Wat€rnomics

D1.1 Usage case and Exploitation Scenarios

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D1.1

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Executive Summary

It is apparent that the lack of water information, management and decision support tools that present meaningful and personalized information about usage, price, and availability of water to end users, hinders the efforts to manage water as a resource. WATERNOMICS aims to address these issues using innovative information, communication and technology (ICT) tools. The project will develop and introduce ICT as an enabling technology to manage water as a resource, increase end-user conservation awareness and affect behavioural changes, and to avoid waste through leak detection and diagnosis. This report describes the key initial step in the development of WATERNOMICS, namely the identification of usage cases and exploitation scenarios.

This report analyses the water information market in order to define a business strategy for successfully deploying a water information platform and to gain insight in customer needs. As water information services will be targeted to public, domestic and corporate users, the report analysed both public and commercial perspectives by engaging key stakeholders and employing Value Network Analysis, Business Modelling and Scenario & Storytelling techniques.

The report leverages extensive stakeholder meetings, surveys and interviews by the WATERNOMICS team to describe the challenges and requirements of potential WATERNOMICS users. The Value Network Analysis describes the relevant parties in a business ecosystem and their interrelations. Business Modelling was used to understand how key resources and activities ensure relevant value propositions are brought to customers and also how WATERNOMICS impacts various stakeholders from a business point of view. Scenarios and storytelling are used to understand and present the user context in which water information services are deployed.

The process described in the report provides a template for specifying the features of an information platform, particularly one that engages a wide variety of users. Initially, based on desk research and stakeholder engagement, a long-list of possible features for water information services was developed. A methodology was developed to shortlist and rank potential features of WATERNOMICS that addressed the key requirements of domestic and public users, corporate users and municipalities. After processing the shortlisted features in three usage scenarios it was observed that, while on a conceptual level water information services look similar across target user groups, the market is very fragmented and no single solution can serve all customer needs. The report demonstrates that a water information platform needs to be designed modular, interoperable and scalable and considerable engagement with end-users is necessary before defining the proposed information platforms architecture and features.

The market research indicates that uptake of water information services is seen from water utilities, energy providers and suppliers of home automation. The risk of independent (non-interoperable) solutions and technologies is apparent. The consequence is that the next generation water information services face a fait accompli and cannot build on the first generation services, delaying and increasing the cost of integrated water management systems. Moreover isolated development squanders the opportunity of sharing cost and unlocking future options. Thus WATERNOMCIS, and indeed any such platform, needs to be cognisant of developments information platforms in the home, energy and industry sector. It should be adaptable and be able to incorporate “new” data and forms of data and utilise these as required.

Finally, the role of key players in exploiting WATERNOMICS is discussed. These actors vary from large companies that have internal skills to purchase and utilise WATERNOMICS to utilities or smaller business that may rely on consultants to advise on and provide such solutions. Thus WATERNOMICS should be adaptable to various business strategies and be an attractive

addition to existing service offerings from engineering, management or sustainability consultants.

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1. Introduction

The goal of Waternomics is to explore how ICT can help households, businesses and municipalities with reducing their consumption and losses of water. In order to better understand the needs and requirements of the various target user groups, it is necessary to survey and gather information from both internal consortium members, pilot sites and external stakeholders.

A key outcome of the work carried out in Work Package 1 consists of identifying use cases and exploitation scenarios for the Waternomics platform. The primary contribution of this report is to summarise the methodology for defining these use cases and exploitation scenarios, as well as potential business opportunities for the final WATERNOMICS platform. The report also details the key features required within the platform, which will enable these use cases and business exploitation scenarios.

1.1 Work Package 1 Objectives

WP1 begins a project long focus on business designing and development which is used to ensure industry relevance of the project outcomes while at the same time providing the best fit requirements, constraints and specifications for project technical development activities. As such, WP1 objectives are to:

- Identify and analyse state of the art water information services;
- Plan, organise and conduct a key stakeholder water workshop;
- Identify and analyse the business models and collaboration opportunities for WATERNOMICS;
- Develop use case scenarios and business strategies for interactive water information services;
- Define the overall architecture for the WATERNOMICS Platform.

The work of this WP will rely on the expertise and field experience of the consortium partners as well as input elicited through the key stakeholder water workshop. This WP will produce as output, the requirements, constraints, business strategies, use cases, and high level architecture that form the baseline for the development of the project foreground.

The objective of this particular report (a deliverable 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 commercial and societal needs. More specific, this report will identify needs, barriers, opportunities, policies, challenges, collaboration opportunities and solutions for each of the targeted stakeholders and thus help define an overall architecture for the WATERNOMICS Water Information Platform (WIP). This document also describes the scenarios from which the requirements and system architecture will be derived.

1.2 Purpose and Target Group of the Deliverable

The objective of this deliverable is to report on the progress of Task 1.1 (Business strategies and collaboration opportunities) and 1.2 (Usage cases and exploitation scenarios). These tasks help to define the roadmap for the WATERNOMICS platform in terms of both business exploitation opportunities and key features and use cases.

The main target groups for this deliverable are:

- Business consultants and water services companies;

- Water consumers in various domains (Domestic, public and corporate);
- Water utility companies;
- Software architects – definition of features suggested for final platform;
- Market analysts for water services.

1.3 Relations to other Activities in the Project

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

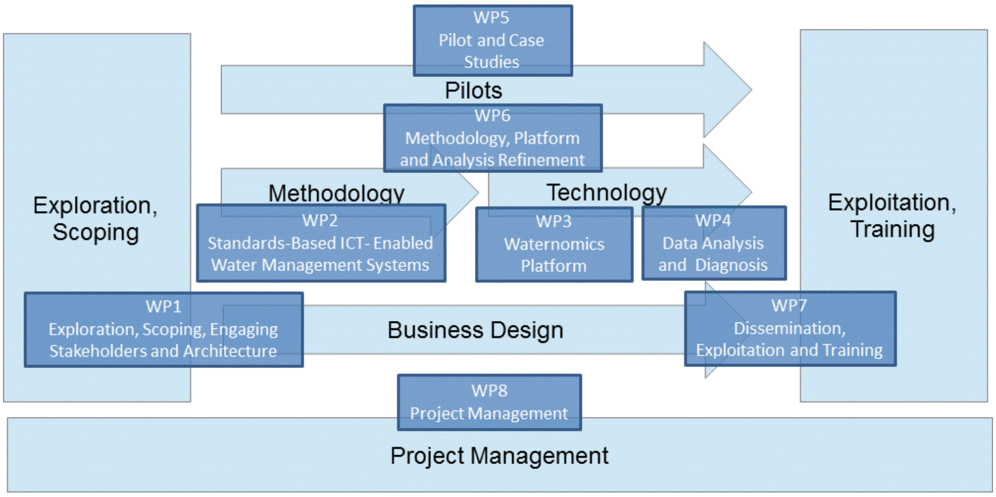


Figure 1 : WATERNOMICS work package structure.

Figure 2 illustrates the relations of this deliverable to other activities in the Waternomics project. These relations are represented as links numbered from 1 to 4 and are described as follows:

- **Link 1**: D1.1 defines the usage case and Initial Exploitation Scenarios that are later used in D1.3 for identifying relevant generic functions, KPIs and System Architecture.
- **Link 2**: D1.2 defines technology assets that are relevant to the Waternomics platform. These technologies are mapped to the generic functions identified from D1.1. This mapping is relevant for determining the overall system architecture in D1.3.
- **Link 3**: Output from WP1 (D1.1, D1.2 and D1.3) will drive the identification of the Waternomics methodology captured in D2.1 and Pilot measurement frameworks in D2.2.
- **Link 4**: Output of WP1 (D1.1 and D1.2) will contribute to the design of each pilot solution.

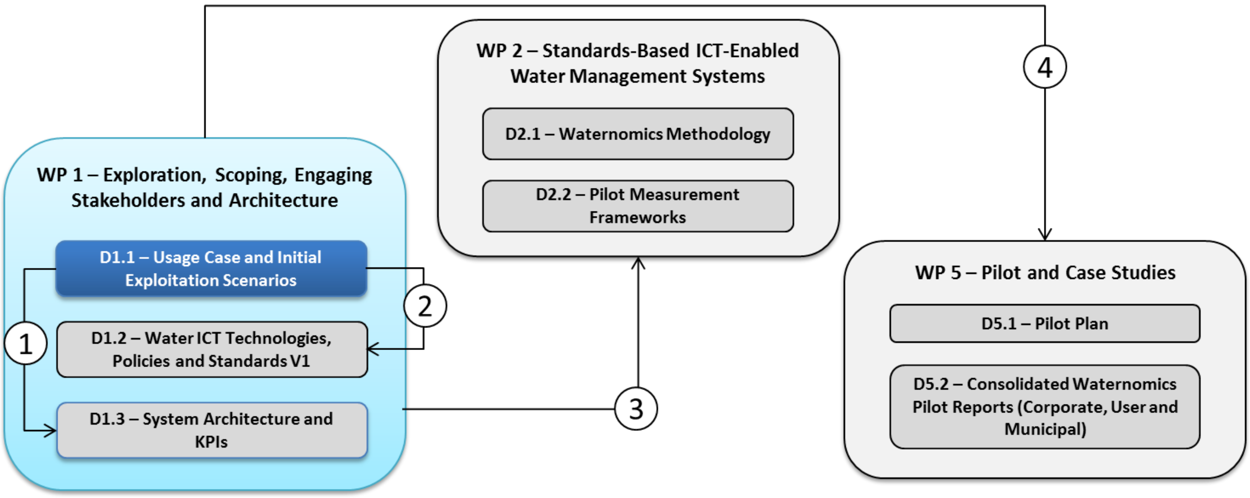


Figure 2: Relationships between D1.1 and other activities in Waternomics

1.4 Document Outline

The remainder of this document is organised as follows:

- Section 2: Use cases and WATERNOMICS features - discusses the set of usage cases and exploitation scenarios that function as the basis for the WATERNOMICS architecture, business models and applications.
- Section 3: Exploitation Scenarios - explores these exploitation scenarios from the point of view of real potential end-users from each of the above categories.
- Section 4: Business Strategies - explores the business strategies linked to these exploitation scenarios.

The report also has a number of detailed appendices that provide further information on various aspects of each chapter; these are as follows:

- 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.

1.5 About Waternomics

Climate change, increased urbanization and increased world population are several of the factors driving global challenges for water management. In fact, the World Economic Forum has cited “The Water Supply Crises” as a major risk to global economic growth and environmental policies in the next 10 years. In parallel, the United Nations has called for intensified international collaboration. To help reduce water shortages, Waternomics will explore the technologies and methodologies needed to successfully reduce water consumption and losses from households, companies and municipalities. Waternomics is a three year EU-funded project that started in February 2014 that will develop and introduce ICT as an enabling technology to manage water as a resource, increase end-user conservation awareness and affect behavioural changes, and to avoid waste through leak detection. In saving water, energy will also be conserved (treatment and pumping) as will the CO_2 associated with energy production. Unique aspects of WATERNOMICS include personalized feedback about end-user water consumption, the development of a methodology for the design and implementation of systematic and standards-based water resource management systems, new sensor hardware developments to make water metering more economic and easier to install, and the introduction of forecasting and fault detection diagnosis to the analysis of water consumption data.

WATERNOMICS will be demonstrated in three high impact pilots that target three different end users/stakeholders:

- Domestic users in Greece implemented by a water utility
- Corporate operator in Italy provided by a major EU airport
- Public and Mixed-use based demonstration in Ireland

Through these contributions, WATERNOMICS will pioneer a new dialogue between water stakeholders. It will enable the introduction of Demand Response principles and open business models through an innovative human centric approach that uses personalized water data, water availability based pricing, and gamification of water usage statistics. To maximize impact, the project highlights business development, exploitation planning, and outcome oriented dissemination.

2 Use cases and WATERNOMICS features

Engaging stakeholders in an early stage reduces the risk and uncertainty for developing a Water Information Platform (WIP). Instead of asking if stakeholders have interest in a particular feature, WATERNOMICS has developed three scenarios that make these features tangible. The scenarios blur the lines separating reality and fiction, enabling stakeholders to project them in concrete “futures”. The scenarios have overlap but focus on different aspects. The two dimensions that have been used to focus the scenarios are (i) target user group involved and (ii) information and services involved.
Not all features described in the scenarios are within the scope of WATERNOMICS but some have been added to create a consistent scenario. As a result, a selection of the features listed will be developed by WATERNOMICS and validated in a real life environment. Three pilots in Greece, Ireland and Italy each target a different scenario and will validate user acceptance and business viability for this selected set of features.
For clarity, the following scenarios are defined for three clearly identifiable end-users / stakeholders that are represented in the pilots:

1. Public buildings “Scholars and Students” (Public users / Education)
2. Commercial building
3. Domestic users

To ensure WATERNOMICS remains relevant to wider commercial and societal interests, external stakeholders play a major role in identifying and prioritising the usage cases and exploitation scenarios for each pilot. The roadmap outlined in Figure 3 gives an overview of the process for the identification of the usage cases and exploitation scenarios that in turn inform the purpose of the WIP under development. This is a necessary precursor for defining the structure and architecture of WATERNOMICS and indeed any WIP.

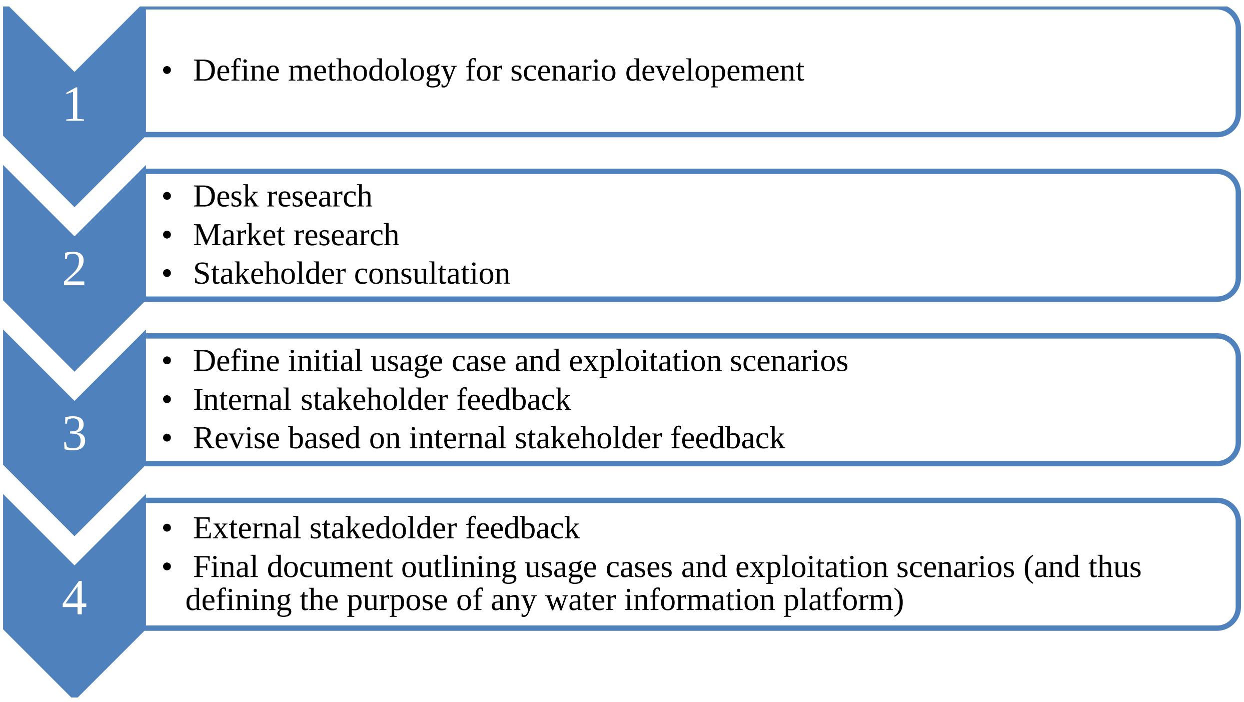


Figure 3: roadmap for developing usage case and exploitation scenarios for a water information platform

Thus the final scenarios should;

- Result in end-user perceived value,
- Achieve actual commercial/business value,
- Cover all target functionality of the WATERNOMICS project, i.e., be compatible with the Description of Work (DoW) document,
- Be technically innovative.

To develop the necessary scenarios WATERNOMICS used a zoom-in method, and as such the process was mainly bottom-up. This process initially involved collecting a large set of functionalities (what the platform can do) and features (e.g. outputs) as the basis for the WATERNOMICS scenarios. These features were then filtered, based on the criteria mentioned above. The final results were integrated in three scenarios that each covers a part of the WATERNOMICS project from a different perspective and together cover the complete scope of WATERNOMICS. Figure 4 outlines the steps in creating the three scenarios.

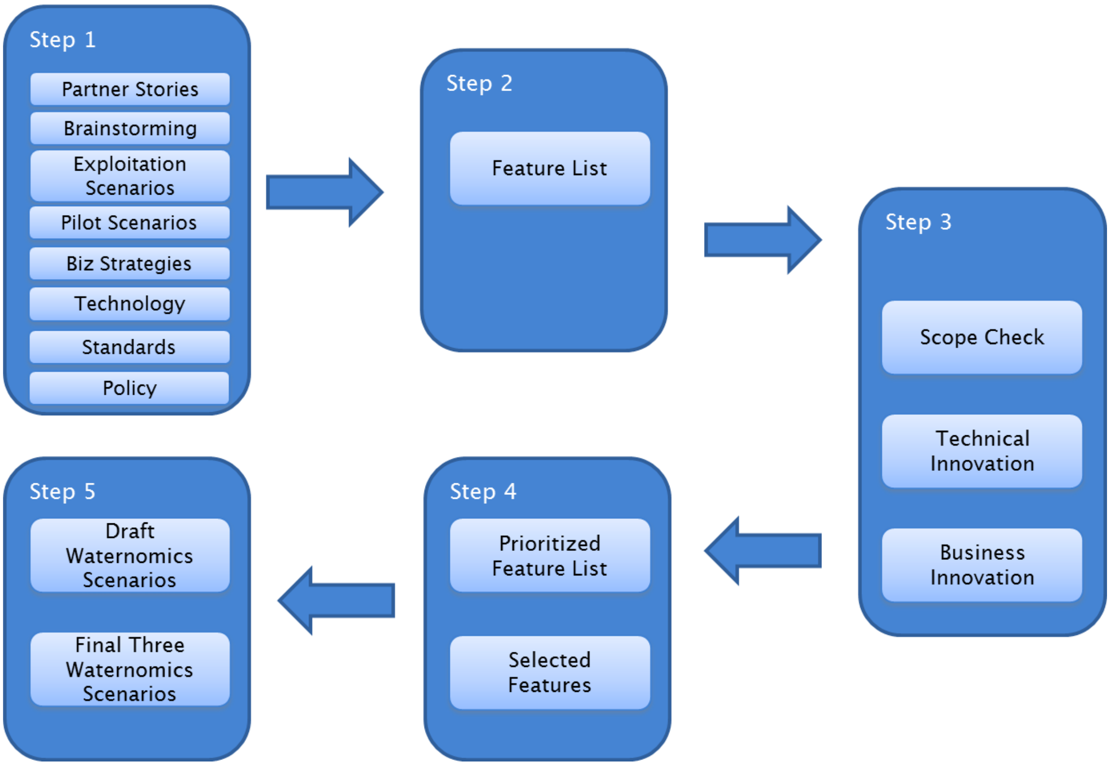


Figure 4: Graphical representation of the scenario development process

2.1 Feature list development

As the scenarios form the basis of the project, initially a broad list of functional and technical features that could be used as the basis for the scenarios were developed to ensure features that added value were not excluded (See Appendix B). These features were developed by consulting with and considering;

- Project partners
- Brainstorming sessions
- Pilot scenarios

- Business strategies
- Technologies, standards, policy

Thus a list of 68 features (where a feature is defined as any identifiable block of functionality, be it user-based or technical) was constructed collaboratively by the consortium. These features are detailed in full in Appendix B.

2.1.1 Feature list prioritisation

Given the criteria outlined earlier that WIP features should align with (i.e. end user perceived value, commercial/business value, technical innovation and aligned with the scope of WATERNOMICS) the broad feature list can then be narrowed down to ensure the WIP is targeted at the end-user and does not offer incidental features. In order to rank features a process was developed to enable, for any given end-user, features of the WATERNOMICS platform to be rated/scored based on their relevance for the application. The broad steps involved in this process are described below.

