4	Efteling	Leisure industry	Interview
5	Family Hotel	Leisure industry	Interview
6	Irish Water	Utilities	Interview
7	Arrabawn Dairies	Food Industry	Interview / Tour

#1 Stakeholder Workshop Malpensa Airport, 29 May 2014

Malpensa Center, Malpensa Airport, Italy

Organization:
The meeting was organized and co-hosted by SEA and R2M at the Malpensa Center Meeting Room of the Malpensa Airport. 19 persons attended including the Mayors and staff of four local area municipalities, a technician from the waste and water management company S.A.P. (serves 18500 people), a guest researcher from the ICeWater project, SEA staff and R2M staff. Recipients were provided with an agenda, Waternomics brochure, nametags, notepads and pens. Refreshments were made available (registration and coffee break) and a lunch was provided afterwards on the airport premise. The meeting ran from 1000-1500.

Invitation:

Antonio Candelieri of the Consorizio Milano Ricerche representing the ICeWater project encouraged us to participate in the Water IDEAS 2014 conference "Intelligent Distribution for Efficient and Affordable Supplies" (www.waterideas2014.com). This conference is in conjunction with the AccaDuoO 2014 Water Fair and will also host a "SWAN Day Workshop." Hence, three things are co-located:

- **SWAN Day**: Smart Water Networks Forum – Worldwide Industry Forum
- **Water Ideas Conference** – A conference hosted by the International Water Association (IWA) and featuring a special session on Water Projects funded by the European Commission
- **ACCADUEO** – International exhibition of technologies for the distribution and treatment of water

Registration is approximately 600 euro.

Workshop Main Points: An important overtone of the stakeholder workshop is that the mayors and water distribution company were all on the order of magnitude of between 8000 to 20000 inhabitants or persons served.

- **Lack of money to invest**: Immediately the subject of lack of funds came up. The topic of water management is of course very important and interesting but seemingly out of reach. The concept of participating in EU research seemed attractive but also out of reach for the workshop attendees. Participating was discussed in two ways:
    - Making use of our project results (or ICeWater) – In this discussion the results seemed out of reach because in very simple terms they felt they are not even at the state of the art and we are pushing beyond the state of the art.
    - Participating in EU research – in this discussion they did not see how they could staff, get access to projects or be involved although they would really like to do that. They clearly see the benefit.

- **New structure to manage water in Italy:** up to this year each municipality has been responsible to manage its own water distribution. Some small municipalities decided to join efforts and set up local consortia to do so. 8 year ago a new law established new entities, the ATO (Ambito Teritoriale Ottimale). These entities are now in the process to be set up and take over on water and waste services. When ATOs will be fully operational, municipalities will only keep the ownership of the water network but will not be responsible for the management. As an example water prices will be decided by the ATO, the municipality will be still able to keep it low for its citizens but in this case will be responsible to pay for the difference. The formation of the ATO is very relevant to the context of Waternomics because it is something similar to what is happening in Ireland with Irish water. The new ATO around the airport of Malpensa will the one of the Varese county (ATO Varese) which will cover 141 municipalities.
- **Lack of distribution network knowledge**: We should not assume that they know the state of their water distribution network. Diagrams are missing, the system has been built over centuries, and institutional knowledge has been lost over time as key individuals with knowledge have retired, plumbing works are now subcontracted to third parties (different one every time) and there is no plumbers among the municipality employees, etc. They do the best they can to keep things working. They would be extremely interested in technologies (e.g. GIS) that help them assess, map and diagnose what they currently have.
- **Leaks are a top concern**: They know they have big leakage concerns (up to 30% and likely between the wells and the distribution pumping stations) but they do not know how to localize and diagnose such leaks in a cost effective way. Investments have generally been the replacement of older equipment as it phases out and becomes replaced by newer pumps and inverters which allow a better avoidance of pressure peaks.
- **In general they lose money on water**: Water prices have been stable since 1992. Electricity prices in that period have increased in multiples. One example was:
  - Between 15000-20000 people
  - Water is billed 500,000 euro per year to the inhabitants
  - The energy cost of the distribution system is 300,000 euro
  - With very minimal staff, minimal maintenance, minimal investment and unpaid billings – water services is not profitable but a burden on the municipality
- **Technologies & Analysis**: Of course they would be interested in improving their situation – but how could we suggest they fund such an improvement? In general – everything is Manual. There is no SCADA, monitoring network, real time information. Period.
- **Raising Prices**: They would like to raise water prices and use the revenue gained from price increases to fund infrastructure investment BUT they do not see that such an action is politically possible / would be tolerated by the inhabitants. In general, there is a resistance to changing anything because the inhabitants have a fear of the prices being raised to pay for investments/change. The topic of better water meters allowing more precise water billing was also mentioned in a good and bad way – of course it is interesting to have better information but will that be used simply to raise prices?
- **Where to invest first**: The municipalities were not concerned with the amount of water consumed by public buildings under their responsibility (schools, municipal buildings, swimming pools…..). They were instead much more concerned in the health of the distribution system, ability to manage it, costs of energy and leaks.
- **COMMUNICATION**: One of the Mayors was fascinated that such great EU projects are happening but his constituents knew nothing about them. That the local news is filled with "nonsense" and not with coverage about things such as Waternomics. They <u>really liked</u> the ideas of cartoons on bills to make things simple and engaging to people. They <u>really stressed</u> that passive communication (brochures) is less and less effective and that <u>unless you have an application</u> for an iPhone – nobody is going to care. They <u>invited us to speak at schools</u> and to

