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Project co-funded by the European
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Program (Grant Agreement No. 619660)

Standards-based methodology for the design and implementation of a water management system



Thank you for your participation in Session 7

S7: Sensing Technologies for Water Resource Management

We believe we can make business and solve societal challenges through work in this area. If you are not aware, visit www.ict4water.eu.



About R2M Solution

What: Innovation, Technology Transfer, and Consulting Company

- We stimulate research ideas
- We bring clients to research programs
- We focus research projects toward exploitation
- We consult to bring research results to market

Competitive Advantages:

- Focus on exploitation
- Multi-disciplinarity
- High risk tolerance
- Energy that comes with a young growing company



Pavia
Catania
London
Madrid

We are involved in the topic area via our participation in

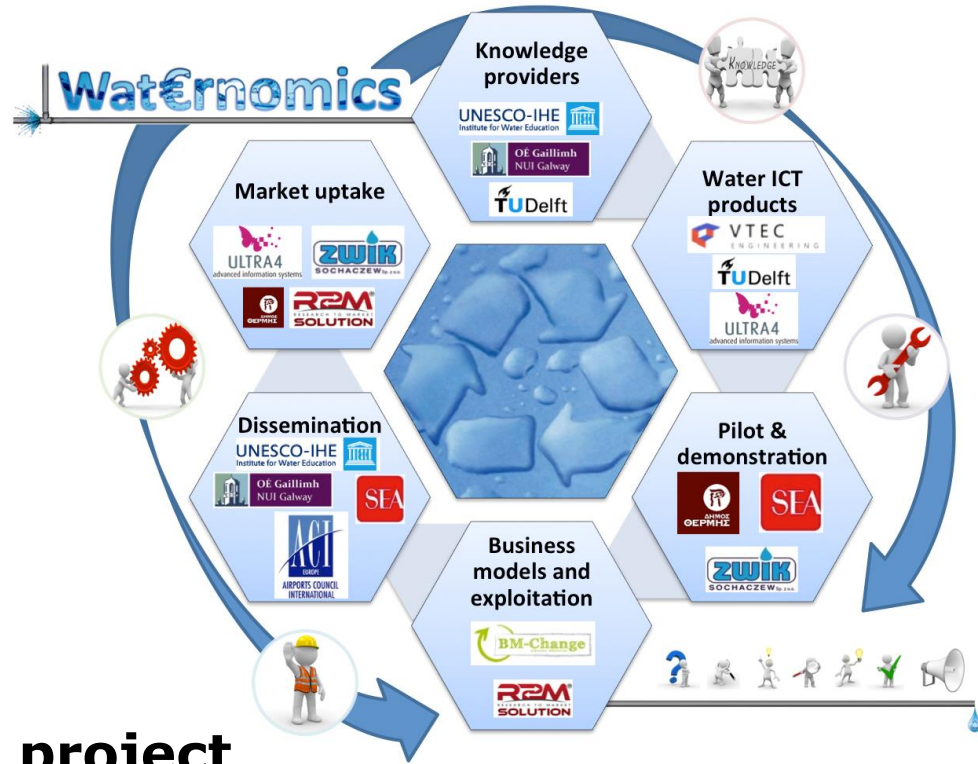


Innovation
Energy Services & Sustainability
Engineering
ICT & Automation

Founded in	2012		23	Company staff
Funding raised:	47	M€	12	research projects
Organizations partnered with:	428		11	jobs created 2014/2015



About WATERNOMICS



- ▶ Type of project: **Collaborative project**
- ▶ Project start date: **February 2014**
- ▶ Duration: **36 months**
- ▶ Call: **FP7-ICT-2013-11**
- ▶ Effort: **416 PM**
- ▶ Budget: **€4.287M**
- ▶ Max EC contribution: **€2.905M**

- ▶ Grant No.: **619660**
- ▶ Consortium: **9 partners**
- ▶ Countries: **4**
- ▶ SMEs: **4**
- ▶ Pilots: **4**



Project Aim & Objectives

WATERNOMICS will provide **personalized and actionable information** on water **consumption** and water **availability** to individual households, companies and cities in an intuitive & effective manner at relevant time-scales for decision making

- Combining information from various sources & domains to offer **contextual water information services**
- Making water usage information **accessible** across devices & locations
- Supporting **personalised interaction** with water information services
- Enabling **sharing** of water information services across communities of users
- Demonstrating generic water information services **can be used in a variety of environments** (i.e. geological, environmental and social)
- Enabling open (collaborative) business models and **flexible pricing mechanisms** that are responsive to both demand and climate conditions