1. A list of the business criteria was assembled by various project partners to enable each feature to be scored or rated based on its business value. A similar process was carried out 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.
2. Based on the four different criteria (user-value, commercial/business innovation, technical innovation and relevance to WATERNOMICS) all features have been scored individually and 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 scoring mechanism as described in Appendices A and B. This resulted in one score per feature. In a plenary discussion involving all relevant stakeholders a selection of features was made based on this prioritised list.
3. The features should at this stage be compatible with the scenario the WIP is being designed for. In the case of WATERNOMICS three scenarios (each representing a pilot location) are being implemented (public buildings, a commercial building and domestic users.

While the scenarios have overlap, but their focus is varied and thus the features of WATERNOMICS vary between each scenario (pilot site). As a general principal it was found that the two key dimensions that were found to distinguish the scenarios and thus inform most features were:

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

2.1.2 Summary

A structured and traceable method was used to define the usage cases and exploitation scenarios for each WATERNOMICS pilot. 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. Based on these scenarios it was possible to identify and prioritise the necessary features of the WATERNOMICS platform. This chapter proposes a methodology that can identify the key features a water information platform should incorporate for any given end-user and exploitation scenario.

3 Exploitation Scenarios

A key part of ensuring a water information platform meets the requirements of various end-users involves testing and revising the platform based on feedback from key stakeholders. WATERNOMICS will achieve this through pilots in Greece, Ireland and Italy that each targets a different scenario.

In this section, generic scenarios are outlined – these are applicable to a broad range of pilot scenarios, thus increasing the reach of this document in terms of user engagement. The specific pilot sites chosen for the Waternomics project are a subset of the generic scenarios described in Table 1 below.

Table 1: Pilot Sites relevant to Exploitation Scenarios

Scenario	Relevant Pilot Site
Domestic and Public Users	Galway, Ireland & Thermi, Greece
Factory	Linate Airport, Italy
Municipalities	Thermi, Greece

The following paragraphs describe for each scenario the business context, the technical requirements and features involved. Each section 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 information service providers, utilities, users paying for services, etc.)

3.1 Scenario 1: Domestic and public users

This scenario describes how the general public and public institutions will interact with the WATERNOMICS platform. One of the primary aims of WATERNOMICS is to strengthen USER awareness about water consumption and conservation. Therefore, the platform must integrate seamlessly between domestic users, public water utilities, building occupiers and public building managers. 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.

WATERNOMICS targets a school and a university building for deployment of the platform in Ireland for two primary reasons:

1. Public schools and universities are high-traffic areas with a high throughput of users that can 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.

A typical storyline in this scenario 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 can with the WATERNOMICS platform on a daily basis and both can use integrate it into their educational process in a variety of ways.

3.1.1 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 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. Peter can also customise his app to focus on areas of most interest to him.

Scene 4: Water Analysis Software
Meanwhile, in London, Peter's 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 local town. Using data collected and made available through WATERNOMICS by the public utility, 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 impact 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. Furthermore potential savings, based on the family's current usage and water tariff are presented to him.

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 a 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 on new features.

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.

3.1.2 Business Context

Various business configurations are possible for this scenario. As an example, one business configuration is described in Figure 5 for each actor involved in the scenario.

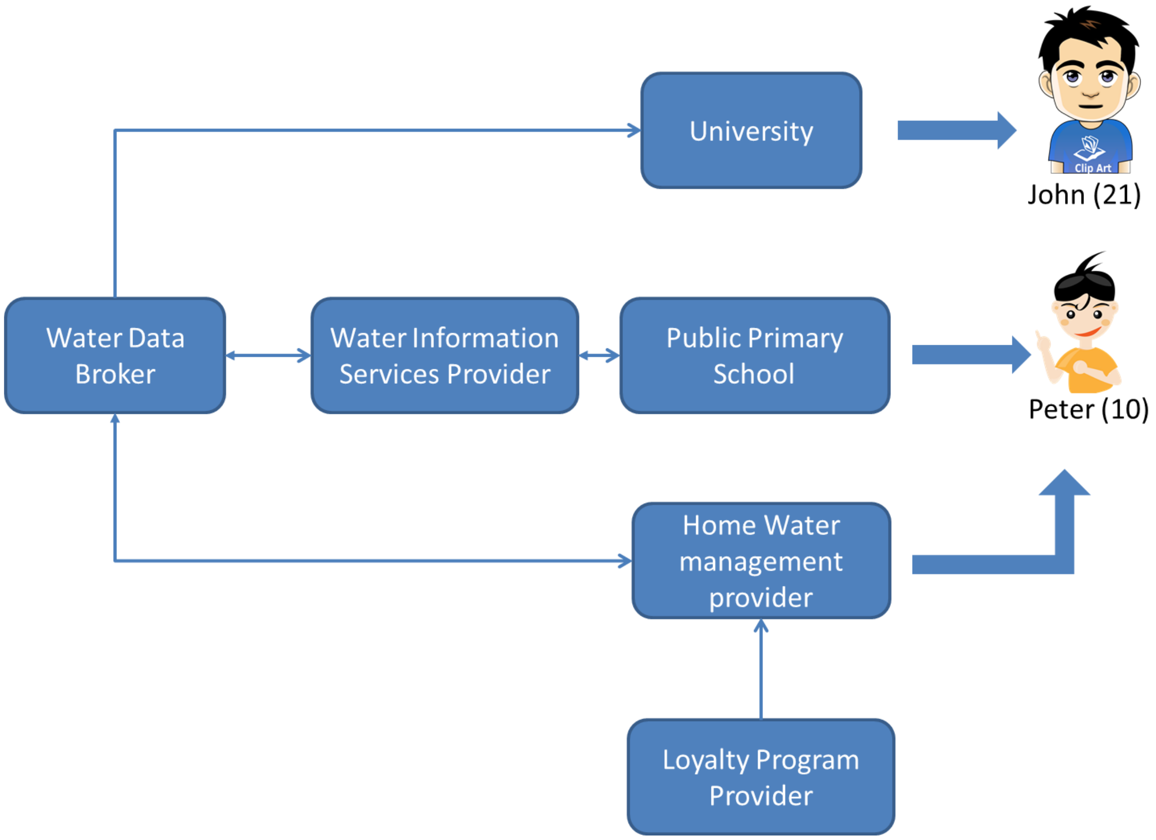


Figure 5: Business configuration for the "Domestic and Public users" scenario

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. Furthermore students can also use information from university buildings to utilise in various projects; for the university this increases the student experience and can be used by the university as a promotional tool.

For the management, protection and distribution of water related data, a new business role is introduced. The **Water Data Broker provides datasets and real-time water usage data to third parties on behaviour of end-users**. 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). The WISP is another new business role, filling the gap between end-users with a growing need for water information related services on the one hand, and water utilities not being able to address this need on the other 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. It should be noted that within an organisation such as a university the Water Data Broker and the WISP may be the facilities engineer for the organisation or an IT manager.

The **Public Primary School** may use the services of a WISP to make students and staff more aware of the availability and usage of water; though the WATERNOMICS platform is intended to remove the need for a WISP by providing easily accessible and relevant data. 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 (HWMP)** offers monitoring, simulation and information services with respect to water usage. The HWMP is comparable with today's providers of home energy management systems, who have a strong focus on design and user experience. 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.

3.1.3 Technical context

This section describes the relationship between this scenario and the technology and potential technological innovations. The numbers shown in *[F]* refer to the features in Appendix B.

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 *[F20] [F42]*. 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 *[F18] [F26]*.

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 *[F26] [F34]*.

Scene 3: Water Awareness Dashboard
A water awareness dashboard *[F2]* 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 between a range of diagrams and statistics they want to see and arrange them as they like. Time-series trends *[F10] [F53]* are used to illustrate progress. The main 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 between a wide range of metaphors of information nuggets that allow them visualise what the statistics mean. Users can also input metaphors in the system so that it calculates and presents information in the way they like. Illustrative comparisons *[F49]* and colour codes *[F47]* are used to better convey water/energy *[F59]* savings in real terms to building occupants. WATERNOMICS will also analyse which information or presentation style 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 [F52] through a secure data transmission system [F9] [F48] 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 [F12].

For example in the earlier scene where John is using WATERNOMICS as part of a university project WATERNOMICS enabled households and businesses within the town inform the simulation application the John is using. The schematics and water distribution network are based on the city itself. Historical consumption data can be used by John to calibrate and validate his simulations thus 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 town 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 [F23] [F40] [F41], the WATERNOMICS platform is capable of delivering personalised information to the end-user. A product recommendation system [F51] 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 person household” or “This appliance could save you € 100 in water and energy bills over 6 months due to reduced hot water consumption”. 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 [F25]. This game is used to teach children [F26] about the importance of different conservation measures.

The WATERNOMICS virtual water management game consists of various levels. A player starts by managing water consumption at 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 they are moved 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 [F18] 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 [F3], 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 crucial aspect however is that sharing personal information of a user's achievements is initiated by the user. This measure is taken in order to mitigate the privacy concerns of participating users. Moreover, when sharing real data users are notified accordingly and in some cases restrictions might also be applied preventing on sensitive information being revealed publicly.

3.2 Scenario 2: Factory

The Factory scenario (Figure 6) 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.

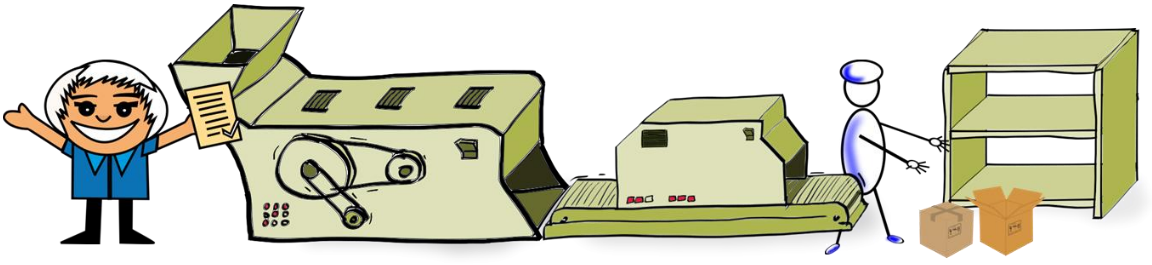


Figure 6: Factory production line

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

3.2.1 Scenario Description

Scene 1: Morning shifta
Jim is the leader of the morning shift and he just entered the factory to inspect 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. He asks Joanne, the team lead of the night shift, for the vital statistics from the night shift. 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 has been working for a couple of hours now and the production line has been running smoothly. Together with his technicians, Jim looked at the historical water and energy usage data of the troubling cooling machine. The machine is 13 years old but has a design lifespan of 20 years. They use WATERNOMICS to calculate the expected additional costs for water during the rest of its expected life time and talked through different scenarios. The Water Management System recommended replacing the cooling machine with a new generation cooler. Although not entirely written of, the savings on water and energy outweigh 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
Meanwhile the WATERNOMICS platform gives a warning that large amounts of water are being used from a pipe near the storage department and that drain number 32, which is a floor drain at the same location, is receiving unexpected large quantities of water. Edith, who is the member of the morning maintenance shift closest to this tap, also receives the warning on her smartphone. She immediately goes to inspect and finds a fallen pallet has damaged the pipe. From WATERNOMICS she indicates the defect and inputs a service request through WATERNOMICS which can link to the factory's management software. The facility engineers

then check if this section of the water network can be shut down without disturbing the primary production process. The real-time detection of this problem has saved serious flooding and also the loss of a substantial quantity of water.

Scene 4: The Sustainability Manager
Joanne, the sustainability manager of the factory, also received an alert on her smartphone that water related incident had happened. She checks WATERNOMICS on the nearest computer terminal and sees that the situation is already under control. While she is in the platform she checks on the water efficiency of the different units and production lines. Overall, water consumption has dropped 40% in the last 3 years since WATERNOMICS was deployed. Joanne had created a mixture of competitions and collaboration to increase awareness of water usage amongst staff. Departments and production lines can earn vouchers when outperforming other units but are also encouraged to share information and best practices by setting common goals for the complete factory. The vouchers 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 chaired the meeting and displayed last month's water usage information from all the companies on the screen. Every company shared their water usage information with the water data broker and had strict agreements about sharing of their data. All companies have agreed to share their data with the other partners in the value chain and this way they can more easily identify opportunities for reduced consumption. 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. As each of the company's manufacture parts for a single product, by reducing their water (and associated energy consumption), they all benefit by having a more competitive product and indeed, are able to market themselves as leaders in sustainability.

Scene 6: Blue label
Joanne was pleased to announce at the Blue Partner meeting that the Environmental Regulator had reviewed their water usage data and benchmarked it with similar industries. Because of their significant progress on reducing water consumption 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 started discussing about how to further improve water and energy efficiency. The team had noticed that specific production activities caused peaks in the usage of hot water. In day-shifts enough energy to heat water was available from their solar panels (with reserve capacity) but water was only being heated on demand but at night shifts water heating costs were high. Alternately when water was heating using electricity it would be cheaper to do so at night. To create a water buffer they planned to place an additional water reservoir which they could fill, when solar energy was sufficiently available or when costs of energy were low, and could use this water as required. Jim's team were able to use WATERNOMICS to aid with this decision by inputting details on energy costs and energy sources. Jim approved the plan and asked the team to work it out in more detail.

3.2.2 Business Context

Various business configurations are possible for this scenario. As an example, one business configuration is described in Figure 7 for various actors involved in the scenario. In this scenario other interested stakeholders may include Company A (a supplier to the factory), Company B (a purchaser of goods from the factory) and the final consumer of these goods.

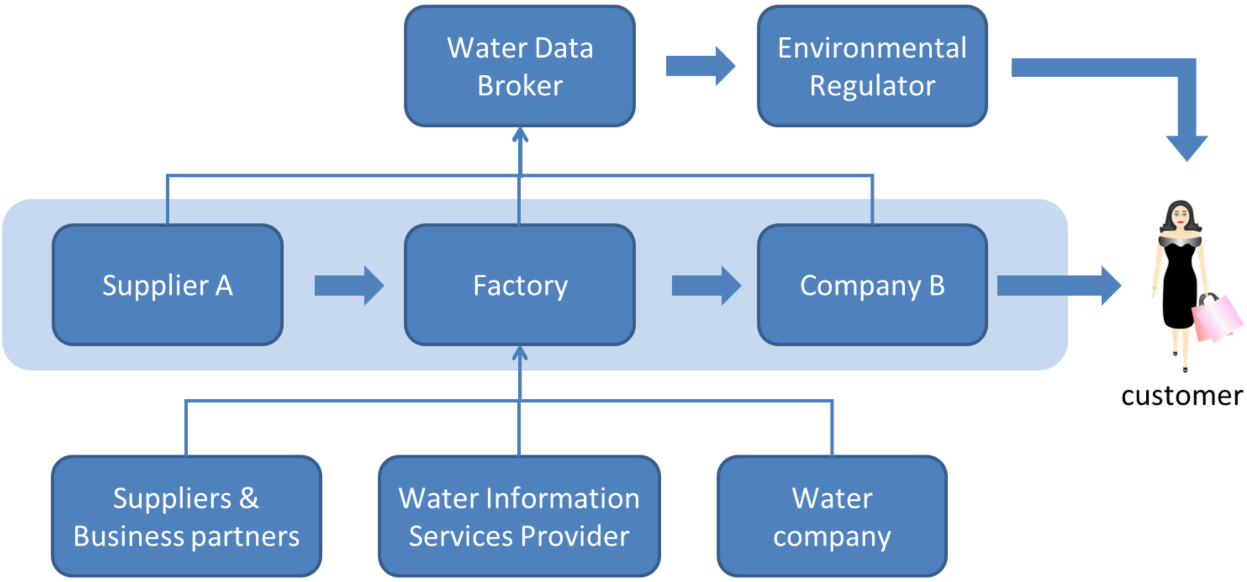


Figure 7: Business context for the factory scenario

The Factory scenario includes mainly the same business roles as in Scenario 1, but now placed in a different context. The core of this business configuration is formed by Supplier A, the Factory and Company B. Together they form the value chain for a certain not further specified product. To manage exchange of water usage related information across this value chain, a number of supporting business roles have been defined.

For the management and stewardship of water related data, the role of **Water Data Broker** is introduced. The Water Data Broker collects water usage related information from the three businesses in the value chain and ensures that only organisations with the correct permissions can access the data.

The **Environmental Regulator** can, as an independent role, collect water usage information on value chain level and benchmark this information against pre-set environmental standards or legislation. This information can be made available to customers who can include environmental aspects more easily in their buying decisions.

The **Water Company** key activity is the delivery of water in sufficient quantities and with the right quality. In this scenario, data analysis and provisioning of water information services is extracted from the Water Companies business and delivered by third parties, being the Water Data Broker and the Water Information Services Provider.

The **Water Information Services Provider** provides the Factory with water usage information from suppliers and business partners. With this information, the Factory can decide which water conservation measures will be most beneficial.

3.2.3 Technical context

The numbers shown in [F] refer to the features in Appendix B.

Scene 1: Morning shift
The WATERNOMICS platform provides commercial users with the ability to monitor how changes in production levels affect water and water-related energy consumption [F59]. Users can adapt he platform to present this information as they require. For example in the business scenes above Joanne has already pre-defined the screen to display key information she requires. The dashboard allows users to develop and conduct user-defined comparisons in order to visualize anomalies and trends. In addition, by correlating existing production line information with water-related information from WATERNOMICS, it is possible to produce relevant KPI's that 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 [F4] which may signify system or equipment malfunction.

Scene 2: Cooling machine
The WATERNOMICS dashboard [F2] provides users with the ability to examine historical information [F53] at various levels of granularity [F22] in order to investigate any issues as they arise. By running various scenarios [F15], it is also possible to determine the cost of equipment deterioration [F59] or malfunction and compare a "do nothing" scenario to the cost of replacement (or other personalised scenarios) [F51].

The WATERNOMICS platform linked dataspace can gather information about a variety of machines given using manufacturers detail (this can be automated where equipment specifications are available in open data formats). Based on this information relevant personnel in the factor can conduct simulations of the water usage of, for example an existing cooling machine, over a particular time period and estimate costs based predicted water consumption. In combination with an analysis of new machines in the market a comparison between the costs of purchasing new equipment against retaining existing equipment can be made.

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 [F4] that may indicate a leak or system malfunction. These anomalies may be communicated to relevant personnel via notifications for a smartphone application, via text message, e-mail, or social media. For example by using a 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 presenting also with a number of possible solutions based on the network diagram (this is an example of automated fault detection and diagnosis; an innovative aspect of WATERNOMICS). The user 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
In this example a technical innovation such as a leader board, linked to groups of people, departments or companies, 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 [F53] are 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 an organisation [F52] [F9].

Another important aspect described 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

This scene demonstrates the social networking aspect of the platform from another perspective. Users/groups and other entities can collaborate and choose to share information between them. 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 *[F9]* securely between users or organisations using a secure data transfer network, backed by standard data encryption protocols *[F48]*.

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 an independent organisation (such as a regulator) and the rewards have a more official character than the rewards at the school and company level. Companies may receive rewards *[F18]* 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 *[F40]* and energy signatures *[F41]* associated with water-consuming devices. By combining these data sources, it is possible to perform this identification with a higher degree of confidence. By linking peak energy usage times *[F21]* 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. WATERNOMCIS enables users to create new reports on specific equipment, and indeed, based on user-inputs detect faults that may be very specific to that factory. Thus Jim's team was able to detect the peaks of water consumption in the specific product lines that required more water than others.

3.3 Scenario 3: Municipalities

This scenario describes how WATERNOMICS 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 a WIP, it is possible for utilities to better manage their existing infrastructure, and identify improvement opportunities.

3.3.1 Scenario Description

Scene 1: Water monitoring
Nikolaos 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 Nikolaos 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, Nikolaos 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
Nikolaos immediately runs a diagnostic on the network and is able to isolate the fault to a 90 m 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, Nikolaos 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 (such as those under development in WATERNOMICS). Using automated signal analysis techniques, they are able to isolate the leak to a 2 m section of the pipe approximately 40 m downstream. They immediately alert the repair team to perform the required repairs at the specified co-ordinates. They inform Nikolaos of the successful completion of their work order.