tell our message to the local community. They stressed again and again that things must be made simple.

- **The ICeWater Project**: ICeWater is at approximately Month 20 and is nearing conclusion of the development phase. They focus mostly on the optimization of the distribution system. Concepts such as overlaying water pumping, storage and buffering with electricity prices and peak demand were presented. The idea(s) that one can move water when energy costs less and that through forecasting one can move water in a more deliberate way and with a better plan that results in using the networks most efficient pumps / equipment. In one case study this led to a 3.1% decrease in overall energy demand (use of more efficient equipment within the network) and a 5.1% decrease in energy cost (purchasing energy during off peak times). The focus of ICeWater is mainly on supply water distribution, the attendees at the WS stated that it is important to consider the whole cycle from wells to wastewater treatment. The technological solution developed in ICeWater has the goal to become self-sustainable. With an initial investment for the client, they can save money which can then be reinvested in the new meters installation that can allow for more savings and so on.
- **Standards**: There was a nice discussion on what should be the standards for new construction joining the distribution network. One could think that they would have to have recyclable water concepts (e.g. make use of water from the roof for irrigation purposes or for water cleaning at municipal level) and that they would require informatics metering systems. This was a good discussion BUT and HOWEVER the challenge is really the 99% of the network and structures already existing and how to deal with them and especially what technologies can be used in such cases (for existing homes) and a cost that is cost effective.
- **Low water rates (in Italy are very much low compared to EU average)** discourage best practices. Cultural change and education are needed. Costs need to be passed on to the end users and people need to change their behaviours.
- **Facility management culture:** The first thing needed is understanding what is the current state and help in establishing a facility management culture for the water distribution networks.
- **Shared networks and resources:** The municipalities were all adjoining to each other and also adjoining to the airport. “District” concepts where they could use water from another network might lead to efficiencies and better management but at the moment the systems (neither infrastructure nor business model) are not set up for that.

Follow up Actions and reading between the lines:

- We would like to consider what a Waternomics Application could look like and how it could be used for communication / user engagement.
- We have one or two or three cartoons – they are effective. We probably need to think of 10…20…30 key messages and design simple cartoons for those – create our characters, etc.
- We will stay in touch with ICeWater. We attach their presentation.
- We will stay in touch with these municipalities and translate literature (newsletters) for them, etc. We will see when it makes sense to accept their invitations and get an article in local papers and/or speak at schools.
- We are investigating the Waterideas 2014 conference. It seems like an excellent venue and would be good to get Waternomics represented.
- All the stakeholders who attended the workshop are interested in knowing how much the solution we are proposing costs of the final client. They would be interested in a second round of this workshop when more data are available.
- All the stakeholders suggested that we engage the ATO and try to propose to it the solution we are developing. The ATO is now at its infancy and it may be very interested in structuring itself in order to easily incorporate in the future the solutions proposed by the two projects presented.

