2nd International Electronic Conference on Sensors and Applications
15 – 30 November 2015, online
chaired by Dr. Francesco Ciucci, Dr. Dirk Lehmhus, Dr. Stefano Mariani, Dr. Thomas B. Messervey, Dr. Alberto Vallan
sponsored by sensors micromachines

Thomas Messervey – R2M Solution, Italy
Domenico Perfideo – R2M Solution, Italy
Louise Hannon – National University Galway Ireland
Sander Smit – Business Model Change, Netherlands

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

Opening Remark

Thank you for you 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

Pavia
Catania
London
Madrid

Competitive Advantages:

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

We are involved in the topic area via our participation in

WatErnomics

R2M RESEARCH TO MARKET SOLUTION

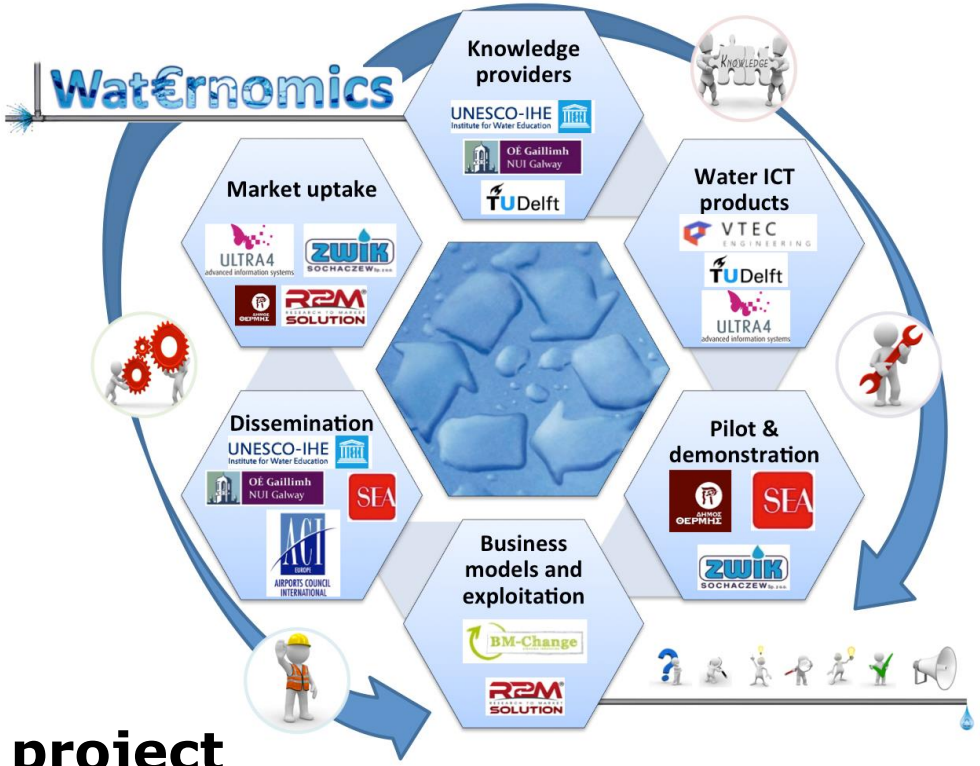
Innovation
Energy Services & Sustainability
Engineering
ICT & Automation