Scene 5: Economic analysis
Once the repairs team have finished their work, Nikolaos 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 an older 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. A key aspect of this analysis is

detailed water consumption data and pattern analysis from within the WATERNOMICS platform.

Scene 6: Pricing mechanisms

Dimitris 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. Again the WATERNOMICS platform provides the necessary data and user flexibility to enable such analysis.

Scene 7: Drought prediction

Back in the utility office, Nikolaos 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. Consumers will be notified via a number of channels but WATERNOMICS platform users will be notified on their platform. The platform will, in turn, adjust to reflect the price premiums and thus enable users to monitor in real-time their consumption to control costs.

3.3.2 Business Context

Figure 8 demonstrates a number of business contexts for WATERNOMICS

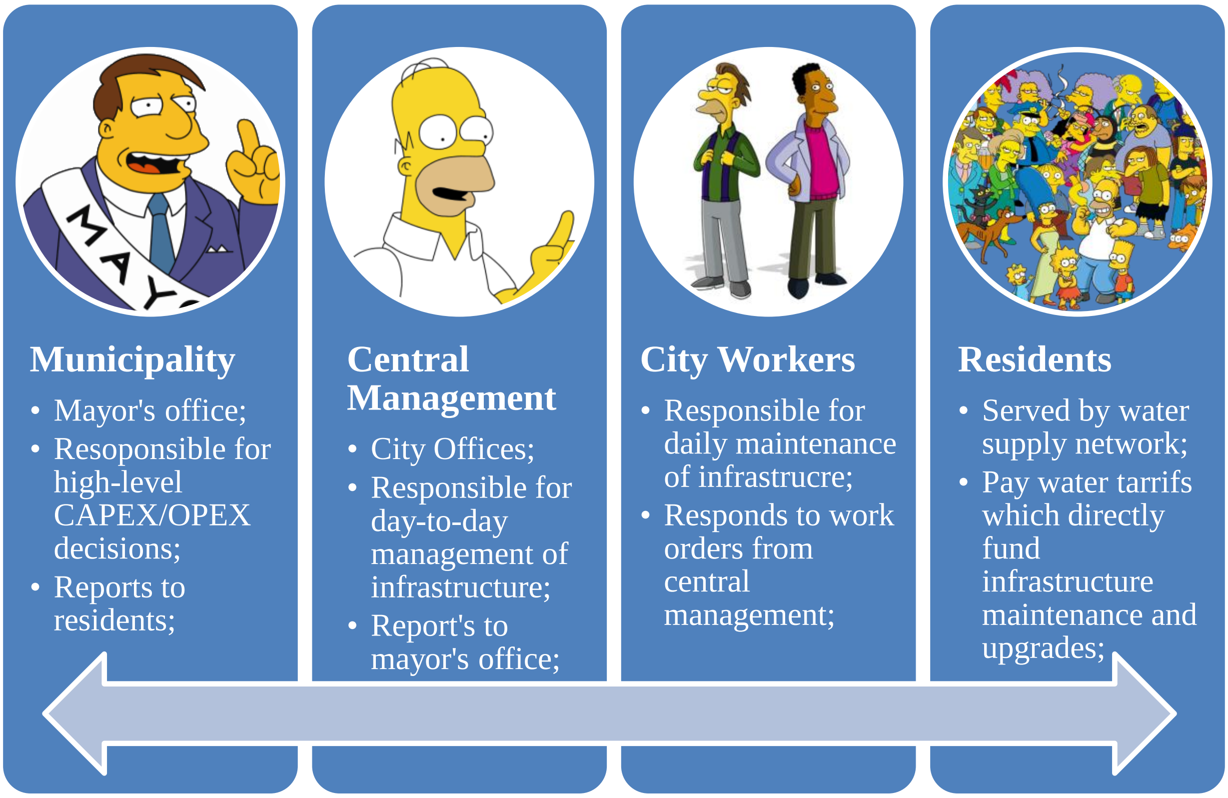


Figure 8: Business contexts for water utilities and municipalities

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 its ability 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.

3.3.3 Technical context

This section describes the relationship between this scenario, the technology and potential technological innovations. The numbers shown in [F] refer to the features in Appendix B.

Scene 1: Water monitoring
Live data [F17] collected from sensor points and nodes on the water distribution network enables engineers and managers to continuously monitor [F2] the status of the water distribution network. On-screen colour-coded alerts [F47] are used to indicate the presence and severity of faults or anomalies [F4] [F6] [F21] in the system. The alert mechanism combines various a data to identify if a specific abnormality is important or not. For example WATERNOMICS can also identify, based on historical network data within the platform, the specific part of the network that may be causing an abnormality. Therefore the notification can enable Nikolaos to rapidly take the decisions necessary to address a given problem.

Scene 2: Fault detection and diagnosis
Sensor-level alarms [F6] 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). Moreover the platform allows users at the municipality to share relevant news with specific. For example, knowing the location of a problem means users in a specific area can be notified of a problem in almost real time.

Scene 3: Remote control
Remote telemetry [F7] and control [F36] allows pumps and valves to be configured and/or switched off remotely. Bidirectional communication is not a feature included in all sensors. However, in cases such as the municipality a specific set of sensors in critical parts of the network allows for that communication and control. This way, Nikolaos can control specific parts of the network and in this case switch off the supply in a whole region.

Scene 4: Leak Detection
Work orders may be sent 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 in branches of the water distribution network. The platform also allows users reporting a problem to enrich information with pictures, sounds or video that can be useful for the technicians when confronting a problem. In addition information about the progress of fault and leakage reports is logged so that higher level operatives in the municipality use them for reporting purposes.

Scene 5: Economic analysis
Using historic data [F53] combined with physical and economic data for the water distribution network, it is possible to perform detailed 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) needs to be analysed in order to make informed decisions on capital expenditure.

The tools of the platform not only allow Nikolaos to calculate the costs of repairs and the turnover over specific periods but also provide him with a set of graphs and infographics presenting this information in a meaningful and useful way. WATRENOMICS allows him to customize diagrams, layout, colours etc. so that the result will be easily integrated in his reports.

Scene 6: Pricing mechanisms

Using past data *[F53]* 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 *[F37]*. The platform tools for exploring pricing policies allow the customization of a variety of parameters such as volumetric charging bands and seasonal variations. This can utilise economic data to estimate the impacts of varying water tariffs on consumption and can be useful where shortages are predicted.

Scene 7: Drought prediction

Weather data and usage pattern data may be combined in order to provide a more accurate prediction of water availability *[F1]* and possible periods of expected drought *[F35]*. When Nikolaos issues the notification to the users he can easily direct them to parts of the platform that indicate drought conditions and water availability so that they can also follow the situation and adjust their behaviour accordingly. These parts of the platform can be easily inserted as components in every user's dashboard so that relevant information is included.

4 Business Strategies

This chapter describes the strategic options for a WATERNOMICS; in particular the commercial and market options, Furthermore the business models that could be used to exploit the innovation within WATERNOMICS are reviews. The strategic options are based on the results of market consultation and desk research.

4.1 WATERNOMICS strategic options

To determine the various options for positioning WATERNOMICS on the market, three strategic levels (Figure 9) need to be considered.

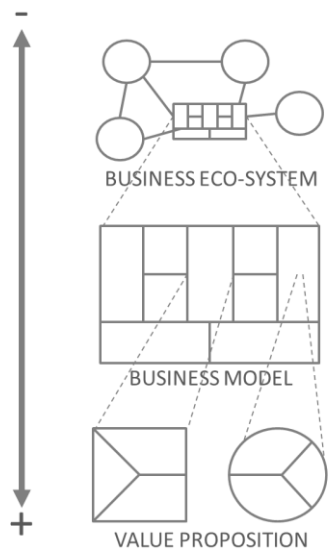


Figure 9: Strategic levels for developing WATERNOMICS business case

Initially in this process the position of WATERNOMICS in the business ecosystem is considered; for example what is it's interaction with water and energy utilities or indeed information driven companies like Google and Facebook. Looking at a level closer the business model for WATERNOMICS platform itself is then considered (e.g. the relationship between customer segments, delivery channels and key activities and resources and the resulting cost and revenue structures). Zooming in at the closest level, the WATERNOMICS value proposition and fit within various consumer segments is analysed. This necessitates a deep understanding of the customer's individual challenges and requirements and the fit with WATERNOMICS value proposition. For the WATERNOMICS proposition to be successful, all three levels need to be strategically aligned and designed in such a way that they complement and reinforce each other. The following section takes a closer look at the strategic options at each of the three levels.

4.1.1 WATERNOMICS business eco-system

The business context in which water utilities operate, is changing rapidly. Three major trends are expected to impact on utilities business model:

1. **Changing customer expectations**. With the uptake of the Internet and mobile devices, customers are used to having access to personalised information anywhere, anytime.

2. **Connected devices.** Sensors and smart meters, combined with new technologies to capture, process and analyse the resulting large amounts of data, provide more detailed and real-time information about the status of the water distribution network and usage patterns.
3. **Change in demand.** Growing populations and decreasing water reserves cause people worldwide to be more efficient with the available sweet water reservoirs.

Uptake of water information services has, to date and to varying extents, been seen within water utilities, energy utilities, some large industry and in the home automation domain. Each of these commercial domains has its own characteristics, policies, regulation and culture and each is affected by, and responds differently to the major trends described above. For the successful exploitation of WATERNOMICS, it is important to recognise which industry is targeted, to understand their attitude towards their changing business environment and to adhere to the rules and business culture of that industry.

Water utilities have an image of being conservative, slow moving, risk averse and monopolistic. One of the major issues water utilities face, is the lack of capital needed for replacing ageing parts of their water distribution networks. Because of the lack of competition and the restrictions imposed by national laws and policies, the incentive to optimise operational efficiency or invest in the customer relation is less than in more competitive industries. Reliably delivering safe drinking water is often the key (and only) concern for utilities.

Energy utilities are in transition – for example customers have become energy producers by installing solar panels or wind mills. Major investments have been made in the energy grid to deal with these and other developments in distributed energy production (micro-generation). As a result, the energy grid is "smarter" than the water grid and energy utilities have more experience and knowledge of smart grid technologies. Because of the liberalisation of the energy market, more effort is put into creating customer intimacy and developing value added services with which energy utilities can distinguish from competition. Energy utilities have invested more in enabling technologies for these value-added services which is, for example, demonstrated by the larger installed base of smart energy meters compared to the number of installed smart water meters.

In the home automation domain new products for energy management are emerging. Targeted at the highly competitive consumer market, these products are well designed and customer oriented. The home automation market is fast growing and consists of many non-interoperable technologies and applications. With telecom operators, broadband service providers and utilities entering this market, competition will be intensified. WATERNOMICS must be cognisant of these developments and flexible in meeting new expectations of consumers to have remote and meaningful access to data that can help them save money but also improve their environmental credentials.

Each of the markets imposes different requirements on a WATERNOMICS business model. Targeting water utilities and their customers, WATERNOMICS should demonstrate the benefits of new connected sensors and meters. Since data collection and analysis is historically not a core activity of water utilities, WATERNOMICS should either offer data analysis as a service or ensure that their value proposition is easily picked-up by non-specialists, possibly supported by sufficient training.

When entering the energy utility domain, WATERNOMICS should focus on the areas where water and energy utilities overlap. Typically these are the areas of customer engagement, metering and billing, and asset management. WATERNOMICS technology should support standards used in the energy domain.

When engaging the consumer market through energy management systems, pricing and product/service design becomes more important. The WATERNOMICS platform should be broken down into separate products or services, each creating sufficient end-user value to justify its purchase and enabling new value added services when used in combination. Complexity should be minimised, though where users require, the platform needs to enable users adapt the platform to suit their individual needs.

4.1.2 WATERNOMICS business model options

For the description and visualisation of a business model, the Business Model Canvas from Osterwalder (2010) is used. Figure 10 shows the nine building blocks of the Business Model Canvas.

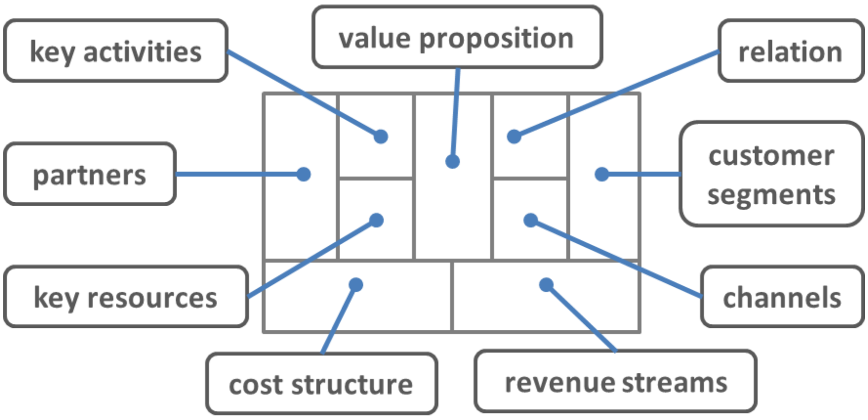


Figure 10: Business model canvas

Finding an appropriate business model for WATERNOMICS means finding a problem-solution fit where the WATERNOMICS methodology and technology is (part of) the solution. WATERNOMICS should encompass innovative value propositions; some of which are listed below:

New value propositions. Smart water technology enables new value propositions, not previously possible today of lack of (near) real time water consumption and water network status information. Examples of new value propositions are personalised water recommendation services for households and corporate users, outsourced water management services for industries or integrated water and energy management services for industries and households.

***Increased customer intimacy** (*Figure 11*)*. Availability of water usage information and increasing the number of customer touch points can create an opportunity for water utilities to increase their customer relationships. Instead of estimated billing, customers can be charged based on real usage and with higher frequencies. Customer support can advise customers on their water consumption can recommend water saving mechanisms in a personalised way and can alert customers when deviations in usage pattern are detected. By having a stronger customer relationship, it will be easier for utilities to get support for water conservation programs or to involve customers in the development of new water conservation initiatives.

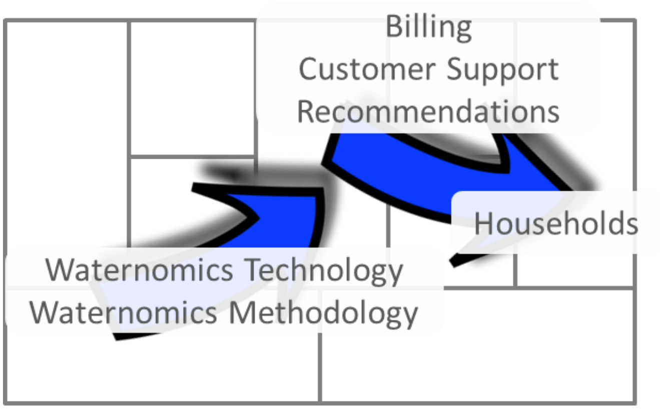


Figure 11: Impacts on customer relations

Service bundling. Water management or information services can be bundled with energy management or information services to benefit from shared infrastructure and resources. Water services can even be bundled with other commodity services like telecom or internet services. All these industries have usage based revenue systems, and similar billing and customer support systems which could be managed more efficiently when combined for multiple utilities or service providers.

New revenue streams** (*Figure 12*). With the collecting of more detailed and near real-time information about water availability, water usage and water related energy usage, new, more flexible pricing options become available. Water prices can be based on actual consumption in specific timeframes. Another area where new revenue streams for water utilities, technology providers or consultants are enabled is in the delivery of value added services based on the information technology required and data and information becoming available. Many water utilities and companies don't have the expertise to set-up and operate a water information system. Companies who do have that experience can offer training, consultancy, project management, strategic management or data analysis services.

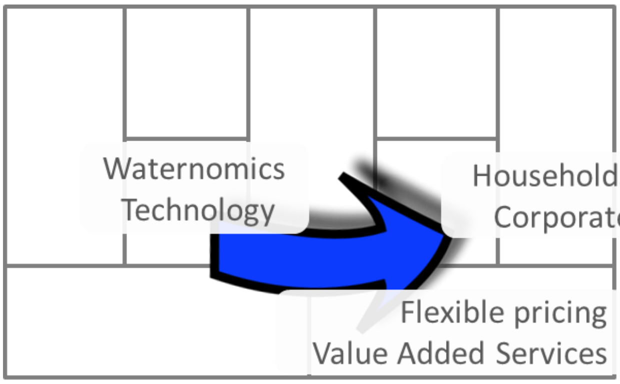


Figure 12: New revenue streams

Delivery channels** (*Figure 13*). Implementing a water information system in an existing organisation can be a complex and challenging operation; often this is facilitated by utilising experts or specialist services. This can be a water utility, delivering a water management system to a corporate customer, a technology provider installing a specific piece of technology in the water distribution network of the water utility or an expert consultant, delivering a water information system to a water utility or corporate user. In case of delivering WATERNOMICS enabled products or services through such channels, the WATERNOMICS proposition should also be attractive for the expert or consultant.

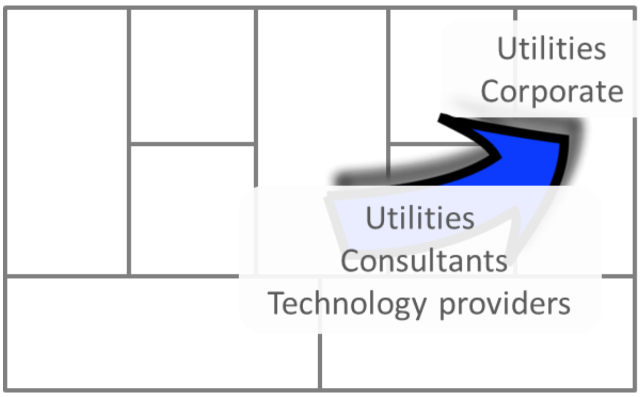


Figure 13: New delivery channels

4.1.3 Delivery of smart water systems through consultants

The consultancy industry is a very heterogeneous domain with small and large consultancy companies, some specialised in a niche market and others covering a broad range of industries and topics. Consultancy agencies specialised in the water domain might be very clear about what they require from a WATERNOMICS product or service and only need to adapt it to their clients' specific situation. Other consultants may be 'new' to the area and need more assistance or help with selling this new technology to their clients. This could be in the form of training on the technology or the methodology or in terms of support for the sales process.

For experienced consultants in the water domain it is important to understand the full potential of the tools and technology, so they can set-up a business case for their clients and include WATERNOMICS in their portfolio. For consultants working not directly in the water domain or with less experience, it might be sufficient to understand the overall concept and key benefits or get an introduction in WATERNOMICS technology and methodology. Drivers for consultants to adopt WATERNOMICS could include:

- Extending their service portfolio
- Offering their clients better solutions for their problems
- Attracting new customers
- Maintaining an innovative image
- Association with an innovative and well-known methodology/technology

The role of the consultant is to advise their clients on the most appropriate solution for their specific situation. Furthermore, consultants can offer specific services like conducting a "water audit/water review" provide a metering and sensor plan or data analysis services.

Typically, a consultancy agency will collaborate with technology providers who deliver the technological part of the solution. One of the ways to deliver the technological solution is through cloud services in a SaaS model. To support consultants in their work and maximise adaption of WATERNOMICS services in a SaaS model, WATERNOMICS should provide:

- Training and information sessions, like webinars
- Case studies, thought leadership and success stories, proving the effectiveness of the WATERNOMICS solution.
- Strong arguments to counter cloud related questions. If the issue of cloud storage is not addressed properly, security conscious organisations may require installation of software on their servers or onsite, which results in higher costs for onsite installation, remote assistance for upgrades, maintenance, etc.

It is key that WATERNOMCIS provides consultants with attractive revenue streams including:

Commission model: Consultants receive a percentage of every sales made from the technology provider. Differentiation can be made based on the expert level of the partnering consultant. Senior consultants could provide part of the services themselves, resulting in a different pricing model.

Time/Material model: Consultants charge their clients for their services based on the time spent and costs made.

4.1.4 Unbundling the water utility business model

Looking at the current water utility business model, the focus of utilities has historically been on managing the water distribution network and managing water quality. With changing customer demands and a shift towards a more service oriented approach, customer relationship management and service innovation gained importance over the last decade. In principal, customer relationship management, service innovation and infrastructure management are different types of businesses with conflicting interests and trade-offs have to be made when a single companies business model spans all three types of businesses. Unbundling of the water utility business model permits the three resulting businesses to focus on their core business. Examples of unbundling of business models are visible in the telecom domain and energy domain (Figure 14). In the telecom domain, network management is handled by equipment manufacturers and separated from customer relationship management which is managed by the telecom operators. The same pattern is seen in the energy domain where energy providers focus on customer relationship management and energy producers focus on energy production and network management.