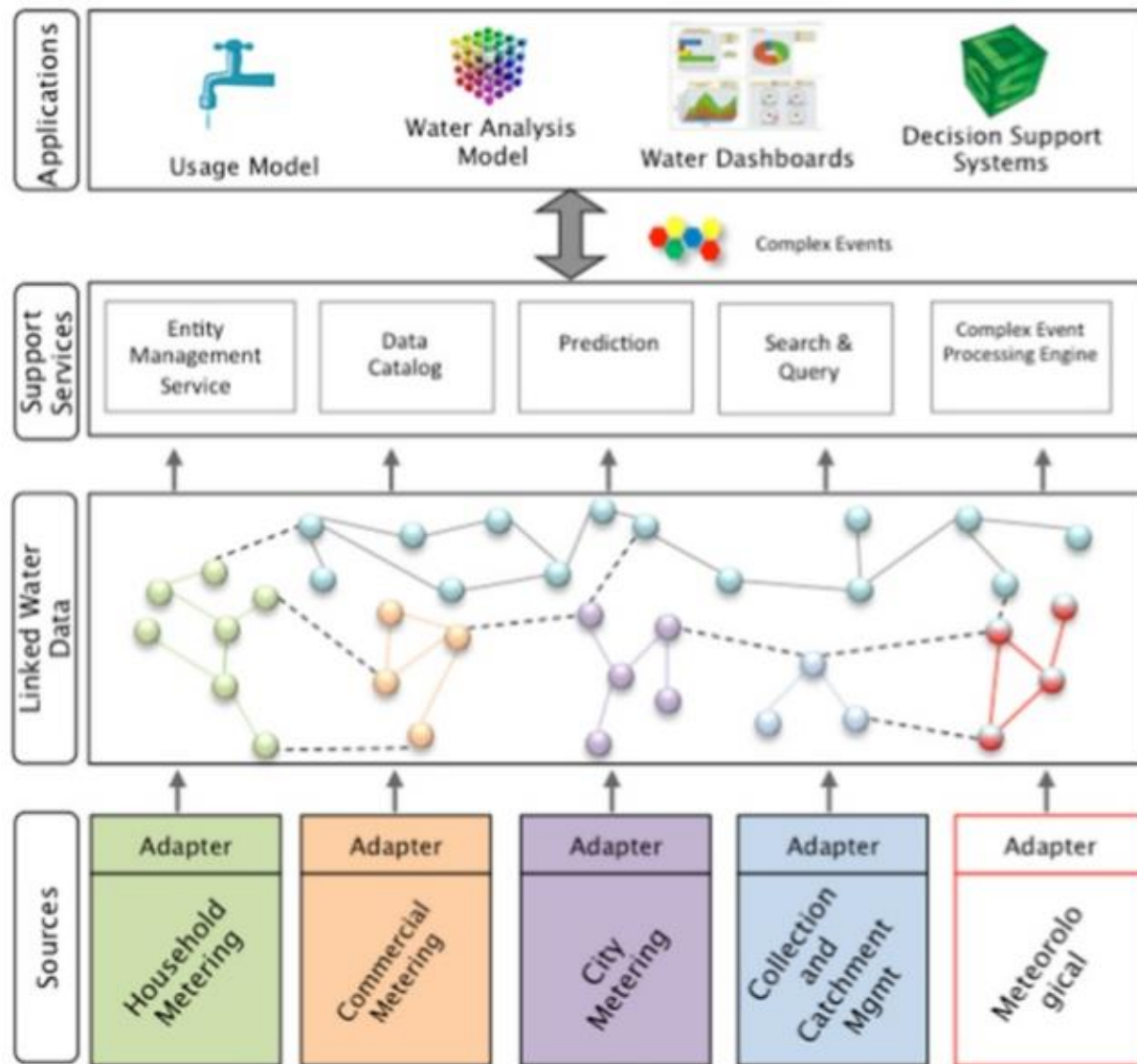


Expected Impacts

- To introduce **demand response and accountability principles (water footprint)** in the water sector
- To engage consumers in new **interactive and personalized** ways that bring water efficiency to the forefront and leads to changes in water behaviours
- To empower corporate decision makers and municipal area managers with a **water information platform** together with relevant tools and methodologies to enact ICT-enabled water management programs
- To promote **ICT-enabled water awareness** to people using airports and water utilities as pilot examples
- To make possible **new water pricing options** and policy actions by combining water availability and consumption data



WATERNOMICS INFORMATION PLATFORM



Water Management Apps

- Water dashboards
- Decision support
- water availability/forecast

Support Services

- Simplify linked data consumption via common services




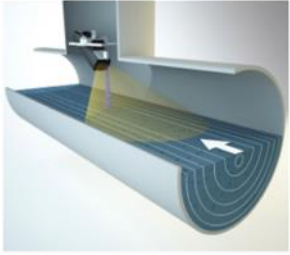
Linked Water Data Cloud







- Rich with knowledge and semantics about water usage performance

Data/Meter sources

- Existing operational legacy systems
- Adapters perform the “RDFization” lift to the dataspace

Sensing Technologies in Waternomics

<p>Data acquisition device and wireless data transmission <i>(BeagleBone Black Board)</i></p>		<p>The data acquisition platform is to use BeagleBone Black(BBB), a very smart and cost-effective single-board computer.</p>
<p>Level sensor</p>		<p>The piezoresistive sensor is immersed in the liquid and transmits the current signal to the display in proportion to the height of the hydrostatic head (water column). For its small size (less than 2 cm in diameter), the "MLS 255" is the ideal device for monitoring the level in areas difficult to access, drilling etc.</p>
<p>Power consumption meter</p>		<p>Energy meter is for displaying the consumption of active energy in single-phase systems.</p>
<p>Open channel flow meter <i>(Raven Eye)</i></p>		<p>The sensor, installed above the flow channel, creates a microwave beam above the surface of the fluid at the centre of the channel. Level measurement is provided by installing a Radar/ultrasonic sensor. Speed measurement is provided by installing a Radar sensor. It's possible to transmit GPRS data to a website.</p>

Typology	Photo	Main characteristics
<p>Electromagnetic flow meter</p>		<p>It is highly recommended due to its accuracy. And the main controller is well-designed for data collection and for further transmission.</p>
<p>Ultrasonic flow meter</p>		<p>It is highly recommended due to its cost effectiveness and easy installation as highlights. The pair of transducers is clamp-on type so it is unnecessary to make any penetration on the pipe. And the main controller is well-designed for data collection and for further transmission.</p>
<p>Mini water meter</p>		<p>Mini water meter has a hall sensor inside that can output pulse signal. The main features of this mini water meter are small size and simple data collection for the residential and commercial water network. What's more, if needed, the function of temperature measurement can also be added to this mini water meter.</p>
<p>Turbine water meter</p>		<p>High degree of accuracy and versatility, it can be utilized for automatic batching, local or remote totalization or remote rate of flow indication.</p>
<p>Pressure meter</p>		<p>Bridge- or strain-based transducers are a common way of measuring displacement. Sensors using this type of design meet a variety of requirements such as accuracy, size, cost, and ruggedness. Bridge sensors are used for high- and low-pressure applications, and can measure absolute, gauge, or differential pressure.</p>
<p>Pressure reduction valve</p>		<p>The valve reduces and stabilizes the downstream pressure independently from the flow value and changes in the upstream pressure. It also keeps the pressure upstream of the valve to a predetermined minimum value.</p>