#2 Stakeholder Workshop Thermi, 13 June 2014

Agenda

10:00 - Welcome

10:20 - Introduction "ICT for Water" program

10:50 - Round 1: "How do water companies today use ICT in their operations?"

11:30 - Coffee break

11:40 - Round 2: "What do water companies expect from a Water Information Platform?"

12:20 - Round 3: "How could customers benefit from a Water Information Platform?"

13:00 - Wrap-up

List of participants:

#	Name	Organisation
1	SPIROU STILIANOS	
2	JESSE VAN SLOOTEN	ULTRA-4
3	KOSMIDIS DAMIANOS	
4	KOUROUPETROGLOU CHRISTOS	ULTRA-4
5	SANDER SMIT	BM-CHANGE
6	KAVOURAS IOANNIS	
7	SPACHOS THOMAS	
8	GEORGAKOUDIS KOSTAS	
9	PASIA THEODORA	
10	PAVLIDOU ELISAVET	
11	FAMELLOS SOCRATIS	
12	PANAGIOTOPOULOS IOANNIS	
13	PAVLOU IOANNIS	
14	PRALAKIDIS STERGIOS	

#3 Interview Mars, 8 April 2014

Date: 08-04-2014
Time: 9:00-10:00
Venue: Veghel, the Netherlands
Interviewer: Sander Smit
Interviewee: Bert Blom
Function: Sustainability Manager Continental Europe & Eurasia
Organisation: Mars Nederland

Organisation profile

Mars is a privately owned, leading manufacturer of food, pet care, chocolate and drinks. They have presence in 74 countries and several factories all over the world like in Russia, Germany, Dubai, USA, and the Netherlands. In Veghel, the Netherlands, their largest chocolate factory is located, producing candy bars like Bounty, Mars, Milky Way etc., for the rest of the world and using 10% of the total cocoa harvest worldwide. The Veghel factory is used as a bench mark for the other chocolate factories. Water is mainly used for cooling, heating (through steam) and cleaning. In the Veghel factory around 250 M3 of water is used per day. This year they have built their own third generation anaerobe water purification station which will be operational in June 2014. The harvested gas should be enough to cover up to 10% of the factories energy. Mars buys water from water service provider Brabant Water and they obtain water for cooling from the nearby canal. Also rain water is collected and used for cooling. They are investigating possibilities for re-use of water.

Motivation

The board of directors has stated in 2007 that they want Mars to be fully sustainable in 2040. For this purpose, the "Sustainable in a Generation" (SIG) program is started. For water they have set targets for the maximum amount of water to be used for the production of one ton of candy. To reach their target they to improve with 3% every year...

Following the Lean methodology, responsibility for improvement is delegated to the lowest possible place in the organisation. The factory is divided in value streams, each representing a production line with two or three shifts with operators. Each value stream has KPI's which are discussed during every handover of shifts. KPI's for energy usage and water usage are not yet in place. It appears difficult to collect and present the data. The water and energy awareness amongst the operators is not very high.

Business

For approving investments for reducing water usage, the effect on the local site is taken in consideration. The effect of investing 200K euro might be bigger in Dubai then in the Netherlands. Funding for sustainability projects is more easily obtained then for other improvement/innovation projects. If there is a payback time, albeit twenty years, the investment will be approved.
Water is billed per usage.
Until last year, Mars received subsidy from the central government for not building their own water purification station. This measure was taken to prevent under-utilisation of the public purification stations. In 2014, this measure was stopped.

Mars has investigated options to share resources (waste water, waste energy, heat, purification station) with nearby companies Friesche Vlag and DHV but it turned out to be too difficult to organise.
Information about water usage is not considered as classified, it is probably published in the sustainability report.

Infrastructure

The factory can be considered as an ecosystem in itself. The various value streams will be made responsible for their energy and water usage and can be compared with each other, like individual households.
Today, water meters are only placed at the entrance and exit of the water system, with a few water meters in between at places that use a lot of water. The metering will be updated in the coming years.
Currently, the status of the KPI's is published on large scoreboards (like whiteboards), placed in the meeting rooms in the factory.