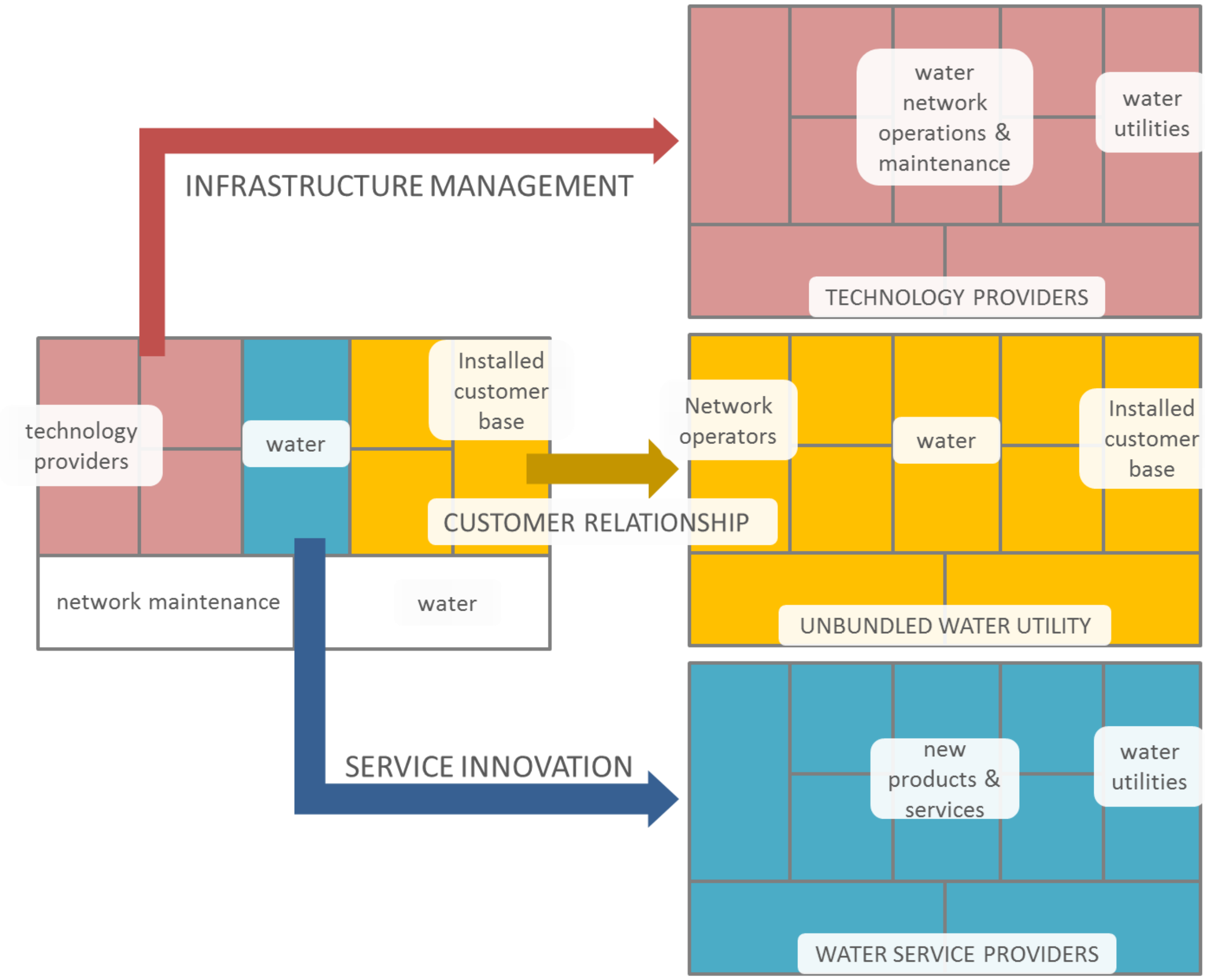


Figure 14: Unbundling the water utility business model

The unbundling of these markets is important as it drives innovation and also provides for a new set of challenges as consumers and utilities relationships change. WATERNOMICS needs to be cognisant of these changing relationships and trends in the water space as summarised below.

Technology Providers. Water utilities have outsourced operation and maintenance for part of their networks to technology providers like Suez Environment, IBM or Siemens. Technology providers can run the water distribution networks more efficiently because they serve multiple water utilities at a time and benefit from economies of scale.

***Unbundled Water Utility*:** After unbundling its infrastructure business, a water utility can focus on customer intimacy and segmenting customers and services. A strong customer relationship increases the effectiveness of water conversation programs. For deregulated water utilities, like in the UK, annual churn (i.e. moving from one utility to another for) can increase to up to 25% making attracting and retaining customers a key activity of the utility.

***Water Service Provider*:** Developing new, attractive services can be done more rapidly and efficiently by smaller, specialised, creative firms with the right skills and knowledge for service innovation. By working with multiple innovation agencies, utilities ensure access to the latest technologies, social trends and media.

In an alternative unbundling scenario, water utilities could focus on water network and operations, leaving customer management to other parties.

4.1.5 Designing value propositions for WATERNOMICS

For the description of the various options, the Value Proposition Canvas (VP-Canvas) from Osterwalder (Osterwalder 2014) is used. The VP-Canvas focusses on two elements of the Business Model Canvas, namely ‘Value Proposition’ and ‘Customer Segment’. With the VP-Canvas customer needs are explicitly linked to the value proposition and allows more detailed analysis of their relation and fit (Figure 15).

The VP-Canvas breaks a customer (segment) down into three elements, being:

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

A good value proposition should address these three drivers in order to be of interest for the customer. WATERNOMICS has the ambition to serve three distinctive customer segments, municipalities, households and corporate users.

Since this is a very high level segmentation, customer jobs, pains and gains can only be defined in general terms. For the design of value propositions around WATERNOMICS, a more detailed look at a specific customer segment is required. From a generic customer segment like municipalities or corporate users, sub-segments can be derived. For example municipalities can have characteristics such as being located in arid regions, low population or high income. Corporate users can be further broken to, for example, energy sector, SME’s or water intensive industry. At a deeper level, the benefits for individual organisations should be considered while at the lowest level, understanding of the job, pain and gain of the individual stakeholder within an organisation, like an operations manager, sustainability manager or field engineer is needed for the design of a suitable value proposition.

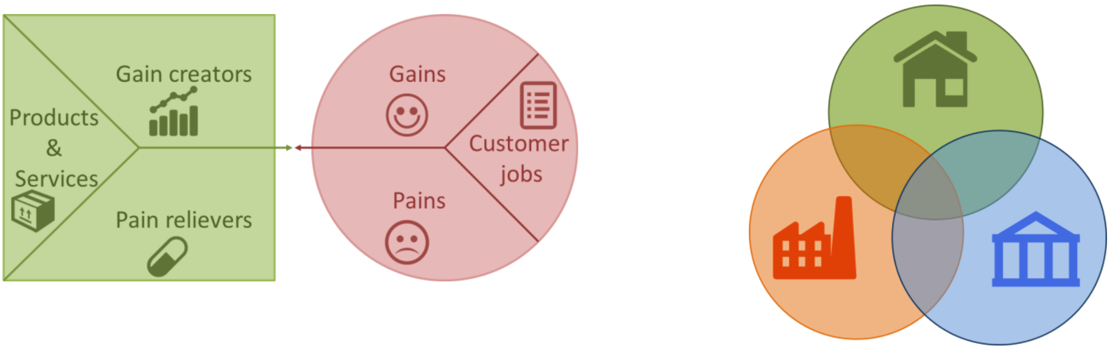


Figure 15: Value proposition canvas (right) and WATERNOMICS customer segments

Since WATERNOMICS aims at changing consumer water consumption behaviour, the strongest value propositions target individuals in every role a consumer can fulfil. For example, a person can be a family member, a citizen or a stakeholder in one or more organisations. The effect of water awareness campaigns or water information services is highest when in all roles the consumer receives the same consistence messages or information, targeted at their specific situation. To determine benefits that cut across all sectors the person's lifestyle, pains and gains on the level of singe municipality, singe household and single organisation are considered. A person's role will vary widely (Figure 16 - e.g. from worker and product consumer to parent) but in general every household and company has a need for sufficient and safe drinking water to support their activities.

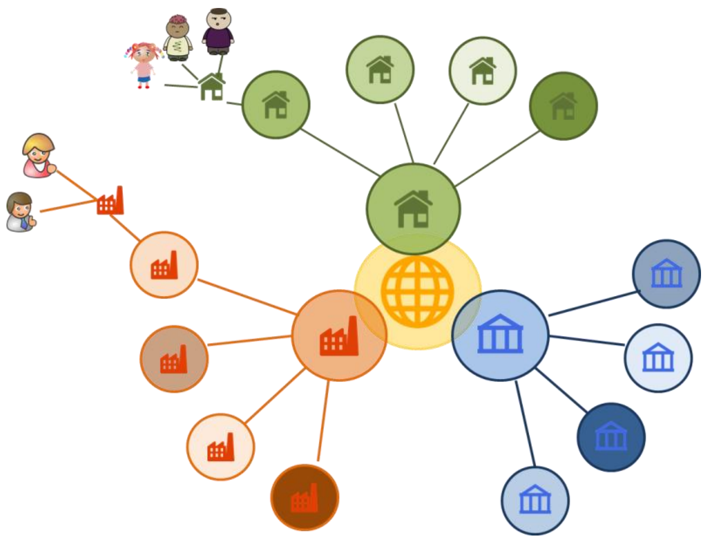


Figure 16: Levels of customer relationship

A person impacts on water use either directly or indirectly. For example, at a household level activities directly affecting a consumer's water footprint include cooking, sanitation, washing of clothes, gardening, maintaining swimming pool etc. Products that contribute to the indirect water footprint are clothes, meat, vegetables, fruit and purchased goods and services.

Indirect water consumption accounts for 98% of the water used by households in the Netherlands and as the lack of water footprint information on a product level makes it challenging for individuals to influence their indirect water usage, it is important to consider this part of their consumption as part of a WIP.

Table 2: Customer jobs, pains and gains of households

Customer jobs	Pains	Gains
Direct water footprint • Bathing/showering • Flushing toilet • Cooking • Gardening Indirect water footprint • Purchasing cloths • Purchasing food • Purchasing products	Disruptions in availability of water No or limited availability of certain products Feeling bad every time taking a shower Unexpected increases of the price of water	Save on water bill No unexpected costs at annual billing Contributing to a better environment Good social reputation

For corporate users water usage is dependent on the business they operate in. In general they share the pains and gains as listed in the table below but the risk level for each element will differ between organisations. Also water consumption patterns and policies of businesses in other parts of their value chain can impact on the reputation or opposed regulation of an organisation. Since more organisations recognise this interdependency, managing of water footprints over value chains is becoming more common, especially in water intense industries.

Table 3: Customer jobs, pains and gains of corporate users

Customer jobs	Pains	Gains
Direct water footprint • Production process • Packaging • Cooling • Heating Supply chain water footprint • Purchasing raw materials • Transportation • Product use	Disruptions in production Insufficient water quality Unexpected increases of the price of water Bad sustainability reputation Regulation restricting water use Increased costs for disposal of waste water Water management in other parts of the supply chain Expiration of water rights	Reduced costs of water Reduced costs of energy Reduced dependency of water Guaranteed access to water Good sustainability reputation

Municipalities roughly share the same customer jobs, considering the citizens their customer, their role is to provide an attractive and safe place to for lifestyle and work. In all of these elements, water plays a role. First and most important, the municipality is responsible for the access of all citizens to safe and sufficient water. Arranging drinking water services (and water purification services) is one of the core activities of a municipality. In all other public services, water plays the same role as for corporate users. The main difference with corporate users is the level of influence a municipality has on public buildings and services. With that influence, municipalities can set an example or standard with respect to water management and sustainability.

Table 4: Customer jobs, pains and gains of municipalities

Customer jobs	Pains	Gains
• Food • Shelter • Mobility • Labour • Education • Security • Public services	Insufficient water for all users Low water quality causing sickness Increased costs for extraction and treatment of water High maintenance costs for water distribution network	Reduced costs of water Reduced costs of energy Reduced dependency of water Guaranteed access to water Good sustainability reputation

4.2 Strategic analysis of WATERNOMICS target markets

To gain an 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, roundtable sessions and the study of publications and reports, business configurations and drivers have been investigated from the perspective of three different target groups; namely municipalities, corporate users and domestic users. To demonstrate the impact of the findings, Osterwalders Business Model Canvas is used to display the elements of the target group business model that are most affected by water management. The results of the interviews, workshops and desk research have been fed back into WATERNOMICS 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. Further details of these meetings, interviews and roundtable sessions are given in Appendices (C, D and E).

4.2.1 Corporate users

Every industry consumes 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 company’s business model.

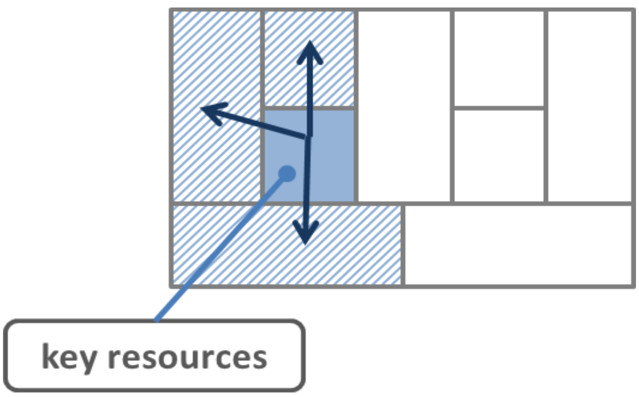


Figure 17: Key areas of a corporate business model impacted by smart water technology

Attitudes towards water management are reflected in the way various businesses execute water efficiency strategies. Differences have been found in the following areas:

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

4.2.1.1 Water management as a key activity

Roughly two kinds of businesses were identified: 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 (Table 5).

Table 5: Comparison of water management in two major food 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

The difference in how water for the production of their products is striking. 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 processes show considerable variation. 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 does not measure water usage in real-time and at a less detailed level, (water consumption measured at its entry to and exit from the factory and large water consuming equipment such as cooling installations).

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

Where water management is considered a key activity, as in the case of Aviko, businesses expect to gain a competitive advantage by controlling and managing their complete water system. These advantages can be of a strategic nature and can include (i) having exclusive access to scarce water sources, or (ii) operational, being able to produce in the most efficient and cost effective way. To establish an autonomous water system, requires investment in systems for water extraction, treatment, distribution and quality control that must in turn lead to rapid payback (though sometimes an investment can be made to give a company a “green” image).

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.

4.2.1.2 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 6 and Figure 18. 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.

Table 6: Water consumption per passenger (pax) for various airports

Airport	Movements	Passengers	Water consumption (m^3)	Water usage per passenger (m^3/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

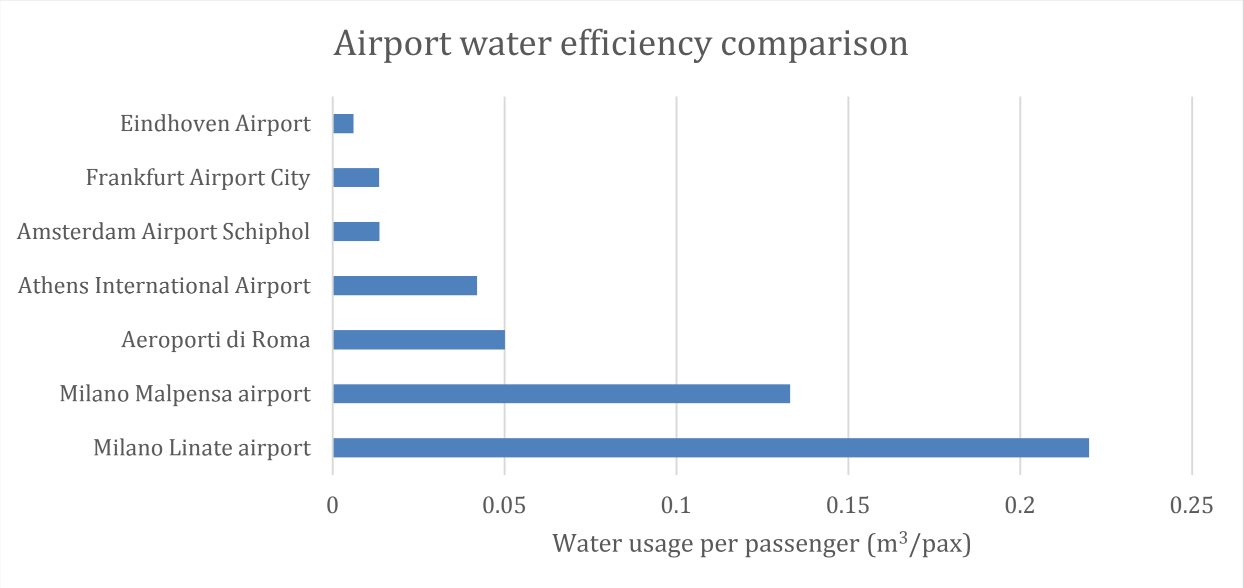


Figure 18: Airport water efficiency comparison

A key difference between industries is the granularity of water consumption data available. 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.

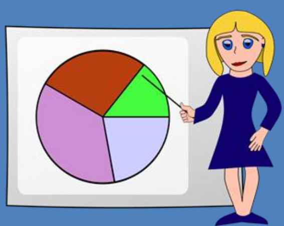
For example, water usage is measured at different time intervals, ranging from once a year in the case of one family hotel interviewed to real-time in the case of Aviko. Due to the low price of water, especially compared to the price of energy, and the lack of environmental damage in the case of leakages, 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.

At Mars, where water measurement is more granular than the hotel but not real-time as in Aviko, 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 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.

4.2.1.3 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. Table 7 provides an overview of the most common stakeholders and their needs.

Table 7: Common stakeholders and their needs in terms of water consumption data

Stakeholder	Data Requirements
 **Maintenance staff /operator**	Maintenance staff need 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 working at different locations, information can be presented on mobile devices such as mobile phones, tablets or portable readers, as separate applications or embedded in existing dashboard applications. The information is actionable, i.e. it should provide meaningful data about the location, implications 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 provide 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, is an alarm required.
 **Senior management**	Senior management need 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 including water pricing, water availability, policies, regulation, and 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 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; this can serve the needs of environmentally aware consumers while not alienating customers with less interest in 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 that information might help companies better relate to consumers, shareholders and other stakeholders to 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.

4.2.1.4 Innovation strategy

Innovation strategies are underpinned by the fact that companies must see payback within a relatively short period of time. The companies interviewed as part of this report (Appendix C, D and E) 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.

When implementing new innovation 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 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.

Companies interviewed that use large quantities of water will have innovation strategies overseen by 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. For example, Aviko is investing in research for less water intensive potato cultivation techniques. Companies that 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), one can distinguish four different types of approaches companies use with respect to innovation in corporate water management (Figure 19). The four different approaches are:

Basic: 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 are typically low, no large investments in water information systems will be made.

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

Optimised: Companies that see water as a key resource but lack a mature water management system, often focus on establishing a water information system specific to 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.

Shared: Companies that see water as a key resource and 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.