Project Pilot Sites

LOCATION	Municipality (Pilot 1)	Corporate (Pilot 2)	Public (Pilot 3 and 4)
	 <p data-bbox="297 833 556 868">THERMI, GREECE</p>	 <p data-bbox="826 833 1193 868">LINATE AIRPORT, MILAN</p>	 <p data-bbox="1456 833 1727 868">GALWAY, IRELAND</p>
	<p data-bbox="224 901 629 935">Domestic users and utility</p>	<p data-bbox="884 901 1136 935">Corporate users</p>	<p data-bbox="1373 901 1812 935">School and University Users</p>

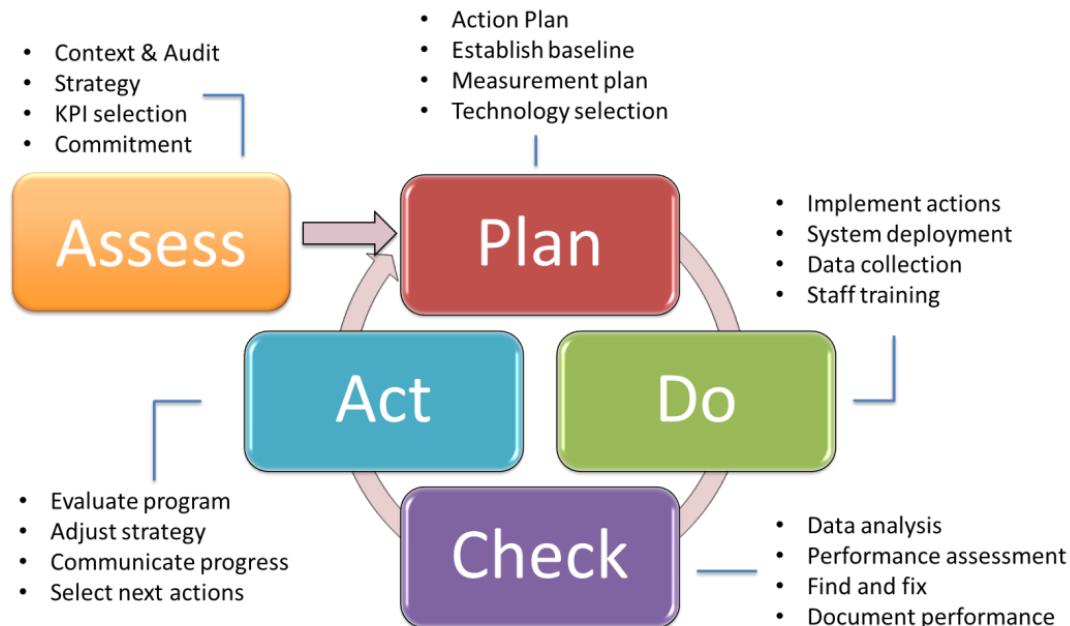


Motivation for Paper

The project features complex infrastructures, multiple sensing technologies, and linked data to make possible analysis for decision making and behavior change.

Water is a tough challenge and it is easier to do nothing.

To put all this together, a standards-based methodology is needed for all stakeholders in the value chain. We've deliberately paralleled the PDCA cycle of ISO50001 to gain immediate familiarity and added an Assess phase to facilitate an initial low-threat exploration to gain commitment. There is also a lot to gain from paralleling lessons learned in the energy sector.



Full View of the Proposed Methodology

Wateronomics

Methodology



We've coded the methodology into a TRELLO board

TRELLO is a free online collaboration environment that can be customized. Using it, we are coordinating 15-20 user efforts through the methodology across 4 pilots. Decision makers may find this a useful tool and as part of the final Wateromics Platform, we'll have this clickable environment available as a resource. Each step is explained and has pointers for more information / where to get help.

The screenshot displays a Trello board for 'WP5 - Pilot Management and Implementation - Engineering Building, Galway'. The board is divided into four columns representing project phases:

- Phase 0 - Assessment:** Cards include 'Assess Water Context' (0/2), 'Conduct Water Audit' (6/6), 'Define Strategy, objectives and KPIs (1)' (3/3), 'Define Strategy, objectives and KPIs (2)' (0/6), and 'Select Water Efficiency Measures'.
- Phase 1 - Plan:** Cards include 'Prepare Action Plan' (0/8), 'Develop Baseline', 'Water system modelling' (0/4), and 'Plan metering strategy' (0/5).
- Phase 2 - Implementation:** Cards include 'Metering Installation and Configuration' (78 comments, 18 likes) and 'Water information system deployment (1)' (4 comments, 3 likes).
- Phase 3 - Check:** Cards include 'Data Analysis' (0/2), 'System Analysis' (0/2), 'Assess Performance', 'Find and Fix', and 'Document Progress'.

A detailed view of the 'Metering Installation and Configuration' card shows a photo of a metering device and a list of team members: LH, MN, PO, SG, YL, AR, JM, LH.

The right-hand menu is open, showing options like 'Add Members...', 'Change Background', 'Filter Cards', 'Power-Ups', and 'Activity'. The activity log shows a recent update by 'Sujan Ghimire' on 'Metering Installation and Configuration' with a message: 'Hi, the vtec BBB in NUIG currently are not recording data locally, due to a situation where when the memory was full(usually takes minimum of 6 months) that the script would behave differently, and data would be'.