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

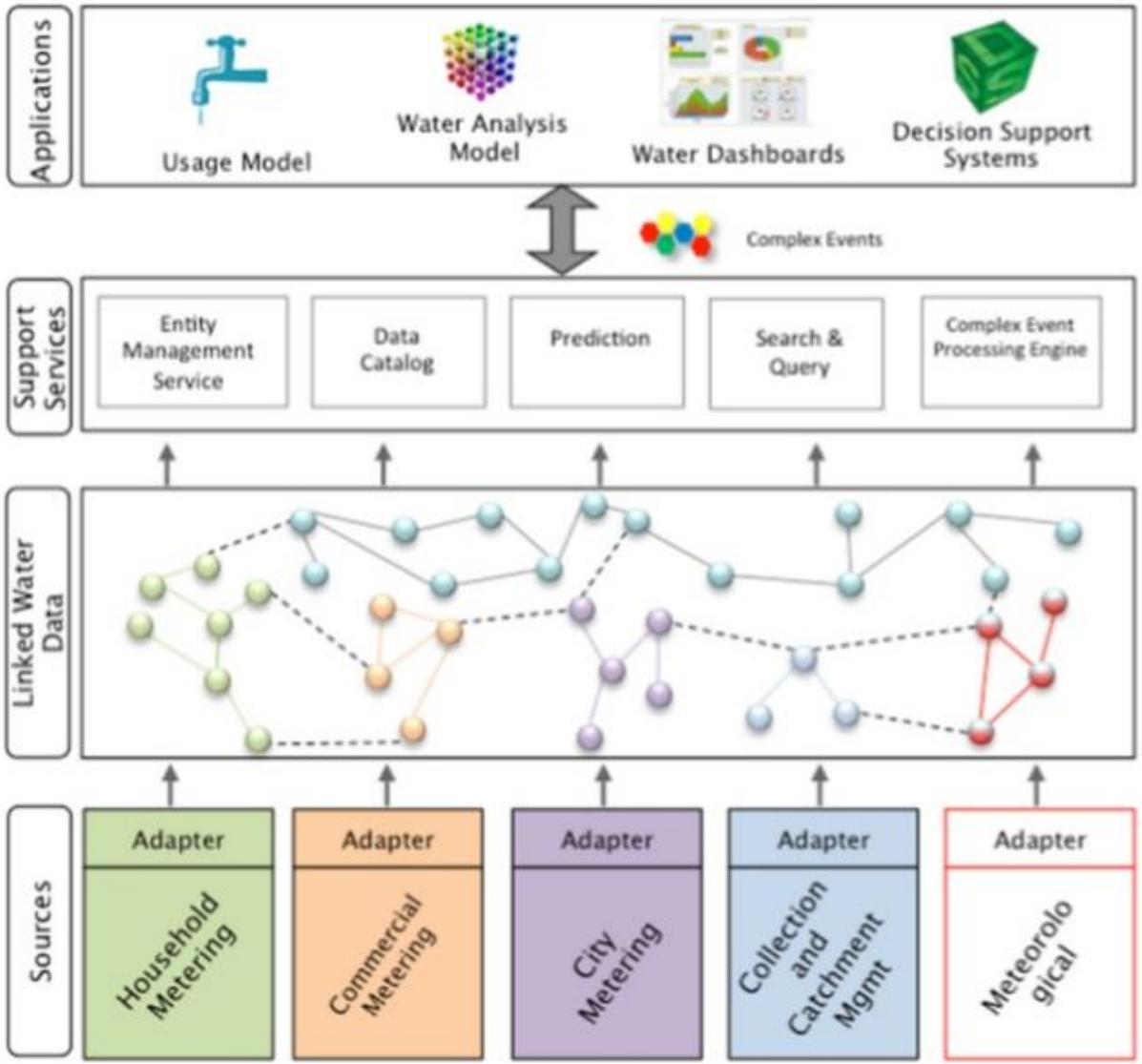
WATERNOMICS will provide **personalized and actionable information** on water **consumption** and water **availability** to individual households, companies and cities in an intuitive & effective manner at relevant time-scales for decision making

- 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

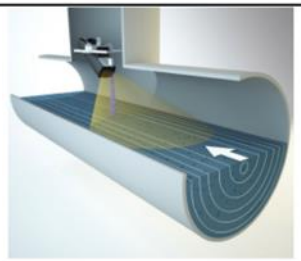
Linked Water Data Cloud

- 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

Data acquisition device and wireless data transmission *(BeagleBone Black Board)*		The data acquisition platform is to use BeagleBone Black(BBB), a very smart and cost-effective single-board computer.
Level sensor		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.
Power consumption meter		Energy meter is for displaying the consumption of active energy in single-phase systems.
Open channel flow meter *(Raven Eye)*		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.

Typology	Photo	Main characteristics
Electromagnetic flow meter		It is highly recommended due to its accuracy. And the main controller is well-designed for data collection and for further transmission.
Ultrasonic flow meter		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.
Mini water meter		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.
Turbine water meter		High degree of accuracy and versatility, it can be utilized for automatic batching, local or remote totalization or remote rate of flow indication.
Pressure meter		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.
Pressure reduction valve		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.

Project Pilot Sites

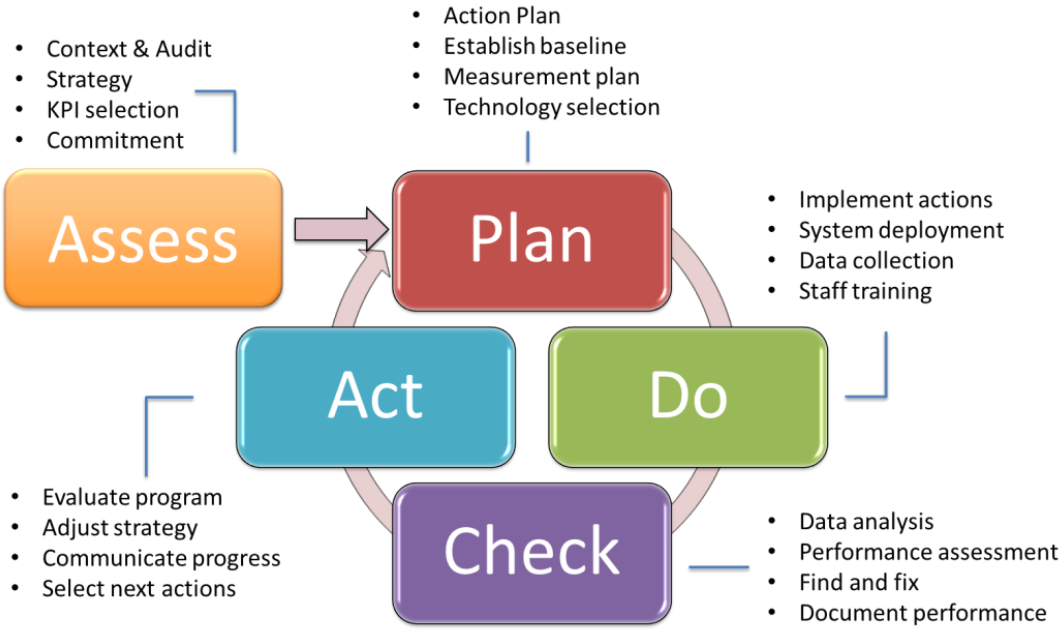
	Municipality (Pilot 1)	Corporate (Pilot 2)	Public (Pilot 3 and 4)
LOCATION			
	THERMI, GREECE	**LINATE AIRPORT, MILAN**	**GALWAY, IRELAND**
	Domestic users and utility	**Corporate users**	**School and University Users**