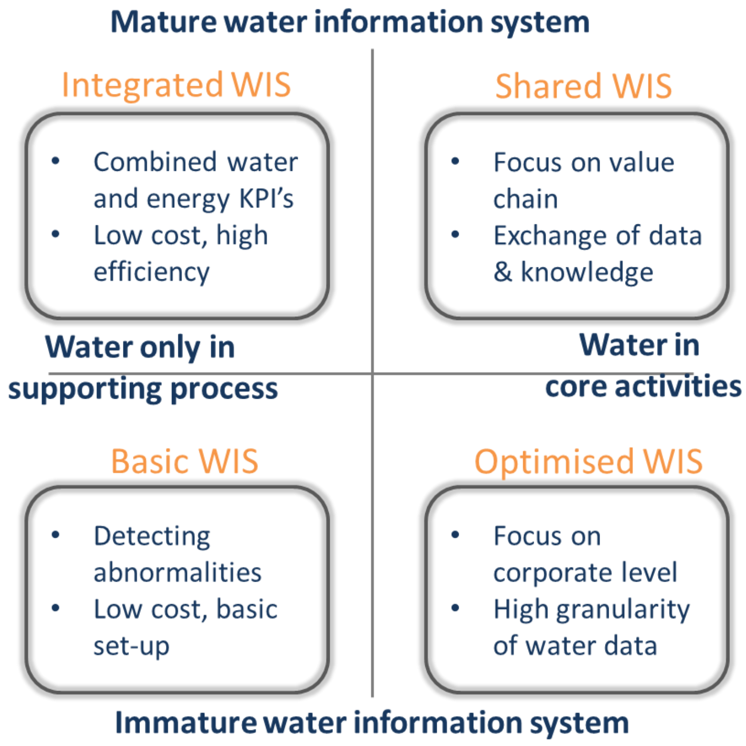


Figure 19: Innovation approaches

4.2.2 Municipalities

Municipalities have an overriding 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. This section reviews the pros and cons of privatisation of water utilities, investigates the various pricing structures used by European water utilities and takes a closer look at how utilities ensure accessibility of water also for low income citizens. These considerations impact on how WATERNOMICS interacts at the municipality/consumer interface.

4.2.2.1 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. Compared to the energy sector, there is less literature on the regulation and profitability of water companies. An interesting insight is that the profitability of water utilities is significantly larger if regulation is done at the municipal level, maybe because of easier regulatory capture, and if a price cap mechanism is in place, i.e. the regulator allows prices water to increase according to the inflation rate minus expected efficiency gains (Reynaud and Thomas 2013).

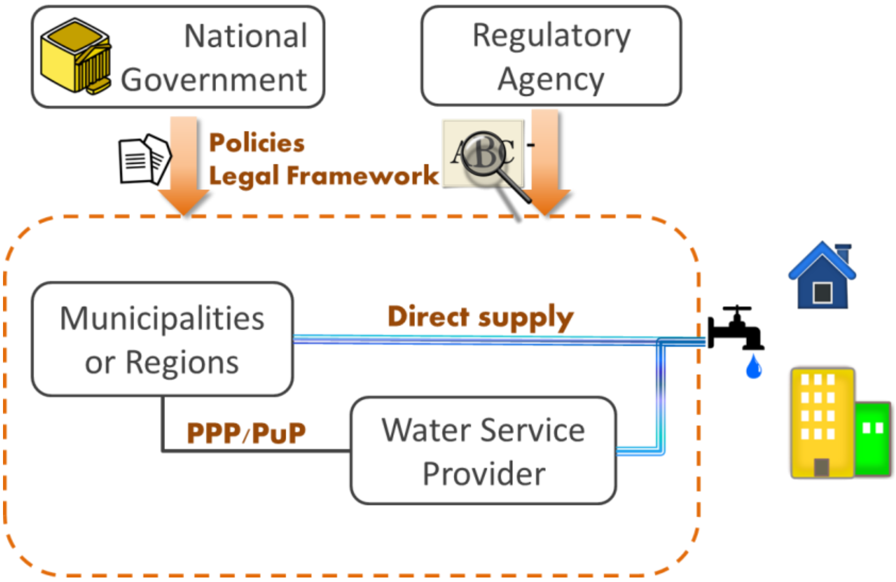


Figure 20: municipal water supply

4.2.2.2 Privatisation of water utilities

Organisations like International Monetary Fund, the World Bank, World Water Council and parts of the United Nations generally favour the privatisation of public services, and view it as a necessary step to both fixing public finances and increasing productive efficiency. However, all agree water must be accessible and affordable for all citizens. 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, non-governmental organisations; political parties and environmentalists who claim that privatisation can increase prices, increase poverty and exclude people from access to clean drinking water (Figure 21).

Figure 21 - Pros and cons of water privatisation

In Europe there are recent signs of a trend to re-municipalising water services as private contracts expire (e.g. Paris and Berlin). Major private water companies such as 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 excellently 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.

4.2.2.3 Utility segmentation

Utilities range in size and level of technological capabilities. Thus merging municipalities necessitates integration of different systems and investment policies to ensure all involved locations are at the same technological level. Considerable investment in physical and management infrastructure is often required and thus market segmentation can become embedded. 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 and thus may provide improved services when compared to smaller less advanced utilities. Thus WATERNOMICS need to adapt to the level of existing technology in place.

4.2.2.4 Pricing structures

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). Indeed in Ireland water has been free of charge for almost all domestic consumers until the recent set up of a national utility "Irish Water". From 2015 a flat rate water charge will apply at a rate of €160 per annum for a single person household and €260 for households with two or more people. Households can offset a portion of this tariff by applying for a "water conservation grant" which is worth € 100 for any household.

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. Table 8 summarises the most commonly used pricing mechanisms.

Table 8: Overview of common water 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

4.2.2.5 A fair water price

Water companies face a 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, decreasing block tariffs have a negative impact on conservation efforts and reduce incentives 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 efforts to do so were politically damaging. In Ireland the introduction of domestic water charges has seen caused considerable political controversy and mass protest leading to recent price restructuring; though it should be pointed out a majority of households have signed up to Irish Water for billing. In such cases, municipalities or utilities lose money on their water operations and recover those costs through other revenue generation (or financing) measures. As a consequence, politicians and regulators alike are held less accountable if pricing of utilities – in our case: water- does not reflect true costs. This can be the case, where inefficient water provision might be masked by tax increases elsewhere. Figure 20 shows various water tariff options.

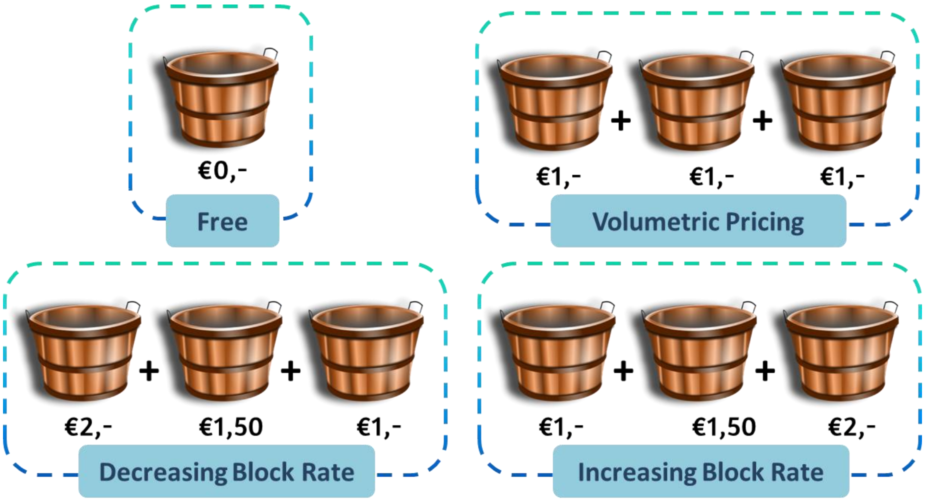


Figure 22: various water tariff options

Other aspects to be considered when determining the water unit price include

(i) the service levels;

(ii) what customers get for their money in terms of quality, education and water availability;

(iii) the operational efficiency of the water company, and;

(iv) should the customers pay for badly managed companies. In other terms both supply and demand side factors must be taken into account.

The European Union 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 (e.g. environmental costs or resource costs). To ensure universal access to water, most governments subsidise water companies. A key question is how policymakers can prevent poorly 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. In the presence of a local monopoly in water provision, information about water prices in other communities should help citizens to assess their water bill in comparative terms, and possibly raise complaints at the local level in order to improve efficiency. This mechanism is called “yardstick competition” and is widely studied in regulation economics and political economy (Shleifer 1985, Besley & Case 1995).

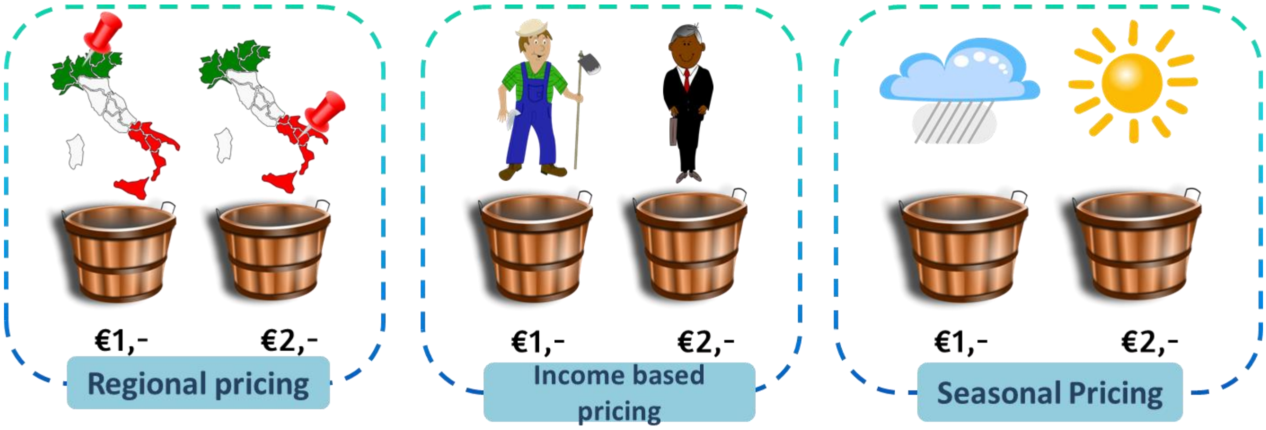


Figure 23: Geographical and socio-economic water pricing options

4.2.2.6 Pricing structures from the energy market

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

- Flexible tariffs (Electricity market): Different prices for different times of the day, depending on the availability of electricity.
- 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. This seasonal variation in water prices might be amenable to gamification efforts for two distinct reasons; (i) water costs change over time and this should imply that the strength of incentives to save on water changes correspondingly, and (ii) the social network aspect of gamification might be enhanced during summer, when water conservation is more of an issue and at the same time people might be on vacation. This might be relevant for some public buildings and for *young* users. 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.

4.2.2.7 Accessibility of water

Water is often relatively cheap. Governments want their citizens to have access to drinking water since water is a basic requirement. To keep water affordable various mechanisms exist, for example in Belgium every individual has the right to 15 m^3 of drinking water per year at no charge. In Thermi (Greece) 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 into 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 – for example an assumption is made 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 at the Thermi round table session (Appendix C) 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! Thus information on water consumption can provide interesting data on lifestyle and habits (as an aside this can also raise privacy concerns). 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. As an example 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.

However, not all conservation mechanisms are well received. For example consumers expect a constant, and high, pressure level on their taps, thus if the pressure level drops due to energy saving measures, consumers will complain to the utility and consider this a fall in the level of service.

4.2.2.8 Technological infrastructure

Utilities are not only interested in average usage but also in expected peak usage on an hourly basis. This is useful for efficient design and upgrades of the water network. One utility interviewed (Appendix C) 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. This level of metering has enabled the utility detect abnormalities in water usage and establish a bank of historical usage information and information on water reservoir levels that inform better models and more efficiency water production.

In terms of consumer relationships the lack of technology can cause significant problems. At its simplest, in many cases 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. Thus there is a need for an early warning system for customers so they can act immediately when water usage increases unexpectedly.

In Thermi, Greece, maintenance staff visits the households and use a handheld device with RFID to read-out the meter. Measurements at the customer's premises are done on a 2-4 monthly basis. 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.

4.2.3 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.

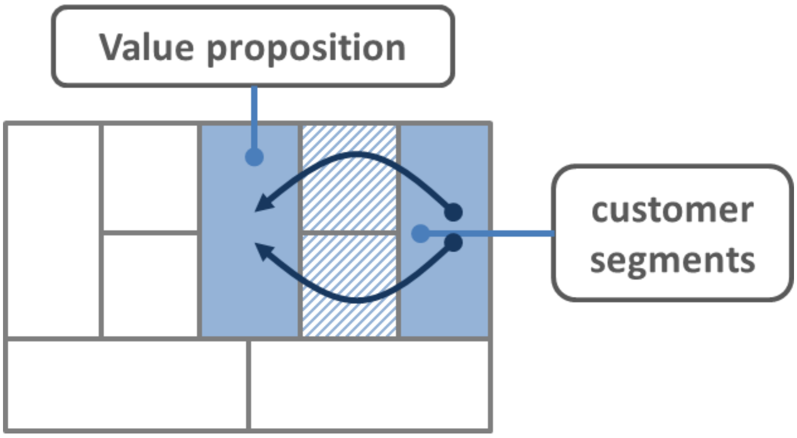


Figure 24: Consumer market business model building blocks most impacted by smart water technology

4.3 Customer segments

Because every household needs water for 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 also be taken into account. 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. The identification of these segmentations and their characteristics is important as it informs the flexibility and adaptability that will be required within WATERNOMICS. Consumers will need the platform to provide appropriate levels of information and detail as befits their requirements and interests. Table 9 provides an overview of the subsets of customers within each segmentation methodology; combining the four segmentations shown in Table 9 results in 980 WATERNOMICS customer subsets. Each segment is detailed below.

Table 9: Four types of customer segmentation

House ownership (Segment 1)	Housing type (Segment 2)	Family household (Segment 3)	Willingness & Ability to act (Segment 4)
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	Side-line Supporters
	Moveable	Couple without children	Cautions Participants
		Single parent with dependent children	Stalled Starters
		Single parent with independent children	Honestly Disengaged

4.3.1 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.

4.3.2 Household type and family household

The type of household largely determines the kind of measures that can be taken to reduce water consumption. This describes the physical building which comprises the 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, but also the characteristics of individual members and the relationship among them 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 as shown in Table 9 since this classification covers all types of typical households that will be encountered in WATERNOMICS.

4.3.3 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 10 provides a short explanation for each of the segments.

Table 10: Population segmentation based on willingness and ability to change

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.
Side-line 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.

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:

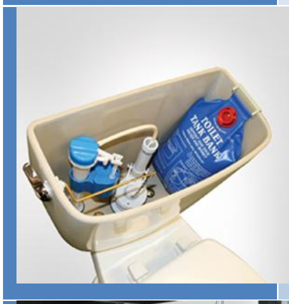
- ***Positive Greens***: They most likely want to have information on what they can do more. Furthermore, they are most likely to seek to influence friends, family and the workplace to be more environmentally friendly and they need the information to do so.
- ***Sideline Supporters***: In this group their green beliefs have not yet been translated to their behaviours.
- ***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.

4.3.3.1 Available water saving products and services

Different kinds of water saving products are available for house owners. The 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. Table 11 shows an overview of the most popular water saving products and price indications.

Table 11: 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 (Figure 25). 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, 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.

Figure 25: home energy management system

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 data at a higher frequency and can present more precise information to the user.

5 Key conclusions for WATERNOMICS

This report identifies a number of key conclusions for WATERNOMICS. Initially the stakeholder interviews, market research and roundtable meetings have shown there is clear need for the development of a water information platform for stakeholders across multiple domains (domestic, utility, public, and commercial). This is evidenced by the sheer breadth of features and exploitation scenarios identified in consultation with pilot partners, consortium members and external collaborators.

5.1 End-user requirements

It is notable that many stakeholders have overlapping requirements but in all cases will need the platform to be flexible to the unique needs of the end-user. This flexibility will be a key requirement when developing the platforms architecture. Other key requirements of end-users included:

- There is a need for a platform that can **present complex information in a more meaningful and informative fashion** that support informed decision making.
- From a commercial end-user standpoint, the platform should **enable the key motivations and drivers for water conservation** including, financial savings, energy savings (these reduce carbon footprints but also result in financial savings), reduced water footprints and social responsibility.
- While the **environment and social responsibility** play an important role, they are **not sufficient drivers for behavioural changes** in almost all stakeholders. However, awareness of these aspects is increasingly of concern for citizens, utilities and business.
- **Data privacy should be a primary consideration** for WATERNOMICS and indeed in any domains where big data analysis is being introduced. It is also clear from surveys and discussions with potential end-users that this aspect of the platform needs to be considered carefully before the public will be willing to trust it with their private information (household profile, consumption patterns etc.);
- From a public end-user standpoint, there is a **need for the platform to appeal to the competitive nature of individuals** to encourage behavioural change. Since users of public buildings will not be heavily motivated by financial savings for the building or institute they occupy, there is a need to employ methods such as gamification and environmental awareness. For example in the leisure and hospitality industry (for example eco-tourism) non-intrusive feedback such as a consumers water footprint could be seen as an added selling point for a business and improve customer experience.
- **Existing platforms lack automated fault detection and diagnosis capability**. It is clear that there is a business case for such a platform for public and private utility operators, and few applications exist on the market today capable of providing such a service.

The report presents business and technical "storylines", for each exploitation scenario, that demonstrate how WATERNOMICS can impact on various end-users. It was considered important to consider these "storylines" to demonstrate day to day use of the platform and inform the platform design.

5.2 Business strategies

The report identified strategic options for a WATERNOMICS; in particular the commercial and market options. The key market trends that need to be considered are:

(i) Changing customer expectations (real-time data, internet, personalised information);

(ii) Connected devices, information available on multiple platforms, actionable information), and;

(iii) Change in demand (demographics, sustainability drives etc.).

Value propositions that WATERNOMICS can exploit include personalised water recommendations, improved relationships between consumers and water providers and the ability to incorporate service bundling. The report identifies these value propositions for householders, corporate/business users and utilities/municipalities. It is clear that WATERNOMICS needs to consider the role of experts and consultants in the water industry. In many cases these consultants provide technical expertise, backed up by a portfolio of solutions to end-users (in particular large business and utilities). Consultants will adopt platforms such as WATERNOMICS where it can improve or extend their service profile, attract new customers, solve customer problems and demonstrate innovation.

5.3 Market Analysis

The report presents a strategic analysis of various market segments (corporate/business, municipalities/utilities and domestic users) and pinpoints the key differences between users in each segment. In the corporate/business segment key differences between companies in their approach to water management include:

- Is water management as a key activity?
- Does the company monitor water usage (and why)?
- Do the company publish water usage information?
- Does water fit in the corporate innovation strategy?

WATERNOMICS should take into account these differences in maturity with respect to water management and offer businesses a roadmap to a more complete and efficient water management system from whichever maturity level they start adopting an integrated water management system.

In the municipal sector the key distinguishing factor is often whether a utility is public or private and what is the role of the water tariff regulator (if one exists) in the market. The presence of a regulator or service contracts between public agencies and private utilities can be a key driver for efficiency. It is notable in this sector that there are widely varying levels of water availability, the percentage of treated water that is non-revenue water and tariff structures. These considerations can define the

When considering the domestic sector the key considerations for WATERNOMICS include:

- house ownership
- housing type
- family household
- willingness and ability to act

All these aspects will influence how domestic end-users interact with WATERNOMICS and their motivation to utilise the platform to ensure water efficiency. WATERNOMICS will face three major categories of domestic end-users (i) “positive greens” – people that are both informed about and motivated to be more environmentally friendly, (ii) “sideline supporters” – this group may be informed and indeed motivated about being more sustainable but might not have effected behavioural change and (iii) “stalled starters” – this group are both sceptical about environmental issues, may not be informed and where they recognise these issues might not have any motivation to change.

The ability of WATERNOMICS to impact on each of these categories will be crucial in ensuring its success in the domestic sector.

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. Each feature is given a score from 1 (low) to 5 (high) under each technical, business and innovation criteria. The average score is taken to give an overall score.