Our methodology also features other tools/resources

- TRELLO Board
- Water Auditing Tool
- Technology Selection Tool
- Strategy Selection Tool
- Minimal Data Set Method
- Water Value Map

Pictured: Water Value Map

Water Value Map		
Prepared for: _____		On Day - Month - Year
WATER INTAKE	WATER USAGE	WATER DISPOSAL
BENEFITS Which benefits do you gain by the use of water? How does your water usage affect your reputation? For which resolution of your problems do you need water?		
SOURCE Where does your water come from? How much water is still available? What are you using your water resources?	PEOPLE Who are using water? Where do people use water for? How much water do people use?	RE-USE What is still of value in your wastewater? For which purpose could you use your wastewater? How can you extract valuable materials or energy from your wastewater?
NETWORK How does the water get to me? How is water distributed within my building? What is the status of my water distribution network?	MACHINES Which devices use water? Do these devices produce wastewater? How much water is used by these devices?	RE-SELL For which parties is your wastewater still of value? How could you transfer your wastewater to other parties?
QUALITY What is the quality of the water you receive? Which water quality do you need?		DISPOSE Where does your wastewater go to? How is your wastewater being treated? What is the environmental impact of your wastewater disposal?
COSTS What are the financial costs of purchasing water? What are the financial costs of treating your wastewater? What is the environmental impact of your water usage? How does your water usage affect your reputation?		

These tools are described and available on www.waternomics.eu in the report D2.1.

More information about pilot activities (ongoing) is presented in the following slides





Thermi municipality

- Situated nearby Thessaloniki - Greece
- Mostly residential area
- But there are also businesses, a technology park and large areas for agricultural use

Pilot is targeting domestic users

10 households identified

a variety of profiles

a variety of water usages

- We are gathering monthly consumption from them for forming a baseline
- We have acquired historical data for consumption for up to 10 years ago
- Questionnaire sent to household owners about family profile and water infrastructure to help in baselining

EXISTING INFRASTRUCTURE



Main water supplies

- Usually outdoors
- Water meters from water utility
- Possibility to use them as a basis for additional installation rejected



In house installations

- Heavy use of flexible pipes
- Ideal for using Mini Water Meter (MWM) sensors



INSTALLATION PHASES

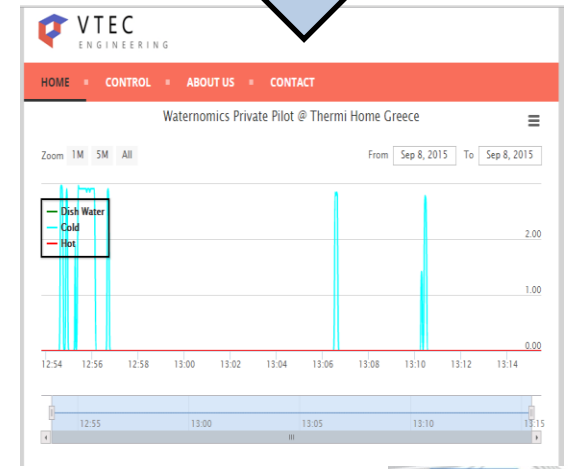
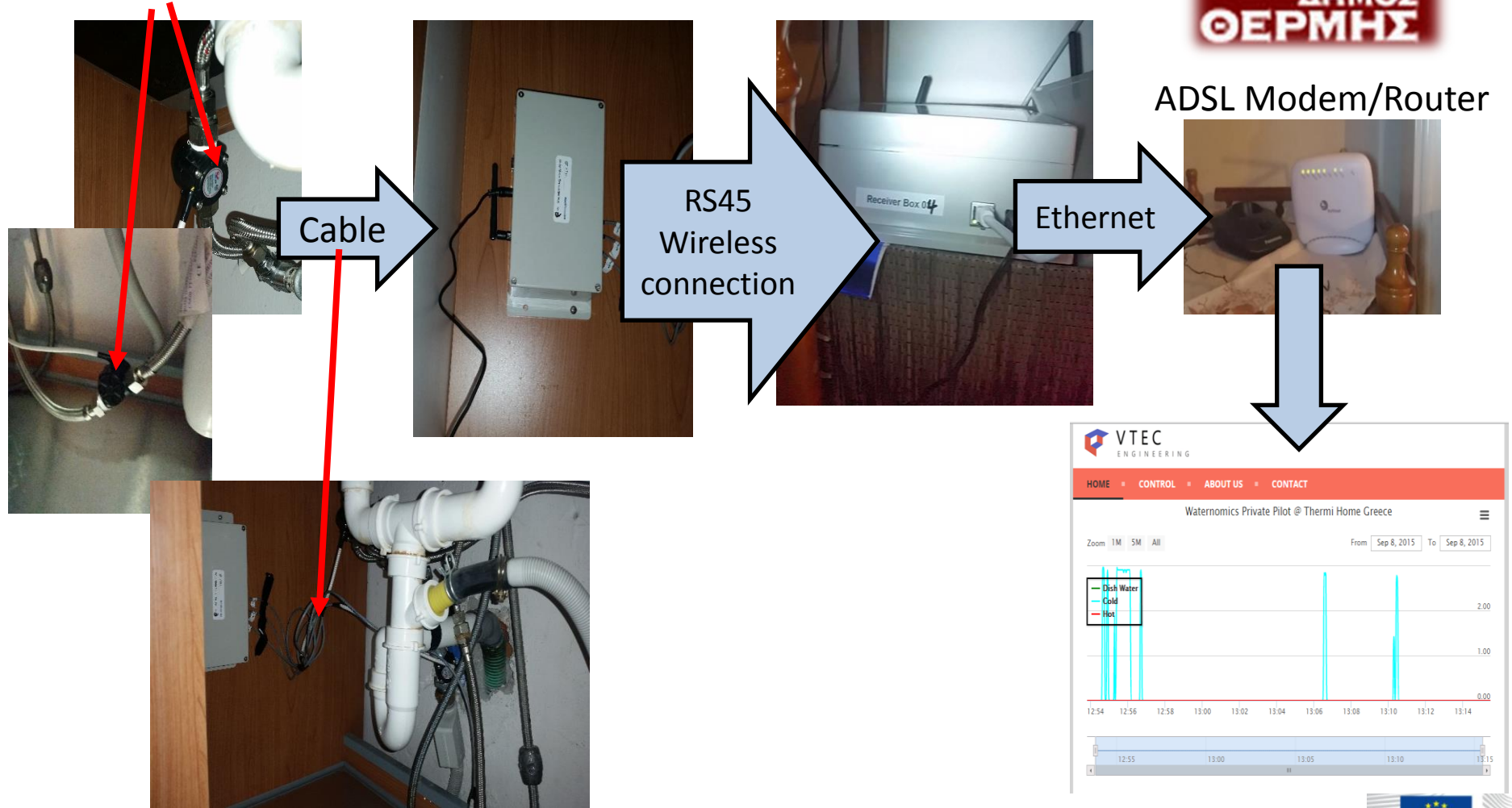