Follow up

The information of "ICT for Water" and Waternomics was well received. A lot of the research items can be directly plotted on the issues Mars is working on, like having more detailed information about water usage or how to increase user awareness.

Mars is open for participating in a pilot, for example to test the effect of measuring water consumption of a single value stream and reporting it back to the operators.

Agreed to stay in touch, subscribe Bert to our Newsletter and return in a later stage when project deliverables are more tangible.

#4 Interview Efteling, 8 April 2014

Date: 26-05-2014
Time: 9:00-10:00
Venue: Europalaan 1, Kaatsheuvel, the Netherlands
Interviewer: Sander Smit / Jan Mink
Interviewee: Ivo Südmeier
Function: Beleidsmanager Ruimte en Duurzaamheid / Landschapsarchitect
Organisation: Efteling

Organisation profile

Efteling opened its doors in 1952, as a Fairytale Forest with ten fairytale depictions set amongst natural surroundings, designed by Anton Pieck. With more than 4 million visitors each year the park has grown to become the Netherlands' most visited daily attraction and one of Europe's most successful theme parks. The World of Efteling also comprises a hotel, a holiday park, a golf course, a theatre and a wide range of facilities for business events.

Motivation

Since the very beginning, care for nature and the environment has always been one of Efteling's highest priorities. This began with the green philosophy of Efteling Nature Park Foundation, which established the Fairytale Forest in 1952. In 1959 the litter-gobbling Big Mouth became a precursor to Efteling's current nature and environmental policy. Today, Efteling continues to support the foundation's goals, both in word and deed.

An eye-catching example is Efteling's meticulous landscape management. Despite the growth in visitor numbers over the years, Efteling's green character has remained unchanged. In fact, Efteling's natural surroundings are an attraction in itself and remain highly valued by visitors. On the international stage, Efteling's natural appearance has received great acclaim. According to annual research conducted by the trade journal Amusement Today, Efteling is among the world's most beautiful theme parks; in 2013 Efteling was ranked third in the category of landscaping.

Lakes and pools where part of this landscape and have been preserved and integrated in the theme park. With the arrival of the Gondoletta (1981), a water attraction inside one of the lakes, it became necessary to manage the water level of the lake more precisely. Water levels could not fluctuate more than 10 cm. After building the roller coaster "Vliegende Hollander" (2007) and water show "Aquanura" (2012) the margins became even smaller and fluctuations today cannot be more than 5 cm. For this reason, a system for automatic monitoring of the water levels in the various lakes has been installed.

Business

All drinking water is obtained from Brabant Water, the local water service provider. Drinking water usage is metered and billed per usage. Drink water usage is measured on the level of theme park, hotel, Holiday Park and golf course. Information about water usage is not considered classified but since annual reports are not made public this information is not publicly available. Since there is only one provider for water, in contrast with energy, water tariffs are non-negotiable. All process water ("Klaterwater") is obtained from Brabantse Delta,

the local water board. With Brabantse Delta, a ten year contract is signed for the provisioning of purified wastewater.

Two persons are responsible for water. One for the strategic planning and one for operations. They are supported by the technical unit who resolve failures and perform maintenance.

Infrastructure

Efteling has two water systems, "Klaterwater" for the golf course, lakes and water attractions and a regular drinking water system for consumption purposes.

"Klaterwater" is the result of a successful collaboration between Efteling, water board "Brabantse Delta" and the province of Noord-Brabant. When Efteling wanted to construct a golf course in 1996, local authorities had concerns about the increasing amount of water needed. Annually, Efteling needs 450.000 m3 water for irrigation and for management of the water levels in the lakes in the theme park. At that time, water was extracted from three wells and the groundwater level was decreasing in the region. A new innovative method was developed to use purified waste water from a purification station nearby for the irrigation of the golf course and the theme park and for managing the water levels of the lakes in the theme park. A 4 km connection with a capacity of 75 m3 per hour was made between the purification station of Brabantse Delta and the golf course of Efteling.