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
75	Water Saving 'Points'	Gamification	Use of a points system to reward or penalise water saving or wastage. This could be offered as an incentive to customers, with the ability to use points for discounts, additional services, products etc.	4.2
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
87	Customisable reporting periods	Communication	Ability to change reporting periods on the WATERNOMICS dashboard	4.1
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
81	Benchmarking	Communication	Ability to benchmarking water consumption against similar buildings, industry peers etc.	4.0
82	League Tables	Gamification	League tables for water consumption by site, country, region etc.	4.0
74	Customisable Dashboards	Communication	Ability to customise the appearance and functionality of the platform front-end for different user groups and stakeholders	4.0
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	Alerts / Alarms	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
77	MNF - Minimum Nightly Flow Indicator / Alarm	Communication	Indication of level of minimum nightly flow, which is a useful indicator for leaks. This should be near zero during off-hours.	3.9
78	Early warning system for leaks	Communication	Use of pressure sensor or flow meter data to alert users of leaks as they occur in order to avoid critical events going undetected for longer periods.	3.9
80	Budgeting / Forecasting	Analysis	Ability to plan and predict future cost of water consumption based on past trends, in order to allow for more accurate budget forecasting	3.8
88	Invoice tracking	Business/Finance	Ability to track water bills / invoices in the platform and compare with metered consumption	3.8
10	Monthly water data visualisation	Communication	Plots of previous monthly water consumption and year on year comparison. Include % improvement indicator	3.8
79	Benefit quantification	Communication	Quantification of cost benefit of implementing water saving measures, in terms of €'s saved, carbon offset, pumping and treatment energy cost reduction etc.	3.8

76	Water Sankey	Communication	Visualisation of water flows through the building or water network. This allows the user to get a better understanding of their consumption, as well as providing a useful basis for a metering roadmap	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
73	User Subscriptions	Business/Finance	Ability to add users to the WATERNOMICS platform under different pricing levels	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 data port 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
83	Root cause suggestion	Communication	Suggestion of possible root cause of particular faults based on past occurrences. For example, a problem was identified in one particular use-case where a rainwater harvesting system frequently had a blocked inlet, resulting in overfilling from the mains top-up system. By tagging this fault, it would be easier for future users to diagnose possible causes.	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 disincentives 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)	Gamification	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
86	Access tracking	Access	Tracking of user access rates, no. of data downloads etc.	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

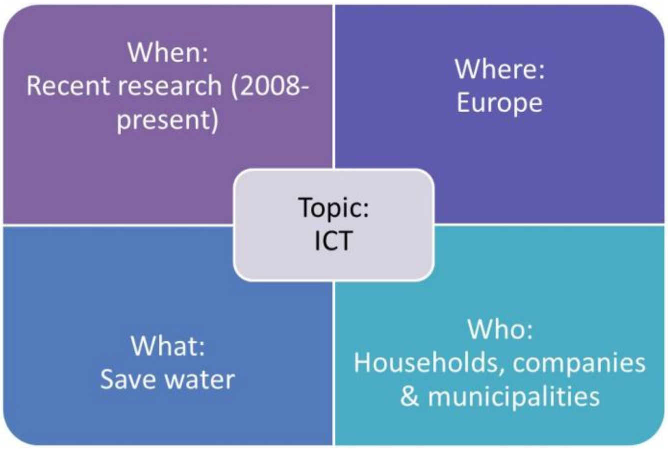
49	Metaphors for measurements	Communication	Monitoring application should be heavily dependent on metaphors to put measurements into perspective for the users. Possible metaphors are • Amount of rains needed to cover the usage • Comparison with daily activities such as (cooking, dishwashing, washing 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
69	Amount of water consumed by public buildings (Municipality)	Metering	Measurements of water flow are needed. Presentation of consumption could be done on a quarterly basis (or every 6 months).	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
72	Possibilities for users to communicate anomalies with Photos and text using a smartphone app	Communication	Users should be able to inform the municipality or water service provider about water network problems taking a georeferenced photos. It could be considered a technology that allow to affect users' behaviour about water importance	3.2
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. CO2 emissions per Litre water consumed, or total CO2 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
84	Cold weather warning	Communication	It was suggested that the user may want to be notified of upcoming cold spells in case of pipe freezing. Also, with regard to root-causing of faults, weather data may be a useful correlator for leaks.	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
85	Water retention tracking	Analysis	Tracking of water retention rates in building water networks in order to predict the quality of water. High retention rates could lead to problems (e.g. stagnation)	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
70	Understanding the current state of municipality water network	Access	Step 0 analysis of the existing network is needful to understand the real issues and needs of municipalities	2.0
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
71	Establishing a facility management culture for the water distribution network	Business/Finance	Availability of data and information about water network are important to allow a correct management of the network	1.3
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: Interview checklist

The following checklist is used during the interviews.



Research Question WATERNOMICS

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, and 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?

Appendix D: 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. Table 12 shows an overview of the interviews conducted and round table sessions organised. Reports of the sessions and interviews can be found in this section.

Table 12: Overview of stakeholder workshops and interviews

#	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 / Questionnaire
8	Water Systems and Innovation Centre (WSIC)	Research and Innovation	Interview
9	Soho Salon	Hair dressing	Interview
10	Eindhoven Airport	Aviation	Questionnaire
11	Municipality of Roccarainola	Municipality	Interview
12	Waternet	Utility	Interview
13	“A Large Dairy Processing Plant”	Food Industry	Questionnaire
14 (a)	Veolia Water	Water and Risk Management	Meeting
14 (b)	Amgen	Pharmaceuticals	Meeting
14 (c)	Renergise	Water conservation	Meeting
14 (d)	Larsen Leak Detection	Leak Detection	Meeting
14 (e)	Shay Murtagh Ltd.	Rainwater Harvesting	Meeting

#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 really liked the ideas of cartoons on bills to make things simple and engaging to people. They really stressed

that passive communication (brochures) is less and less effective and that unless you have an application for an iPhone – nobody is going to care. They invited us to speak at schools 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

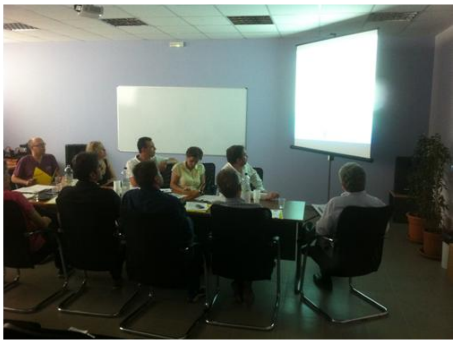
Agenda

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
1	SPIROU STILIANOS
2	JESSE VAN SLOOTEN
3	KOSMIDIS DAMIANOS
4	KOUROUPETROGLOU CHRISTOS
5	SANDER SMIT
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





Organization:

The meeting was organized and co-hosted by the municipality of Thermi at the meeting room of the civil protection office.14 persons attended:

- The deputy Mayor and staff from the Municipality ,
- The technical director from Thermi's water supply and sewage municipal enterprise,

- The technical director from the Municipal enterprise for Water and sewage of Serres (a city of 100.000 people)
- The technical director from the Municipal enterprise for Water and sewage of Lamia (a city of 80.000 people)
- A hydro geologist and a chemical engineer from the water supply and sewage of the city of Thessalonica (1.000.000 living people)
- A researcher from a private company (design office)
- And of course our partners Ultra4 and BM-Change

Recipients were provided with an agenda, WATERNOMICS brochure, notepads and pens. Registration and coffee break was on the list. The meeting ran from 10.00-15.00

Presentation

First of all Sander Smit from BM-Change made a presentation of the WATERNOMICS project ,so participants could get an idea of the program and have a starting base to discuss and then followed a three round session of discussion concerning the following:
Round 1: “How do water companies use ICT in their operations today?”
Round 2: “What do water companies expect from a Water Information Platform?”
Round 3: “How could customers benefit from a Water Information Platform?”

Meeting Main Points:
We invited people with applied experience that could assist to the implementation of the program and to the development an ICT tool useful and effective for mass use.

Round 1
It turned out that the water companies are not in the same level in terms of ICT use in the way they operate. Companies that serve a large number of residents are more familiar to the use of ICT, with telemetry and GIS but are mainly used to control the consumption of water and not to inform and educate the public.

Round 2 .NEEDS OF WATER COMPANIES
1) Portability of data of house total water consumption continuously and in real time, in selected check points of the internal water supply network in order to verify the non-invoiced water, per region, per area and per year period.

2) Continuous record of the total water consumption for each house per day and after that statistical analysis of the results and use of them for the network management

3) Continuous record for all separate water consumption uses (e.g., water supply, irrigation, etc.) of housing and large-scale consumers (e.g. schools, hospitals, camps, etc.), in order to see the possibility to use , in addition to water, other networks (e.g. irrigation, water reuse of treated wastewater, etc.).

Round 3. CUSTOMER BENEFITS
1) Continuous indication of water consumed by the user, in instantaneous and cumulative time while it is being recorded and billed from the water companies and parallel display and corresponding costs in €.

2) Continuous updates to the users for the alternative use of the respective amounts of water by other users while consuming

3) Continuous indication of the maximum, the average and the current pressure network operating in the region, to avoid usage of drinking water for uses that can be postponed for a while (e.g. Laundry rooms, balconies, etc.) , and to update network failures.

4) Continuous graphical display of the quantity of water consumed by the user per hour throughout the 24 hours for labelling internal leakage of the house.

#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

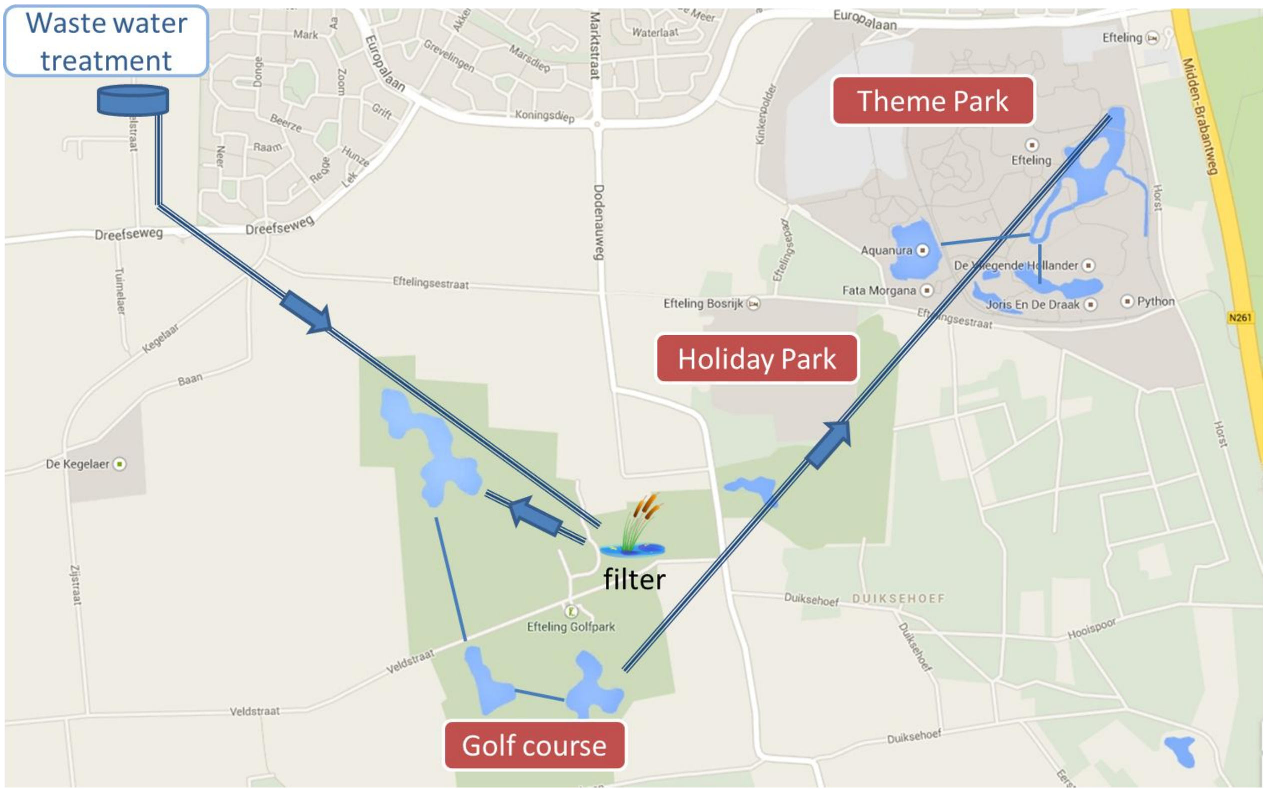
All drinking water is obtained from Brabant Water, the local water service provider. Drinking water usage is metered and billed per usage. Drink water usage is measured on the level of theme park, hotel, Holiday Park and golf course. Information about water usage is not considered classified but since 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.

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.

#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 (see Appendix 7.a);



#7.a Arrabawn Stakeholder Questionnaire Response, 12 December 2014

Date: 12-12-2014,

Interviewee: Site facility manager

Organisation: Arrabawn Dairies, Nenagh

Motivation

For Arrabawn, water availability and quality are both considered critical to ongoing operations. In particular, water quality is monitored carefully, and presence of particular pollutants (e.g. Nitrates) is maintained below levels enforced by local government and regulating bodies (Environmental Protection Agency, EPA).

With regard to the benefit of a water information/management platform to an organisation like Arrabawn, the response from the plant manager was positive. A system is already in place on site. Limits are set in the current management system, and used to detect water consumption anomalies. At present, the plant has significant levels of water monitoring, but this is not directly translated to an effective management plant. As with many large facilities, there is an abundance of metering, causing a situation where management are data-rich but information-poor.

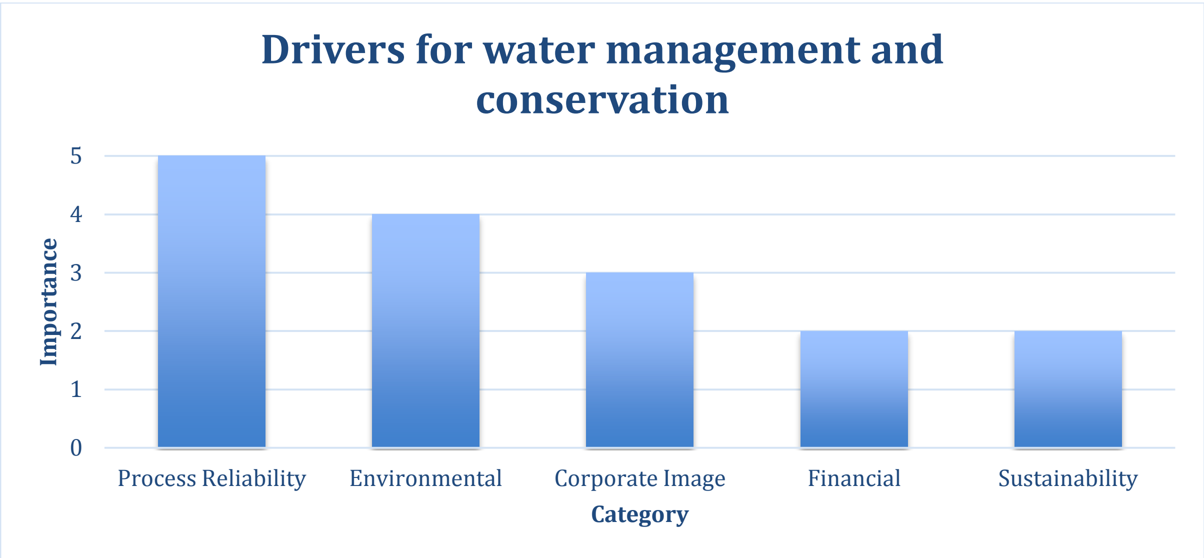


Figure 26: Drivers for water management and conservation

In terms of drivers for water management and conservation, Arrabawn is primarily driven by process reliability and environmental regulations. In other words, the main drivers are those which are critical in the day-to-day running of the plant. Corporate image and sustainability are important, but would not drive the implementation of a water management system. This is an important consideration, as it implies that there must be a solid business case for the implementation of a water information / management system before it is even considered. For the plant manager, corporate image and sustainability do not feature highly on their concerns, although they are critical to the Environmental and Sustainability department within the company. This raises a second point of importance – the ability to target the platform to relevant end-users, and furthermore, the ability to convey relevant information to these users. What is important to the plant manager is not necessarily a concern for the environmental manager and vice versa.

At present, Arrabawn dairies adopts a number of processes and technologies targeted at improving water conservation on their site:

- Leak detection;
- Daily water limits / quotas;
- Re-use of evaporator water in boilers for steam;

Business

Arrabawn currently draws it water from two sources:

- Public supply: this is priced on a demand-based tariff;
- Groundwater Pumping: this has associated pumping and treatment (e.g. chlorination) costs;

The usage of water is a growing concern for the organisation, as well as the public. Water is starting to be considered a strategic asset, particularly in the case of public water consumption. In addition, it is envisioned that a water extraction fee will be enforced in future, which puts further pressure on the efficient management of water consumption.

With regard to whether the WATERNOMICS platform should be delivered as a **platform** or a **service**, the maintenance department would prefer a service (less software maintenance costs), while the environmental department would prefer a product.

Finally, regarding pricing models for a water information service, the plant manager suggested the system should be delivered for a flat fee, with possible bonuses for water saved by the system operator.

Infrastructure

The site in Nenagh currently operates 16 magnetic water flow meters which log values every minute, and are monitored on a daily basis (i.e. daily totals) via a web-based platform. This information is not currently used as a means of optimising operations or minimising water costs. Water data is required on a (near) real-time basis for operations.

Innovation

Innovation is mainly required in the area of water sensors, which are still quite expensive. Therefore work is needed to bring down the cost of metering. In addition, it was noted that there is a perception that clamp-on meters may be inaccurate – therefore the accuracy and reliability of wireless/clamp-on meters is also an area that needs to be addressed.

In the area of ICT and information platforms, current systems are overly complex, and require innovation in terms of ease-of-use and accessibility.

Forecasting and monitoring is not considered important unless there is a drought, which is unlikely in Ireland (at present).

Water Consumption

The majority of water consumption is supplied by o-site groundwater pumping (95:5 ratio vs. public supply). Regarding water distribution on site, it was mentioned that a Sankey diagram mapping water flows would be very useful. Currently the majority of water is consumed by the Clean-in-place (CIP) system (approx. 60% of total water consumed). In order for water to be re-used on-site, it first required chlorination. Water quality is governed primarily by EU water directive 92 (Potable drinking water).

#8 Water Systems and Services Innovation Centre (WSIC), Nimbus Embedded Systems Research Centre, Cork, Ireland, 24 November 2014

Meeting Information
Date: 24-11-2014
Time: 12:00-13:30
Organisation: Nimbus Embedded Systems Research Centre
Venue: Nimbus Centre, Cork Institute of Technology (CIT), Cork, Ireland
Interviewer: Daniel Coakley
Attendees:

- Aoife Kyne, Senior Researcher, Water Systems & Services Innovation Centre (WSIC)
- Brian Cahill, Programme Manager, Mallow Systems Innovation Centre (MSIC)
- Kevin Fitzgibbon, Co-ordinator at Water Systems & Services Innovation Centre (WSIC)

Background to Meeting
NUIG, and in particular, the Informatics Research Unit for Sustainable Engineering (IRUSE), have had an ongoing collaboration with the Nimbus centre in Cork through a number of different prior research project engagements (EMWiNS, NEMBES). The primary actors in this relationship are Dr. Marcus Keane (IRUSE, NUIG) and Dr. Dirk Pesch (CIT).
Daniel Coakley, who is a member of IRUSE, met with Brian Cahill (MSIC) at the Intel Ireland Research Conference (IIRC), held in Dublin, Ireland on 18th November 2014. Daniel had also previously met with Aoife Kyne (WSIC) at the Sustainable Water Systems conference in Galway, Ireland, on 26th June 2014.
Daniel presented the WATERNOMICS platform, and described the project to Brian at IIRC, who suggested a follow-up meeting with Aoife and Kevin at the Nimbus Centre in Cork.

Profile
The Innovation hub to address Ireland's water infrastructure is located in the Nimbus Centre, Cork Institute of Technology. The Water Systems and Services Innovation Centre (WSSIC) is a joint venture between Cork City Council, Cork County Council and the Nimbus Centre at Cork Institute of Technology. WSSIC creates an expert resource in modernizing Ireland's water infrastructure by taking advantage of Nimbus' technological knowledge and leveraging both Councils' experience in Water Resource operation. The Focus of the hub is summarised here. Nimbus' water interests are solidly supported by CIT's excellent resources in the water space.