MWM

Transmitter box

Receiver box

ADSL Modem/Router





Milano Linate Airport

- Situated nearby Milano Center - Italy
- Corporate
- there are also shops, bars and restaurants in the Terminal

Pilot is targeting corporate and decision-makers users

A District Meter Area has been chosen

To conduct water and pressure metering

To implement a global water balance

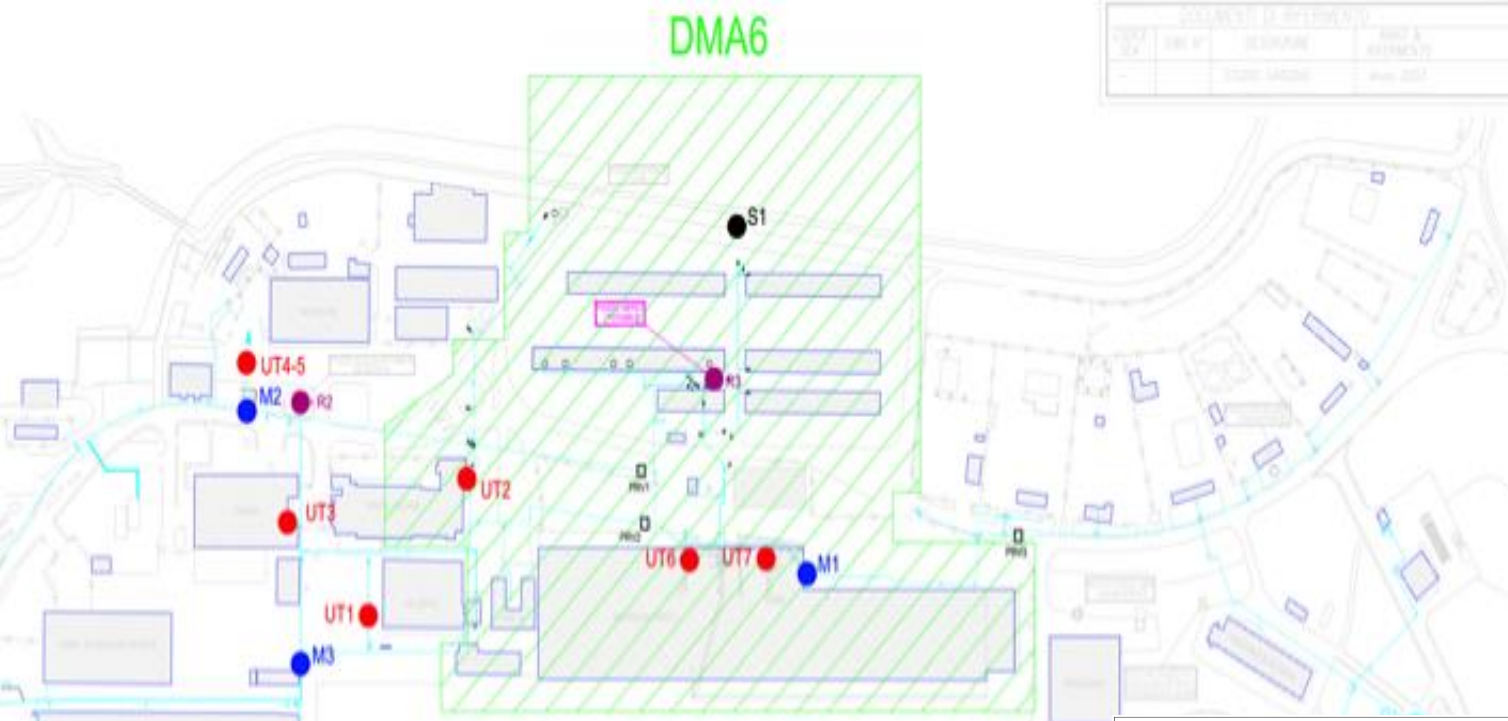
- We have acquired historical data for consumption for up to 3 years ago
- Interviews have been implemented to understand the managers / designers and maintenance people needs
- A global metering plan has been implemented to have full control and real-time information about the water network