Because in some attractions visitors in the park can get in touch with the water, the quality of the water would have to meet the same quality standards as swimming water. For this purpose, one of the world's first large scale reed-bed filter was built with a of size 7.750 m2, for treatment of the purified wastewater. After passing the reed-bed filter, the water flows to the three lakes in the golf course. The water quality meets the quality standards and is safe for use in the theme park. The water is stored in the lakes at the golf course and can be pumped to the theme park

when needed e.g. for irrigation or water level management. Fluctuations in the water levels of these lakes is not a problem since they are embedded in a natural way in the landscape, in contrast to the water levels in the theme park, which have to stay within a strict range in order not to disturb the attractions.
By making clever use of the differences in height in the landscape, only two pumps are needed to get the water in all lakes. The end result is that Efteling has a self-supporting water system which even contributes to the ground water level. Annually 400.00 m3 of purified wastewater is obtained from the purification station and 450.000 m3 of clean water sinks into the ground.

The water levels in the theme park are managed with help of multiple sluices from which two can be operated manually. All lakes in the park are equipped with sensors measuring the water level. The information is automatically send to a dashboard application. The trend is to remove underground water piping in the park and to use water streams, integrated in the theme parks landscape, for distribution of the water through the park.

Drinking water is obtained from Brabant Water and distributed through a regular water network.

Sustainability
In recent years, Efteling has introduced various initiatives in the environmental field. The Bird Rok attraction, Efteling Hotel and Efteling Village Bosrijk are all air-conditioned by means of a natural well, 40-80 metres underground. Furthermore, the water in Efteling Village Bosrijk's indoor swimming pool is heated by means of a combined heat and power system (CHP). At this moment all attractions are set-up in the most energy efficient way. To investigate if energy usage can be reduced even further, plans are being discussed to monitor energy usage per attraction in order to get more detailed information about the energy usage of the theme park.

Smaller water and energy saving measures are combined with regular maintenance and reconstruction. For example, water saving shower heads have been placed in the bathrooms of the hotel and the lights in roller coaster “Vogel Rok” have been replaced with LED's.

To increase the impact of sustainability projects, focus and commitment the
Efteling currently rewrites her policy. The idea is that sustainability projects should fit in a larger framework instead of being fragmented activities. Part of this new mission is to offer every guest a day in a world of wonders, escaping from day-to-day life. A world where guests should not have to worry about water or energy saving measures. They should be hidden, automated or fit in Efteling's philosophy.

In the area of sustainability, Efteling collaborates with partners and exchanges knowledge and experience with larger companies in the region.

Follow up
Mr. Südmeier would like to be kept informed about future developments of the Waternomics project and the ICT for Water program through the Waternomics newsletter.

#5 Interview Family Hotel, 20 May 2014

Date: 20-05-2014
Time: 11:00-12:00
Venue: Hilvarenbeek, the Netherlands
Interviewer: Sander Smit
Interviewee: Wants to remain anonymous
Function: Owner
Organisation: Anonymous, called Hotel A

Organisation profile

Hotel A is a privately owned hotel located in a village in the south of the Netherlands and is classified with a one star rating according to the "Nederlandse Hotel Classificatie" (NHC). The hotel is housed in a 100-year old building and renovated in 2011/2012. The hotel is run by the family with a staff of ten, mostly part-time, employees. The hotel has 30 rooms from which 14 with bathroom and 16 rooms share a bathroom. Their annual water usage in 2013 is 1033 m^3. Approximately 5-10% of this is used for consumption, the rest is used for other purposes. The hotel also has a pub and a restaurant. 75% of their guests are business, the remaining 25% is tourist. Majority of the guests are returning low-class workers who stay for longer periods of time while they work at projects in the area. The hotel occupancy is around 80%.

Motivation

Water management does not have much priority and is dealt with in a pragmatic way. Investments in water and energy saving measures should contribute to a decrease of operational costs or an increase of revenue and profit. Measures should be non-intrusive for their guests. Energy saving measures are being taken in combination with planned reconstruction activities. During last reconstruction, water saving shower heads have been placed in the bathrooms. The floor heating makes use of a heat exchanger. There is no grey water system or system for collecting rain water.