WSSIC harnesses state-of-the-art technology in water quality monitoring, leakage reporting & repair, remote monitoring and much more. Current water projects, five of which are funded by seed funding from the three main partners, one of which is an Enterprise Ireland-funded 'Innovation Partnership', and another an Enterprise Ireland-funded 'Commercialisation fund', have inaugurated the WSSIC's activity. The projects encompass embedded system design, wireless technologies, website design, programming, optics, sol-gel and polymer chemistry, electrochemistry, miniaturisation, case studies and workflow design.
The resulting innovations are being rolled out across County Cork, with a view to deploying to all city and county councils in Ireland. With this, the WSSIC becomes the internationally recognised hub for innovation in water-based systems and technologies. Alongside more efficient water services and monitoring processes, the WSSIC is a catalyst for the creation of new Irish-based enterprise and jobs.
WSSIC engages with key players in the water industry, providing technical guidance in the development of the Irish strategy on water. Delivering Locknote speeches at events like National Water Summit at Croke Park, Dublin, provide an insight into the available technology to interested parties. Regular media contributions and tweets spread the word on WSSIC developments.
The strength in this three-way partnership between Cork City and Cork County Councils and CIT, each providing equal funding, and contributing synergistically from their varied areas of expertiese, assists WSSIC in accelerating progress in Munster.

Cork City and county council provide funding and resources to WSIC, including access to a full waste-water treatment plant (WWTP) in Macroom, Co. Cork, with a population equivalent (P.E.) of 5,000.

Relevant Research projects
WSIC are currently engaged in a number of different research projects in the area of embedded systems for sensing and control of water systems. In addition, they are involved in energy harvesting from water and wastewater. Below are a number of projects of interest to WATERNOMICS:

(a) WatNos – Water Network Optimisation

This project focuses on energy cost optimisation for water treatment networks

- Minimises operational cost based on system modelling;
- Provides and operating model, not just list of physical assets;
- Pricing model modelling – determining best time to purchase energy;
- Identify low cost periods for pumping etc.;

(b) Aquametrics

Using sound for asset identification

- Measuring consumption and water levels;
- System for use of single metering instead of multiple site meters;

Other water Research Projects
There are many water projects in progress at the Nimbus Centre focused on innovation and development for technology in the water industry. These projects have been awarded funding through both the Enterprise Ireland Commercialisation Fund and

through The Water Systems and Services Innovation Centre (WSSIC). WSSIC is a joint CIT/Cork City Council/Cork County Council initiative to develop a centre for water related technologies and systems. It has been operating for nearly 2 years and has now moved into its second phase of expansion. Of the 70 people in the Nimbus centre about 10 are involved in water projects. The Nimbus Centre is always looking for new opportunities to support technology development in this sector and are expanding their network and project portfolio.

- Aquamonitor, in partnership with Faaltech
- Technology for mitigation of Fats, Oils and Greases in public water (with DynoRod)
- Remote Monitoring of District Metered Areas
- Remote Supervision of multiple small sites
- Workflow Management
- Centralised Data Acquisition System for DMAs

For full descriptions, see: http://nimbus.cit.ie/tec/nimbus-centre-water-research-projects/

Follow up

The researchers at Nimbus were very interested in the activities in the WATERNOMICS research project, and associated water/wastewater projects at NUI Galway (ITwat, Dairywater). Daniel forwarded the Nimbus researchers a copy of latest slides on the WATERNOMICS project, as well as links to online resources for the project.

Relevant Links

- http://nimbus.cit.ie/water
- http://nimbus.cit.ie/mallow

Contact Info

Name	Role	Email
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Aoife Kyne	Senior Researcher	Aoife.Kyne@cit.ie

#9 Interview Soho Salon, Tilburg, the Netherlands

Date: 12-11-2014, Time: 10:30-11:30
Venue: Tilburg, the Netherlands
Interviewer: Sander Smit
Interviewee: Wim van Gool Function: Owner
Organisation: Soho Salon

Organisation profile

Soho Salon is a hairdressers' salon located in Tilburg, the Netherlands. The salon offers cutting, styling and colouring of hair. Besides the owner, two other employees work at the salon. It's a family business that exists for over fifty years.

Motivation

Water management does not have much priority and the level of water awareness is low. Water is considered to be available at all times and at a very low price.
Conservation measures are taken in the form of placing percolators on the taps of the two washbasin and the placement of LED lighting. These measures are primarily driven by societal changes with respect to environmental behaviour. It has become normal today to work more sustainable and these measures are now commonly available and affordable. Soho considers itself part of the early/late majority and not an early adopter. The financial benefits are minimal because of the low price for water.
Initially WvGoor indicates to have no need for more information on water and energy usage but after talking more in-depth about water consumption and related energy usage, he says to value a water/energy information system to increase awareness amongst himself, personnel and customers.

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. Annually, the salon consumes between 350m3 and 400 m3 of (drinking) water. Per month, 46 euro is paid for water but this bill also includes costs for sewage and local taxes. In comparison, the salon pays around 300 euro per month for gas and electricity. Water usage is metered and billed per usage. Water is a necessity for the salon. Without water, hairdressers cannot wash the customer's hair.

Infrastructure

A single, analogue water meter is placed at the entrance of the building measuring the incoming water used in the salon and the apartment above the salon. The meter is provided by water service provider Brabant Water and read out once a year manually by the owner. The meter values are reported to the water company through an on-line form. The salon has one drinking water network with four taps: toilet, kitchen and two washbasin.

Follow up

The owner has interested in the work of WATERNOMICS. The WATERNOMICS flyer is handed over. WvGoor recommends to prepare a project flyer for a broader audience in the Dutch language since he believes that more people should be aware of the price of water consumption in terms of energy and carbon footprint. A first step to increased awareness could be the promotion of projects like WATERNOMICS.

#10 Eindhoven Airport, Retrieved feedback on interview checklist, 21-11-2014

Checklist filled in by: Gaby Mols
Function: Policy Officer Corporate Responsibility
Organisation: Eindhoven Airport

Eindhoven Airport

Eindhoven Airport has a mission. Eindhoven Airport wants to be a multimodal, sustainable transportation hub, so that the airport contributes to the economic growth in Southeast Brabant. A modern airport, where speed and experience are added values. A modern airport also means that we want to be one of the leaders in the field of sustainability.
Open communication with the community and local and regional authorities contributes to mutual understanding of each other's interests and capabilities and is the first step to good cooperation.
The Alders table Eindhoven was created in collaboration with ministries, county, municipalities, residents, environmentalists and industry representatives in the region and with Eindhoven Airport to agree on a responsible and sustainable growth of Eindhoven Airport for the period until 2020.
In order to limit the use of water a much as possible, various investments have been made such as:

- Eindhoven Airport has been ISO14001 certified since 2003
- Eindhoven has been accredited level 3+ of the Airport Carbon Accreditation program.
- **An Aquifer** has been installed to control the climate in the terminal. The water is drawn from a depth of 65 meters and connected to the floor heating in the terminal via a heat exchanger and heat pump. The heated water is then stored at a depth of 65 meters. In the summer months this facility provides the necessary cooling. Ground water extraction is minimal because the water is recaptured. This system covers the total heating demand of the terminal and hotel reducing to one third the electricity consumption for heating.
- **Grey water system: a** buffer has been installed on the airport site to collect rainwater. The system has been constructed in such a way that the water in the underground storage is also used for flushing toilets and urinals (grey water).
- In the hotel guests are made aware of towel usage.
- Water saving douches

Eindhoven Airport has environmental conditions for all of the contractors.

- The contractor shall make maximum use of energy saving measures in performing the work and supply of services and goods. The contractor should pursue implementation of energy reduction measures. However, this may not be detrimental to the work or supply of goods or services that has been agreed upon with Eindhoven Airport NV.
- The contractor must be able to present an overview of the activities, resources, products or services carried out by him that can cause contamination of the waste water and/or sewage. This also includes preventive measures contamination of waste water and/or sewage.

- The activities or used resources carried out by the contractor should not interfere, damage or cause inconvenience other than strictly necessary. If this cannot be verified, written approval of the environmental coordinator of Eindhoven Airport NV is required to carry out the activity or to use the resources.

- The cleaning of equipment, vehicles or aircraft may only take place at areas specified by Eindhoven Airport NV . The user of this particular area may only use those detergents and cleaning materials that do not harm the environment. The requirements of paragraph 1 shall apply.

11. Municipality of Roccarainola (NA) - Italy

Date: 08-09-2014
Time: 11:30-13:30
Venue: Roccarainola (NA) - Italy
Interviewer: Domenico Perfido
Interviewee: Avv. Raffaele De Simone
Function: Mayor of the municipality
Organisation: Municipality of Roccarainola

Municipality profile

Roccarainola is an Italian town of about 7.500 inhabitants in the province of Naples in Campania.
It is located in a central position on the borders with the provinces of Caserta, Benevento and Avellino. The town of Roccarainola has an area of 28.1 km ^{2}. Currently there are several sub- towns that make up the municipality and they are: Roccarainola center, Gargani, Piazza, Sasso, Fellino and Polvica. The municipality, with several other municipalities, is part of the Comunità Montana Partenio - Vallo di Lauro which provides a structure to support tourism and services.

Figure 27: Location of the Municipality in Italy

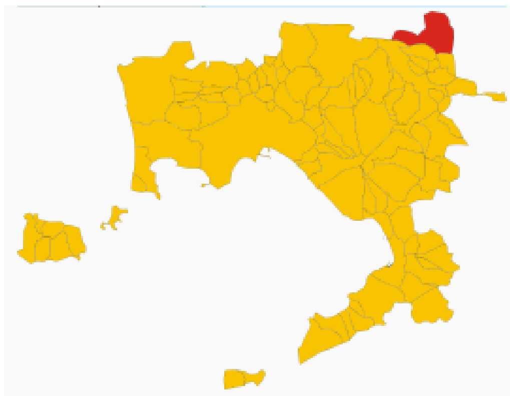

Figure 28: Location of the Municipality in the province of Naples

The town of Roccarainola has a number of public structures such as schools, municipal offices, museums, and other public buildings that are directly controlled by the municipal administration under the responsibility of the elected mayor. Currently the mayor is Avv. Raffaele De Simone.
Until 2006, the municipality controlled water management and distribution using an independent water network consisting of two collection wells and reservoirs. After 2006, the implementation of Law n ° 36/94 (L. Galli) initiated the reform of water services in Italy with the aim of achieving the integrated management of the entire water cycle, providing that its management was entrusted to a single subject. This Law also identified A.T.O.s (Optimal Territorial Areas) and in the year 2006, with the Legislative Decree 03/04/2006 n. 152, the municipalities within the boundaries of the ATO had the obligation to transfer the management of integrated water services to the company G.O.R.I. s.p.a. which stands for "Gestione Ottimale Risorse Idriche" or "Optimal Management of Water Resources." As a result, since

2006 the municipality of Roccarainola buys water from water service provider G.O.R.I. s.p.a. and it doesn’t really know the water consumption for all its inhabitants but only for the public structures.

Motivation

Since the very beginning, care for nature and the environment has always been one of administration’s highest priorities. The municipality is part of the Parco Regionale del Partenio (national park) and environmental stewardship is part of is charter/mission.

The city administration is very sensitive to the issue of saving water and energy but actually KPI’s for energy usage and water usage are not yet in place. It appears difficult to collect and present the data. There is not a system for system losses localization that could advise inform water service provider (G.O.R.I. s.p.a.) for any malfunctions of the urban water supply.

Business

All drinking water is obtained from G.O.R.I. s.p.a., the local water service provider.

Drinking water usage is metered and billed per usage with a volumetric pricing.

By some financial reports it appeared that the average annual consumption of water for the public offices in the municipality is about 20.000 m³ for a total of about 35.000 €.

Since there is only one provider for water, in contrast with energy, water tariffs are non-negotiable and there are no incentives for public infrastructures.

One person (maintenance office) is responsible for water. However, this person does not have a technical unit because it is GORI’s team to intervene in case of need.

Infrastructure

The town of Roccarainola is fed from the aqueduct of the Campania Region with the water from the springs of S. Maria la Foce (Sarno), Mercato Palazzo, Santa Marina di Lavorate and Cancello.

The water that is extracted from the two existing local wells is utilized by GORI only in critical cases. Today, water meters are not placed at the entrance of the water system, so there is no knowledge at the municipal level of water consumption for all the town inhabitants but only for the public structures.

Follow up

The information of “ICT for Water” and WATERNOMICS was well received. A lot of the research items can be very interesting for Roccarainola municipality, like having more detailed information about water usage or how to increase user awareness. The WATERNOMICS platform would also be more appreciated if it could give the opportunity to the people to signal a leak in the water supply using geo-referenced photos taken with smartphones. To imagine such a scenario, think of hikers in the countryside that come across a leak in the water infrastructure. At the moment, perhaps twitter would be the most likely place the hikers would publish that data if they decided to take action. There would be no link to GORI, the municipality or any water manager.

Roccarainola is open for participating in a pilot, for example to test the effect of new water measuring technologies.

The Mayor Avv. Raffaele De Simone would like to be kept informed about future developments of the WATERNOMICS project and the ICT for Water program through the WATERNOMICS newsletter.

12 Interview: Jan Peter van der Hoek (Strategic Center Waternet)
Place/Date: Amsterdam 22 October 2014

1. Submetering inside the household is already something that Waternet is discussing to do at the Board of Director level. Positive aspects of it are the amount of information that the organization can obtain from users to improve their processes (ie. peak consumption, uses within household, etc.). Negative aspects: the jurisdiction of a water utility in the Netherlands reaches only until the entry of the house, all services offered beyond that are open to the market.

Should they do it: Waternet would ideally be the owner of the data for own purposes. But more realistically the data would belong to the consumer. The consumer would remain owner of the data and would allow the company (any company) to access, use and analyse the data and offer advice.

2. Metering of outflows is currently a point of discussion at Waternet provided the new introduction of water sources inside a house. In general, and currently in NL, outflow meters is not the responsibility of the water utilities, but of the water boards. That is a problem in NL, in order to do that they should create the

Possibility to design an integrated water cycle tariff (drinking water/sewerage). This could in NL at the moment only be possible for Waternet (because of unique institutional arrangement in NL where Waterboard and water utility are merged), but even Waternet is limited by legislation to change that pricing system (currently being discussed). JPvdH believes that introducing such meter will also encourage water reuse practices inside the house and reduce drinking water consumption.

3. Water information services: Not currently offering those services because it is an open market (refer to statement 1) and not interested for them to compete in such a market. However, they would interested in doing it if the costs of metering and innovation can be shared with another utility provider (ie. energy provider)

4. This is true, but water availability is not a problem in NL. So it would not have a big effect on Dutch consumers (in Amsterdam at least). It would be, in general, good to expand that type of information to quantity and quality (for transparency reasons) but to achieve consumption reduction it would only work in combination with other information (ie. In relative terms to what it would mean for their immediate access, or if the user is aware of water shortages).

5. Water management services to business: this is a likely business case for Waternet (interested in). Waternet is already doing it in a very small scale - mostly on pilot cases (save water, recycle water, quality they need for a certain process, deliver water and remove additional compounds). However, in order to venture further in these markets they would have to overcome: 1) be active in an open market (not their core) 2) create a private company (sister company of Waternet) since public companies in NL cannot venture in these markets.

6. Consumers are already rewarded if they consume less water in the water bill (In case of scarcity yes rewarding is a useful tool). It is also difficult for a company to encourage less consumption because it impacts revenues. Waternet does not have any active policy to encourage

reduction in water consumption because they have enough water (Evides does not either - they tell them to consume no more than needed- , Vitens does because of requests from shareholders (provincie Gelderland and their exploitation of wells under the

Veluwe) or because reduced exploitation of wells reduces investments in new drillings).

7. Agree partly. Water is not an economic good: if you introduce a real price based on the amount available you might have a problem that not everybody can pay. Is that a social acceptable solution? JPvdH has his doubts. Moreover, price elasticity for water is very low and change prices are not immediately reflected in consumption pattern changes (and water is still very low % of all utility services/household expenditures). In any case, Waternet has no block tariffs at the moment (only maybe applicable currently for industrial consumption) and does not consider seasonal tariff (because of no scarcity).

#13 "A Large Dairy Processing Plant", 04 November 2014

Background:
"A Large Dairy Processing Plant" is the largest multipurpose co-operative in Ireland, with interests in Dairy Ingredients, Consumer Foods, Agri. Stores, Animal Feed Milling and Livestock Marts & Trading.

Invitation:
A questionnaire (see Appendix C) was sent to the "A Large Dairy Processing Plant" plant manager 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.

Motivation
The plant noted that a water information system would be useful, primarily in monitoring drains (i.e. wastewater out) on site. At present, water awareness is very high on site due to the critical nature of water availability and quality in their daily process.

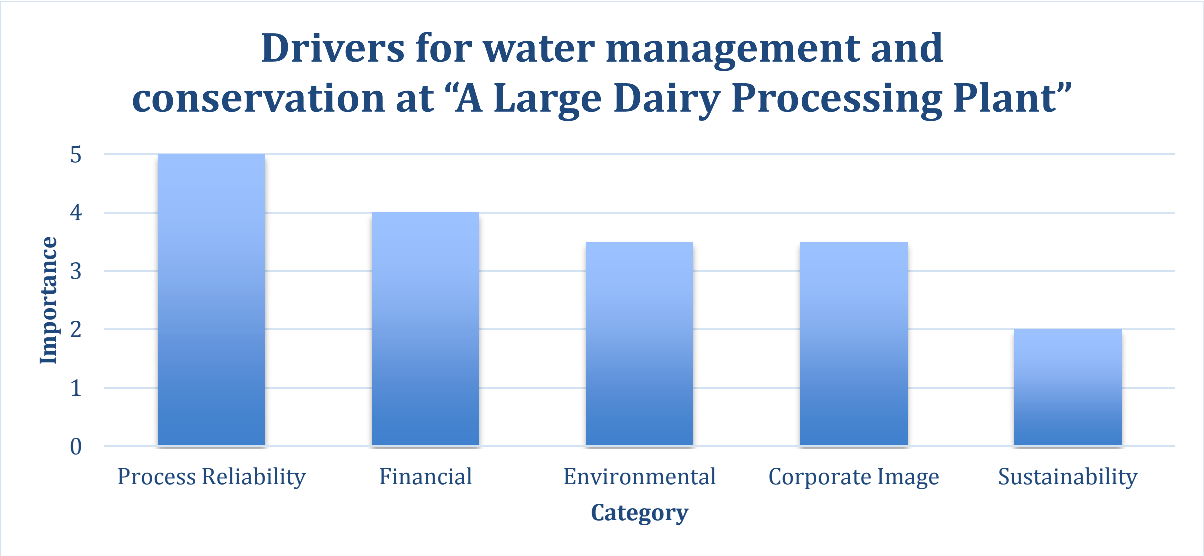

Figure 29: Drivers for water management and conservation

This plant is primarily driven by process reliability and financial incentives for water management. As with other plants, environmental and corporate image considerations are important but are not a key driver for water management.

However, the organisation do appreciate any effort to reduce water consumption, as this reduces waste effluent to the wastewater treatment plant, thereby reducing overall running costs.

Business
The plant currently pays a demand-based water tariff at commercial water rates.

Innovation
The following areas of interest were highlights:

- Alarms at problem areas as they occur (e.g. sensor faults etc.)
- Increased consumer awareness of water consumption;
- Rewards for water conservation, and penalties for excessive consumption or wastage;

#14 Event: 'A Drop in the Ocean or Money down the Drain: Water Management in Industrial, Commercial and Domestic Sectors', 29 May 2014

Organiser: Association of Energy Engineers (AEE), Irish Chapter
Venue: GreenIsle Hotel, Co. Dublin
Date: 29 May 2014

Background:

An event was organised by the Irish Chapter of the Association of Energy Engineers (AEE). The focus of the event was water management in industrial, commercial and domestic sectors. It has long been known that there is a strong link between energy and cost with water usage in facilities whether they are large sites with multiple grades of water and wastewater or commercial hotels with high peak demands on their water systems. Water is a multi-million euro sector in the Irish economy providing clean drinking water and treating wastewater with engineers having important roles in the design, installation, operation, maintenance and management of the associated treatment processes.