METERING PLAN IMPLEMENTED



DOCUMENTO DI IDENTIFICAZIONE			
TIPO DI DOCUMENTO	DATA	DESCRIZIONE	PRODOTTORE
-	-	STUDIO METRICO	Nov 2017

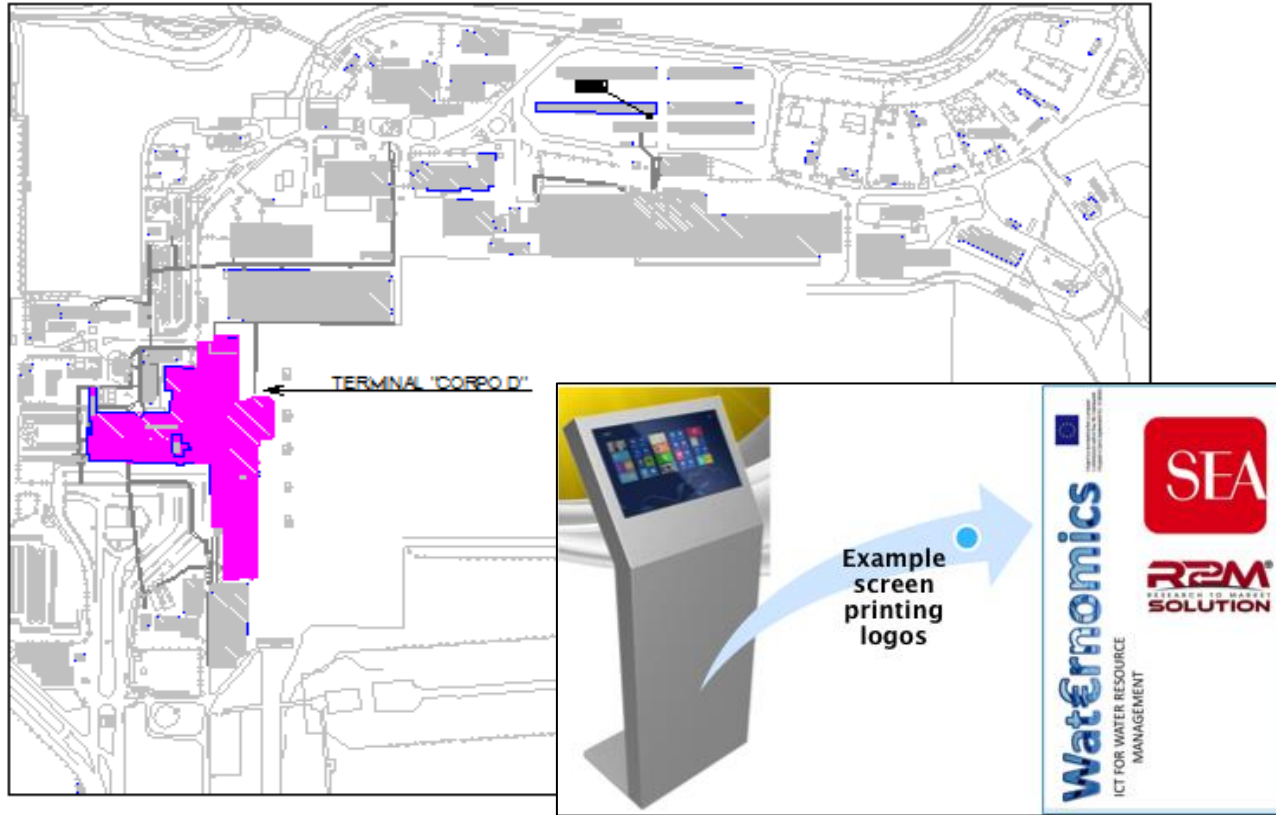


LEGENDA

- Volumetric flow meter + pressure meter + energy meter (for the wells)
 Ultrasonic flow meter will be installed in parallel
- Electromagnetic bidirectional flow meter + pressure meter (to isolate DMA6)
 Ultrasonic flow meter will be installed in parallel only in the point named M1
- Electromagnetic bidirectional flow meter + pressure meter (to improve the metering in the network)
- Volumetric flow meter (to monitor building not included in DMA6)
- Volumetric flow meter (to monitor the total water input in Terminal building)
- Pressure meter (to monitor the Control Tower)
- Open channel flow meter (to monitor discharge point S6)
- Ultrasonic flow meter (to monitor the Cooling Tower)
- Pressure reduction valve
 PRVx



METERING PLAN IMPLEMENTED



Touch screen displays will be installed in Linate Airport to convey information about Waternomics project, Waternomics success and involving the users in improving their water consumption behaviour through video / tips / games.

Terminal Building. This water metering area is selected to have the project interact with airport terminal staff, passengers that use the terminal, and the shops and common areas that are located within it.





NUI Galway

- one of Ireland's National Universities, founded in 1845, NUIG is ranked in the top 2% of universities in the world. NUIG has more than 17,000 students and 2,500 staff.

Pilot is targeting university users

A large variety of users targeted

Maintenance staff

Operational management

Students/Guests/Customers

- We are gathering water consumption from existing water meters for forming a baseline
- We have acquired historical data for consumption



Main water uses in the **Engineering Building NUIG**

No.	Water Supply System	Example of Usage
1	CWS - Cold Water Supply	Laboratory Work, Bathroom Sinks, Showers, Canteen, Cleaning, Top-up
2	MWS - Mains Water Supply	Potable Water at Water Fountains, Canteen, Laboratory Eye/Emergency Wash etc.
3	DHW – Domestic Hot Water supply	Bathroom Sinks, Showers, Canteen, Cleaning
4	GWS – Grey Water Supply	Bathrooms for Toilet Flushing



Key Stakeholders

- Maintenance Staff /Operators
- Operational Management
- Senior Management/Bill Payers
- Staff/Students/Customers
- External Stakeholders/Research Interests



PILOT 3: ENGINEERING UNIVERSITY BUILDING - GALAWAY (IRELAND)

There were originally 11 water meters on the water system at the Engineering Building; 5 meters connected to the BMS.