When water leakage is detected, most of the times visually detected or by sound, measures are being taken immediately. The water company, just as the energy company, notifies them when water usage shows strange values. Most of the times this is caused by changes in occupation rate.

The hotel is compliant with all regulations and certification required by law or insurance company.

The owner is aware of the Green-Key program (http://green-key.org) and has investigated the list of requirements. Their conclusion was that certification would require major investments in time, materials and reconstruction of the building which would not be earned back by increase in guests or otherwise so they decided not to adopt Green-Key.

Business

All water is obtained from Brabant Water, the local water service provider. Unlike energy providers it is not possible to switch from water provider, resulting in a lack of incentive to pay much attention to water.

Water usage is metered and billed per usage. Information about water usage or energy is not considered classified.

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The hotel has investigated the option to build their own well for water supply but the pay-back time turned out to be equal to the expected lifetime of the technical equipment.

Infrastructure

A single, analogue water meter is placed in the basement, measuring the incoming water. The meter is provided by water service provider Brabant Water and read out once a year manually. The hotel has one drinking water network which is used for all purposes. The municipality is in the process of building a separated sewer system (wastewater and surface water) but it's not clear if drains from the hotel are going to be connected to this system.

Follow up

The owner has no interest in the European ICT for Water program or Waternomics. If a water monitoring dashboard application would become available, there is interest in using it in order to respond earlier on unexpected changes in water usage. Also cheap leakage detection applications are considered useful. In general, water saving solutions should be practical, require only minor investments or being subsidised and have a payback time of years max.

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#6 Irish Water Stakeholder Interview, 4 June 2014

Irish Water head office, Dublin, Ireland

Background:
Irish Water are a semi-state company establish by the Irish state to manage nationwide water and wastewater treatment, supply and distribution. A meeting was organised with a number of key technical staff in order to make them aware of the Waternomics project, outline the key objectives and deliverables, and help identify any synergies which may exist.

Invitation:

A meeting was organised with senior technical representatives to discuss WATERNOMICS and its relevance to Irish water.

Agenda

- WATERNOMICS Introduction (see presentation slides)
- Water conservation
    - Sensor and metering devices
    - Consumer, commercial and utility awareness
    - Linked data/Data handling
    - Tariffs
- Pilot sites and their potential to demonstrate WATERNOMICS
    - Proposed pilots
    - Can we carry out work that can be as relevant as possible to Irish Water
- Irish Water challenges that WATERNOMICS could address
- Opportunities for demonstrated platforms/technologies

Workshop Main Points: Provided an overview of the WATERNOMICS project and key objectives. Discussed opportunities for using the WATERNOMICS platform to address some of the challenges faced by utilities. Some key points from the meeting included the following:

- Metering can be a difficult problem, particularly where meters may be required on private land (e.g. farms) or in multi-tenant buildings (e.g. apartments);
- Need to identify customer-side leaks vs. main supply side losses to the system;
- Methods for dealing with occupancy ratios in tariffing (Adults vs. children);

- How to incorporate geographical and socioeconomic factors;
- Analysing CAPEX / OPEX investment scenarios – need to incorporate CBA / NPV into any financial KPI's;
- Multilingual application for education would be useful;
- Water conservation flag for schools with best record for water conservation (similar to Green flag programme for recycling);
- Future scenarios:
  - Water and climate change
  - Weather
  - Energy consumption changes
  - Usage models for different end-users
- Main drivers for change:
  - Economic
  - Reputation / Image
  - Corporate social responsibility
- WATERNOMICS platform as a service vs product;
  - Product is preferred
  - Service charges for changes to service in SLA's
  - Product with adequate support and training is preferred for utilities
  - More control over information vs. external service;
  - Capability is kept in-house;
  - Customer confidentiality also needs to be considered;

Follow Up Actions:

- Further interview to be arranged with Irish Water once initial internal feedback from consortium has been gathered and collated;
- Irish water to be kept updated with WATERNOMICS dissemination activities;

#7 Arrabawn Stakeholder Interview, 13 June 2014

Arrabawn dairy production facility, Nenagh, Tipperary, Ireland

Background:
Arrabawn Dairies is responsible for the production, distribution and marketing of the Arrabawn fresh brand and agency brands in the mid-west region of Ireland. The Division is also charged with the development of new brands to meet the constantly changing needs of the consumer. The facility comprises a state of the art milk processing plant in addition to a distribution facility. Regional distribution depots are located in Galway, Athlone, Mayo and Nenagh.