Agenda:

(a) Mapping, Metering & Monitoring: Success stories and techniques developed on a large industrial site by Mick Corcoran (Amgen)

(b) Technologies for Water Reduction / Recovery & Reuse – An industrial perspective by Martin Phelan (Elga Water Systems)

(c) Leak Detection & Management – An overview of projects and useful techniques for all users by David Smith (Larsen Water Management)

(d) Rain water harvesting – Applications in water capture, storage and filtration by Raymond Smyth (Rainman /Shay Murtagh)

(e) Water efficient fittings and equipment by Brendan O Sullivan (Renergise)

#14(a) Veolia Water, 29 May 2014

Speaker: Martin Phelan

Background:

Veolia Water is the world leader in water services. It handles water and wastewater services for clients in the public sector and in various industries. It also creates and constructs the required technology and infrastructure. In 2012, Veolia Water employed 89,094 people and recorded revenue of €12.078 billion. 37.2% of its revenue comes from France, 30.2% from other European countries, 8.8% from Americas, 16.2% from Asia and 7.6% from Africa and Middle-East.

Veolia is Ireland's leading environmental services company. They provide a range of energy, waste and water solutions and are dedicated to carbon reduction, protecting the environment and building the circular economy.

Minutes:

Water Management and Risk

- By 2030, 40% of world will live in water-scarce regions, 50% by 2050;
- Impacts in terms of production, quality of water etc.;
- This is a particular issue in industries like food, drink and pharma which require a validated water supply;
  - Validated site - Validated supply (From a validated potable source)
  - Costs in terms of testing, proving, transportation etc.;
  - Leads to increased exposure to risk if validated water source is unavailable (e.g. contamination concerns);
  - Product failure -> Impact on brand image.
- Need to balance demand, quality, supply and environmental regulation;
  - Treatment of water and waste generation;
  - Contamination in returned water;
  - Ways of treating, recovering water.

Risks	Industry Costs	Economic Externalities (Uncontrollable)
Operation	Site water infrastructure	Shortages, allocation changes
Financial	Waste recovery	Cost of capital, water scarcity
Regulatory	Compliance costs	Ecosystem status
Reputational	Legal costs	Litigation costs

Definition of water related risks:

- Physical - operational license;
- Price risk - increase in water prices;
- Regulatory risk - penalties, compliance costs, fines for non-compliance;

Traditional Water Costs

1. Direct Costs
   a. Freshwater and disposal costs
   b. CAPEX and OPEX for water and wastewater infrastructure;
2. Indirect costs
   a. Insurance
   b. Legal and Litigation;
3. Financial Impact of Risks - Operational, Financial, Regulatory, Reputational (CSR - Corporate social responsibility);

True cost of water = 1+2+3

This is especially important in industries which rely heavily on water for processes (e.g. Drinks, pharmaceutical, dairy, etc.) where water may make up 70-90% of process requirement:

- This is highlighted by the fact that Moody's now examine water security on industrial sites as part of credit risk assessments.

What can be done?

- Recycle, Reuse and recovery opportunities;
- Risk mitigation.
- Change in perspective:
  - Investment in sustainable water solutions is essential;
  - Look across spectrum in terms of impact to business.

Water Reuse

- Evaporation, filtration & membrane technologies;
- Dairy water by-products;
  - Use in production of fertilisers;
- Filtration;
- Reverse osmosis;
- Storage and distribution systems;
  - Ozone and chlorine monitoring - examine stringency of setpoints.
- Numerous case studies on water recycling in industrial processing available from Veolia:
  - Case Study 1:
    - Payback = 7 months
    - Investment = €20k CAP
    - Recovered 50% wastewater (2.25m3/h - 1.12 m3/h)
  - Case Study 2:
    - 100% recycling of wastewater;
    - Incorporated wastewater storage tank and recycling system;
    - Waste from waste storage was used in 'dirty' processes on site (e.g. flushing systems).
- Opportunities
  - Direct and indirect cost optimisation;
  - Risk mitigation (look at risk of interruption to supply and define backup strategy, validated source, systems in place and implementation plan.)

  - REACT programme: In the event of a break in water supply, how can you maintain current business/process outputs (e.g. Aquimove system for replacement supply)
  - Site preparedness:
    - Decrease time to restoration of production;
    - No capex investment required;
    - Ensuring continuity of supply;
    - Risk mitigation - increased stability.
- Business continuity (recovery system);
- Investment opportunities with lower CAPEX and lower payback.

#14(b) Amgen Pharmaceuticals, 29 May 2014

Speaker: Mike Corcoran Utilities Lead,
Dun Laoghaire, Ireland

Background:

Amgen is an American multinational biopharmaceutical company headquartered in Thousand Oaks, California. Amgen is the world's largest independent biotechnology firm.

Minutes:

- ADL water monitoring and targeting programme
- Fill finish, septic finishing site;
- Class A Isolator environment;
- Main water incomer (257 m3/day)
  - Pumped water: 110
  - Evaporated: 75
  - Foul: 62
  - Process: 118
- See AMGEN water Sankey - this was used to visualise water flows through the branch network and identify meter location requirements;
- Meters installed - Accuracy not important (5-10%), ease of use/installation is key;
  - Vortex
  - Magmeter
  - Clamp-on
- Water Sankey
  - Give big picture of water distribution network
  - Identify SEU's for water, and opportunities for conservation (WCM's)
  - Use eSankey software
    - Can link to excel spreadsheet, csv data
- Many of the savings identified to date have been picked up on the inexpensive water meters as opposed to the more expensive BMS, Magmeter loggers ("An inexpensive monitored system is more effective than an expensive system that is not monitored")
  - Based on routine checks;
  - Cheap meters on small branches;
  - Sankey used as the water metering / distribution bible;
    - Only updated if major changes are made;
  - Easy projects have generally been on basic lines (e.g. toilets, sanitation)
    - Typical faults include passing ballcocks/cisterns, leaks to garden irrigation system.
  - Currently around 1/3 meters are automated, and 2/3 are manually logged;
  - Accuracy is not important (5-10% is fine) - looking for outliers;
- AMGEN spends around 65% of electricity bill on HVAC, high chiller load and evaporative cooling requirement.

#14(c) Renergise, 29 May 2014

Speaker: Brendan O'Sullivan

Background:

Renergise Ltd offer a comprehensive water conservation service in Ireland. They offer water saving products and recommendations on water saving measures that best suit specific client requirements.

Renergise Ltd was founded in 2009 with offices in both Co Kerry and Co Galway in Ireland. Renergise has firmly established itself as the leading supplier of water saving products in the Irish sustainability market, providing water management solutions for both the commercial and domestic markets throughout Ireland.

These Services Include;

- Water Audit service
- Detail recommendations on water saving technologies, with savings / payback projections
- Water Monitoring / Leak Detection Services
- Supply & distribute a comprehensive range of water & energy saving products / with best spoke leading edge technologies
- Onsite training and awareness days

Minutes:

Renergise provide water conservation to domestic and commercial consumers;

- Combined water charges in Ireland (Water In + Water Out) vary across the country
  - Typically around €1.59 - €3.04 per m3
  - This is only going to get more expensive over time.
- Example of savings in a 100 room hotel
  - Savings: €2.30/m3, approx. €150k p.a.
  - Retrofits included occupant controls, shower head replacement, tap faucets, urinals etc.
  - 50-60 leaking ballcocks;
- Look at combined savings on water and energy
  - Typical 3-6 month payback on most projects;
  - Simple inexpensive solutions;
  - All work may be carried out by maintenance staff in the building;
  - e.g. Shower head replacement:
    - JETcore flow regulator system;
    - Shower/tap flow regulator;
    - Replace aerator: reduction from flow of 20L/min -> 3-4L/min, for a cost of €3-4
  - Push taps, closes after 10sec
  - Sensor taps in commercial buildings, less contamination potential, can save up to 80%, include a 12-24 hygiene rinse for non-use;

    - Urinal management system
        - 24 hour flush cycle
        - Solenoid used to detect occupancy and induce flush after a few mins;
        - Max 3 flushes per hour on a 20min cycle, compare with regular cycle which continuously flushes throughout the day;
        - Savings up to 92%
        - Cost < €300
- Monitoring of water usage and awareness:
    - Conduct audit and issue potential savings report;
    - Monitor on main incomer meter (m3/hr.)
    - Identify major leaks from baseline water consumption (MNF - Minimum Nightly Flow), i.e. lowest water usage;
    - Data gives the tools to ask questions about what is happening;
- Track water usage and display as part of energy cost and KPI's
- Examples of common leaks in typical systems:
    - Toilets, Cisterns;
    - Urinals;
    - Ice storage;
    - Water storage tanks;
    - Pipework.
- Staff awareness and audits
    - Explain to staff the impact in terms of quality, cost, and ultimately salaries;
    - Signs/Dashboards for awareness, Discussion at team meetings;
    - Regular site audits.
- Online System for water monitoring on website
    - Set alarms, track and monitor usage;
    - Text/Email alert system;

#14(d) Larsen Water Management, 29 May 2014

Speaker: David Smith

LARSEN WATER MANAGEMENT

Background:

LARSEN is the **only Irish water Leak Detection Company with 25-years' experience** and an unrivalled track record in water leak detection and water network surveys, working throughout Rep of Ireland and Northern Ireland

Minutes:

Focus on provision of leak detection, water auditing and fire hydrant testing

- Established in 1989;
- Focus was on commercial sector, but now moving more to private industry and consulting due to changes in water charging;
- Only leak detection company in Ireland with ISO accreditation;
- Customers:
  - 50-60% business with local authorities - now Irish water;
  - Government agencies - OPW, HSE, Dept. of Education, Dept. of Defence
    - Own and operate some of the oldest water infrastructure in Ireland;
    - Dates back to British empire;
  - Private industry;
  - Consulting engineers;
  - Developers;
- Water Audit
  - Logging on main water meter;
  - Analyse demand profile/pattern;
  - Key indicator = Minimum Nightly Flow (MNF);
  - Daily water demand profile can provide an estimated water loss figure
  - Example:

Demand (m3/day)	MNF (L/s)	Annual Demand Cost (€)	Loss (m3/day)	Annual Water Loss (€)
204	1.7	197,000	125	121,000

- Leak Detection
  - Process to be followed after a leak has been verified;
  - Network Proving: validate the integrity/configuration of the water network;
    - Drawings of infrastructure - as-built layout;
    - Network may (in some cases) be feeding a neighbouring supply;
    - May have a faulty non-return valve causing flow past the site;
    - Purpose here is to verify that a MNF is actually indicative of a leak, and not a network proving issue;
  - Step-Testing
    - Close off sections of network to establish where MNF is going;
    - Carried out at night to minimise network disruption;

  - Pipe Tracing: Identify exact location
    - Acoustic Leak Detection (used in >90% cases)
      - Most effective on metallic pipes;
      - Less effective on PVC;
      - Leak noise correlators used to remove the human interpretation element in some cases;
        - Only as good as the information input to system;
        - Require length, diameter, material etc.;
        - Determine approximate location of a break;
      - Ground microphones used for this testing
    - Tracer Gas System (used ~ 5% of cases)
      - Used primarily in pharmaceutical/industrial facilities where disruptions are costly/impossible;
      - Also used in 24/7 process, or sites where there is already a lot of background noise/vibration;
      - Invasive procedure - requires emptying of pipe and pumping with Hydrogen gas;
      - Hydrogen is detected as it rises to the surface
  - Second and Third passes are nearly always required in order to identify all leaks on a system.
    - Some network level leaks may be masked by noise on site;
    - May not be able to detect/locate upstream leaks due to background noise on branches of the network - therefore these leaks need to be fixed during the first pass;
  - Equipment for leak detection has changed very little in 22 years of business (bar tracer gases used today)
    - Data analysis has improved;
    - However the people and processes are key to success in leak detection.
- Case Study
  - Hospital
  - Housing Development
    - MNF = 1.5 L/s
    - 121 houses
    - 0.7km mains
    - Target MNF = 0.06L/s (Acceptable baselines set by water authority, check reference guides for how to calculate this figure);
    - 12 leaks pinpointed and repaired;
    - Flow: 156m^3/d > 133m^3/d > 69 m^3/d > 44m^3/d
    - Achieved through process of continuous detection and fixing;

- Additional Studies:
  - Housing Development
    - Typical house consumes 324-365 L/day (expected figure)

	Cost (€/year)	Consumption (m^3/day)	Consumption (L/s)
Before Survey	151,000	156	1.51
After Survey	42,500	44	0.01
Reduction	108,500	112	1.50

- Before = 1290L/property/day
- After = 364L/property/day
- Reduction = 926L

- School - Northern Ireland
  - 1 leak found
  - Reduction of 11.7m3/week
  - Saving of £1,680 p.a.

	Weekly Demand (m^3)	MNF (L/s)	Cost p.a. (€)
Before Survey	11.9	0.019	1700
After Survey	0.17	0.000	20
Reduction	11.73	0.019	1680

- Retail Case

	Daily Demand (m3/day)	MNF (L/s)	Cost p.a. (€)
Before Survey	58.8	0.6	40,780
After Survey	2.8	0.01	1,940
Reduction	56.0	0.6	38,840

- Discussion Points:
  - Be careful on sites with storage tanks
    - Nightime replenishment from 12-6am may cause rise in MNF, inaccurate portrayal of site water consumption;
    - For example, in schools it is necessary to look at the weekend profile to get a more accurate picture, or preferable in summer months.
  - Leak detection process:
    - 1st pass - leaks on the network, close to or at the meter box,
      - These generate a lot of background noise;
      - May not be able to identify/locate secondary leaks until these have been identified and rectified;
    - 2nd Pass - identify leaks at connection to mains;
    - 3rd Pass - leaks on the mains network upstream of site.
  - Creep is a big issue
    - Recurring faults (ballcocks, footpaths etc.)
  - Ian Boylan: Potential of ESCO type model in Water
    - Water bill may only account for a fraction of energy bill, so not as appropriate in this regard;

- Martin Phelan - Sensors and Connectivity
  - Satellite probes, communicante via GPRS, curent avalable;
  - Measure pressure, conductivity, flow, chlorine etc.;
  - Predictive leak detection
  - Web-based analytic process;
  - Monitor water into site, key parameters;
- David Smith - Metering Philosophy
  - Well monitored cheap meters > Unmonitored expensive meters;

#14(e) Shay Murtagh Ltd., 29 May 2014

Speaker: Raymond Smyth

SHAY MURTAGH

Background:

Shay Murtagh Precast and Shay Murtagh (Precast) Ltd. were set up in 1975 and 1981 respectively. Between them, the companies manufacture, supply and install a wide range of concrete products to the building and civil engineering industry throughout Ireland. This presentation focuses specifically on the provision of water recovery systems for domestic and commercial customers.

Minutes:

Focus on design manufacturing and construction

Water Recovery Systems - Refer to water framework directive, EU (http://ec.europa.eu/environment/waste/framework/)

- Water Recovery systems:
  - Initial capital cost, low running cost
- Rainwater harvesting
  - Refer to DIT report on RW harvesting (see here)
- Advantages:
  - Reduce mains consumption by up to 50%
  - Software water for washing processes;
- Installation
  - Filter (3P Teknik)
    - designed to handle hydraulic load
    - Takes out dirt/debris;
  - Calmed Inlet
    - Stop potential for disturbing debris in base of filtration system;
  - Sedimentation
  - Flotation and Overflow
    - Remove scum, oil, floating solids at surface;
  - Pump to PoU (Point of Use) or mains header
- Retrofit systems
  - Save 80-90% compared to baseline;
  - 2 film sediment filters and UV filter provides very good treatment;
  - Require 1m3/m2 roof space for storage per year;
  - Calculate total roof area to meet demand;
  - 4-5 days storage is recommended;
  - Water goes to an external underground tank
    - Mains water may be used to top up external tank in order to prevent stagnation, using motorised valve and solenoid;
    - Need to be careful of faulty valve causing unnecessary topping and overfly bypass;
- Typical House
  - 3000L = 10days storage

- 150L/person/day (50% storage) x 4 = 300L/household/day
- Increased storage > increased risk of stagnation
- Storage requirement will depend on flow profile;
- Cost of $4m^3$ Tank = €2,500 + Works;
- UV filter - add approx. €500;
- Payback period will depend on water charges;

Appendix E: Stakeholder feedback EUW2014

Combined feedback form from European Utility Week, collected by Sander Smit, BMC

Spoken with: Eric van der Laan – CGI (CGI)
Igor Ljubekovic – Siemens (SIE)
Johan van Erp – BrabantWater (BW)
? – Imtech (IT)

Date: 5 & 6 November 2014

1. **Water Data Broker / Sub-metering:** More detailed water usage data is needed to enable personalised water information services. Who will facilitate sub-metering in a home environment and who will own the data?

CGI: Because of the importance of the data/information, I don't expect that the data will be managed/owned by the consumer but by the utilities. Data will be made available to third parties when legislation is in place that protects the privacy of the consumers.
SIE: Initially the utility, but in the case of products delivered through retail channels, the company delivering the product will own the data, look for example at the Nest thermostat.
BW: I expect that the information driven companies of today, Google, IBM etc., will gain access to this data by launching connected products for the consumer market, e.g. home energy management systems. Utilities can never operate with the same speed these companies do.
IT: Expect that products that support sub-metering be installed by the house owner who can purchase them at builder's merchants. The data will be collected and owned by the house owner.

2. **Outflow:** Do water providers foresee metering of wastewater outflow and if so, who will be responsible for metering water outflow?

CGI: I do not foresee a need to measure outflow. When people start using rainwater harvesting it contributes to a sustainable society and brings societal benefits. No need to measure and bill this separately.
SIE: Expect the water purification utility to install these sensors because they have a clear benefit by measuring the quantity and quality of the water entering their plants.
BW: Yes, not only for water treatment providers but also for measuring the levels of energy remaining in the wastewater (think of the temperature of the water). BW considers this area interesting enough to start research on it, so it could be the water companies driving this.
IT: Don't expect a meter on the sewage but metering on the additional inflows of water, like a rainwater harvesting system. Expect the house owner to install this to keep track of his savings.

3. **Water services:** Who will offer water information services to domestic users? Water providers, third parties or energy providers?

CGI: In the Netherlands, the market for value added water information services is very small. Currently, there is no urgent problem that would activate/stimulate people to adopt new services. First we need scarcity of water, in quantity or quality.
SIE: In a multi-utility approach I expect the energy utilities to take this role. They have more experience with value added services and currently have, in general, a closer relationship with their customers.

BW: Billing and abnormalities in usage is communicated about on an individual basis. Water quality is communicated about on a group level, e.g. to a group of users linked to a specific segment of the water grid. This is mostly done in the case of maintenance when the water can be coloured for a short time period. We then advise not to use the washing machine but first open the taps to flush the pipes. We think of communicating other quality indicators, for example temperature of the water because this effects your energy bill. The warmer the incoming water, the less energy you need to heat the water for a shower or heating the house. *IT:* The water utility.
4. **Water availability information:** To increase people's awareness it is necessary to share information about the availability of water. Will this information become publically available?
CGI: Not relevant for the Netherlands, we have plenty of water. *SIE:* Yes, this information need to be shared not only to increase end-user awareness but also to link with social movements in the society where people take ownership for their environment. *BW:* In the BW region (BW uses 100% groundwater) there is sufficient water for the coming decades so this information might not be very interesting. Nevertheless we would happily share data that does not violates privacy rights in some open format to see what applications third parties might come up with. *IT:* Not in the Netherlands, there is no lack of water here.
5. **Utility business model:** Will water utilities move towards a service oriented business model?
CGI: Only if a substantial part of their business consists of service related activities and the potential market is large enough. Otherwise there will be no business case for a services oriented business model. *SIE*: Definitely yes. *BW:* Yes *IT:* Don't know.
6. **Pricing:** When water is becoming scarcer, pricing can be used as an instrument to stimulate water conservation. As a result, the pricing policies most popular in the future will be flexible pricing, increasing block tariffs and seasonal rates. Agree?
CGI: In the energy domain we are involved in two pilots with dynamic pricing, now running for multiple years (Easystreet, Muziekwijk, Zwolle). We see that dynamic pricing changes customer behaviour. The function most used is the direct feedback mechanism, where people can see on a display what the current price level of energy is and on that moment decide to start a wash etc. or not. Programmable functionalities, start my dish washer only when the price is in a certain range, are not used. *SIE*: Yes, the increasing block tariff seems most appropriate for that. *BW:* Today we have contracts where capacity is limited at a certain level, mostly to prevent that other customers suffer from large intakes of one heavy user. This is only applicable for water intensive B2B customers. Because of the availability of water in our region, there is no need to use the price instrument for domestic users. *IT:* A pricing model based on the usage of water would be fair. Make drinking water expensive and grey water cheap to prevent that people use drinking water to flush the toilet and to stimulate the use of grey water systems.

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