As part of the WATERNOMICS Project, an additional 8 meters were installed to monitor and assess water usage by type in line with the stakeholder KPIs and the platform objectives.

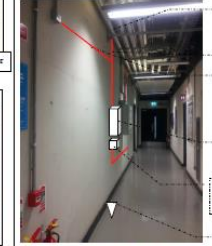
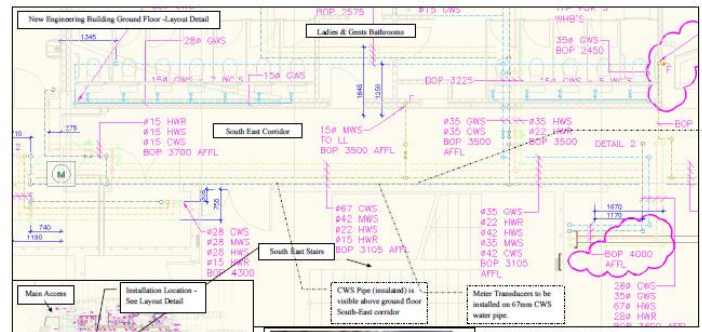
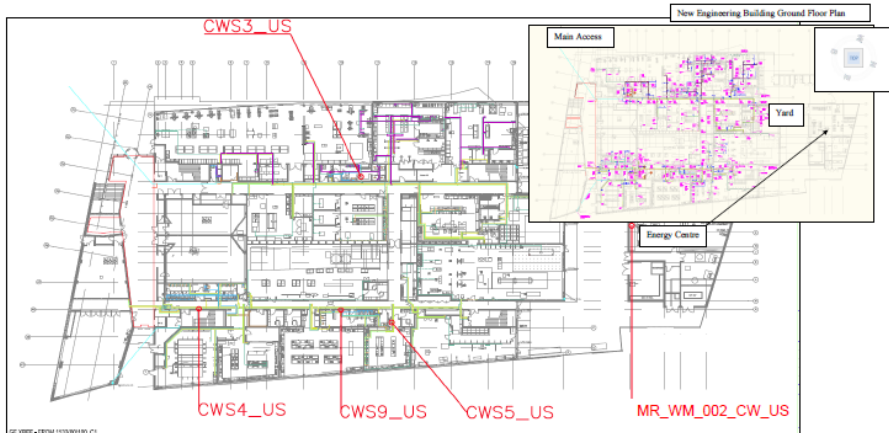
The WATERNOMICS Meters are VTEC Ultrasonic Meters with point to point data connections via BBB.



Photos 1, 3, 4 Installed Meters NUI Galway



PILOT 3: ENGINEERING UNIVERSITY BUILDING - GALWAY (IRELAND)



Meter Control Unit to be installed as per specification in new enclosure on wall north of gas monitoring box see details.

Meter Transducers to be installed on 67mm CWS water pipe.

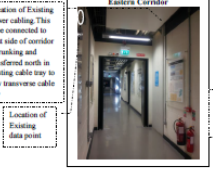
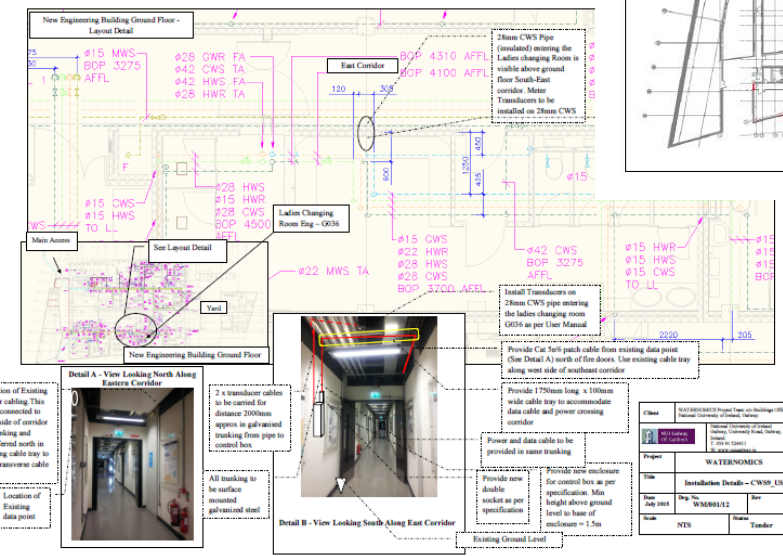
Provide 25mm dia. tracking surface mounted galvanneal steel, 1400mm in length approx. to carry transducer cables.

Provide new enclosure for control box as per specification. Max height above ground level to base of enclosure = 1.5m. Enclosure to be located 500mm north of existing gas monitoring/control.

Provide new double socket as per specification.

Existing Ground Level

Class	WATERMOMICS
Project	WATERMOMICS
Title	Installation Details - CWS4_US
Date	July 2015
Drawn By	WME0107
Scale	NTS
Author	Tender



25mm CWS Pipe (insulated) entering the Ladies Changing Room is visible above ground floor South-East corridor. Meter Transducers to be installed on 25mm CWS water pipe.

Provide 25mm dia. tracking surface mounted galvanneal steel, 1400mm in length approx. to carry transducer cables.

Provide new enclosure for control box as per specification. Min height above ground level to base of enclosure = 1.5m.

Power and data cables to be provided in same tracking.

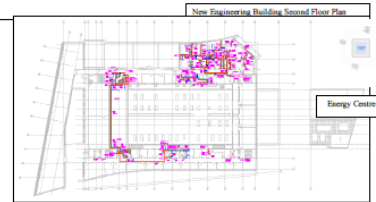
Provide new double socket as per specification.