Invitation:

We were invited to tour the Arrabawn facility in Nenagh through collaboration with the Irish DairyWater project (www.dairywater.ie). This project is focused on investigating the carbon footprint of large dairy production facilities in Ireland through a life-cycle analysis (LCA) of the raw-materials, chemicals and ingredients used in production, transport and distribution.

Workshop Main Points: A tour of the existing plant in Nenagh was carried out, focussing specifically on the water-intensive phases of production. The amount of water used in production is at a ratio of approximately 1.2:1 Water:Milk, indicating significant potential for cost-savings through water efficiency measures. There is also a significant energy cost associated with pumping and treating the water used in dairy production.

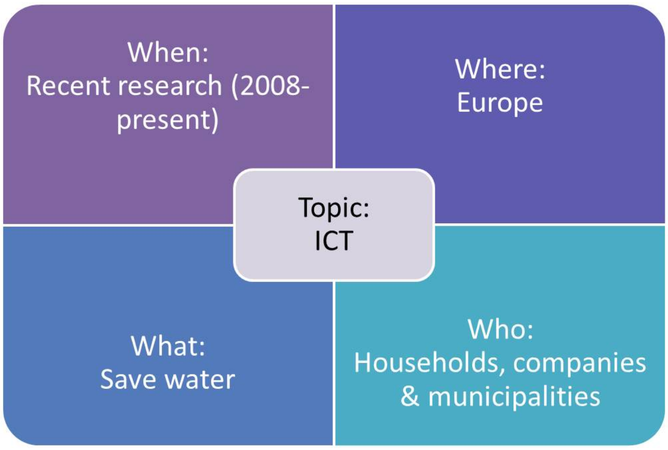
Follow Up Actions:

- The waternomics interview (see Appendix D) was forwarded to technical staff at the Arrabawn facility for further feedback and comments;
- A follow-up interview will be arranged with further dairy production facilities in Ireland in co-operation with the DairyWater project;



Appendix D: Interview checklist

The following checklist is used during the interviews.



<u>Research Question Waternomics</u>

How can ICT help households, companies and municipalities save water?

Interview checklist: sub-questions sorted on areas of interest:

Motivation

- How can ICT help raise the awareness of water consumption from our target groups?
- Are users aware of their water usage and by which mechanisms?
- Are people aware of upcoming shortages in (drinking) water?
- How important is water in the daily routine of our target groups?
- Do people already take measures to save water and why is that?
- What is the driver to change water consumption behaviour: reputation, financial incentives or ecological consciousness?
- What kind of benefits do people see in saving water, e.g. financial, environmental, other?

Business

- What does the current value web for water services look like?
- What pricing mechanisms are used in the water industry?
- How is water billed?
- Is the payment of water directly related to its consumption? If yes, how?
- What are the barriers for the water treatment and distribution market entry for SME's with innovative solutions in this area?
- Is water a main business or a means to other ends? If so, what is the economic value of water and, in relation to, other ends?
- Is the current utility business model sustainable or end-of life?
- Should a water information platform be offered as a product or a service?
- What type of water use reductions are you targeting?
- Would water use reductions have significant impacts on energy, resource and other business costs?
- How privacy sensitive you view a person's or a business's water usage?

Infrastructure

- How water consumption currently is measured?

- What form should a Water Information Platform take and what data should it present to (a) water suppliers (b) large business (c) smaller consumers – SME/domestic?
- What kind of users currently use water usage information and why these specific users?
- How many devices are used to measure and collect water usage information?
- What kind of devices are used to publish water usage information?
- How reliable are devices currently used for water usage measurement?
- What kind of devices would you like to see developed to measure, collect and display water usage related information?
- What level of water information is required (real-time, near-real-time, bi-yearly)?
- How does a Water Information Platform relate to other ICT platforms in the immediate environment e.g. an energy management system, HRM system, alarm system etc.?
- How important is the reliability of a Water Information Platform?

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