Existing Ground Level

Class	WATERMOMICS
Project	WATERMOMICS
Title	Installation Details - CWS9_US
Date	July 2015
Drawn By	WME00912
Scale	NTS
Author	Tender



Class	WATERMOMICS
Project	WATERMOMICS
Title	Ultrasonic Water Meter Installation Location - Third Flr. Dia
Date	July 2015
Drawn By	WME0103
Scale	NTS
Author	Tender



Class	WATERMOMICS
Project	WATERMOMICS
Title	Ultrasonic Water Meter Installation Location - Second Flr. Plan
Date	July 2015
Drawn By	WME00912
Scale	NTS
Author	Tender



Coláiste na Coiribe secondary school under construction ~3km from Galway City (75,000 pop.);
The 7,400 sqm school will be Ireland's largest Irish



language second level school with 720 pupils (boys & girls aged 12-18);

Key Stakeholders

- Maintenance Staff/Operators
- Operational Management
- Senior Management/Bill Payers
- Staff/Students
- External Stakeholders (Parents)/Research Interests



Principle water uses in **Coláiste na Coiribe**

No.	Water Supply System	Example of Usage
1	CWS - Cold Water Supply	Laboratory Work, Bathroom Sinks, Showers, Staff Kitchen, Cleaning, Rainwater Top-up, Practical Rooms
2	MWS - Mains Water Supply	Potable Water at Water Fountains, Staff Kitchen, Home Economics & other Practical Rooms, Laboratory Eye/Emergency Wash etc.
3	DHW – Domestic Hot Water supply	Bathroom Sinks, Showers, Canteen, Cleaning Staff Kitchen,
4	GWS – Grey Water Supply	Bathrooms for Toilet Flushing

Metering Plan

14 in-line water meters will be installed at the Pilot and a BMS Display

Metering Objectives

The meters will provide data monitor and assess water usage characteristics by type in line with the identified stakeholder KPIs and the platform objectives.

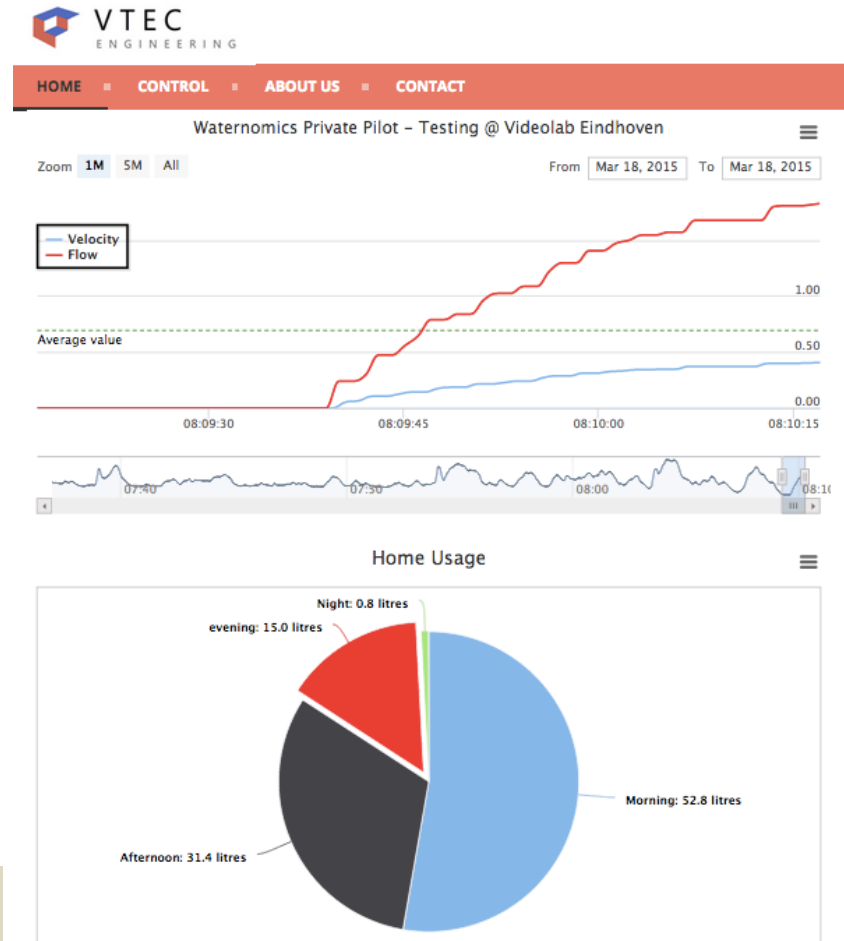


PHOTO TRANSMITTER



- ▶ Waternomics information Platform development
- ▶ Meters installation in pilot sites
- ▶ Innovative FDD meters development
- ▶ FDD methodology and method development
- ▶ Validation of the Waternomics standards based methodology

Waternomics Year 1.....A lot done
.....More to do.



Conclusions

- Water management considering water as a resource is a challenge
- Finding innovative ways to address ageing water infrastructure is a challenge
- To facilitate decision makers and stakeholders at all levels into taking action to address these challenges, a standards-based framework / methodology can serve as a powerful enabler
- Water efficiency measures can make economic sense. The business model works.
- This paper has presented such a methodology which is now under validation in 4 unique pilot actions in the Waternomics Project. We'll report on that over the next two years.
- We're always available to talk about solving water problems. Much of the work is available online and we are happy to be contacted directly.

More info about WATERNOMICS:

www.waternomics.eu

www.r2msolution.com



Thank You



Innovation
Energy Services & Sustainability
Engineering
ICT & Automation

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