Motivation for Paper

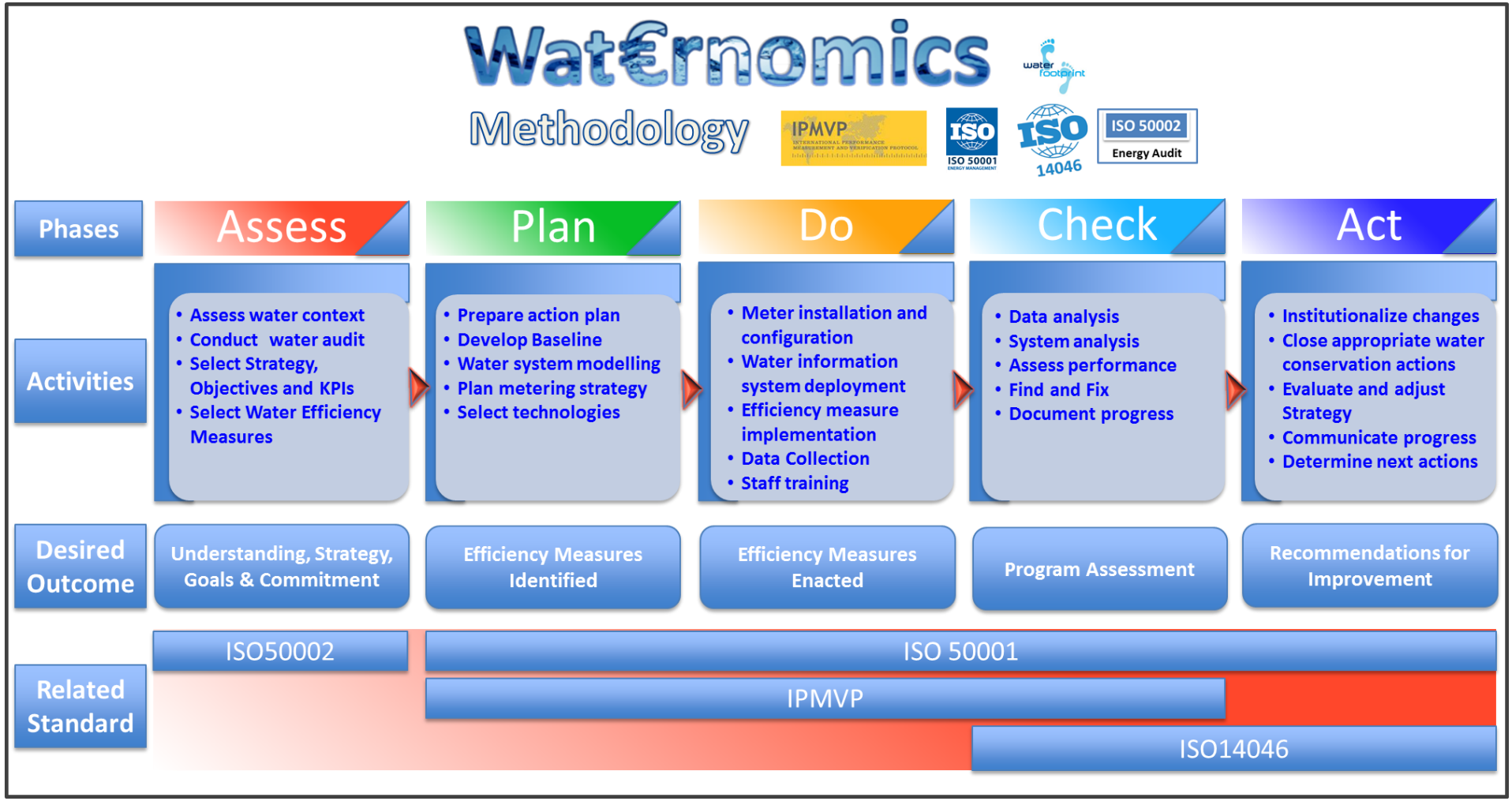
The project features complex infrastructures, multiple sensing technologies, and linked data to make possible analysis for decision making and behavior change.

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



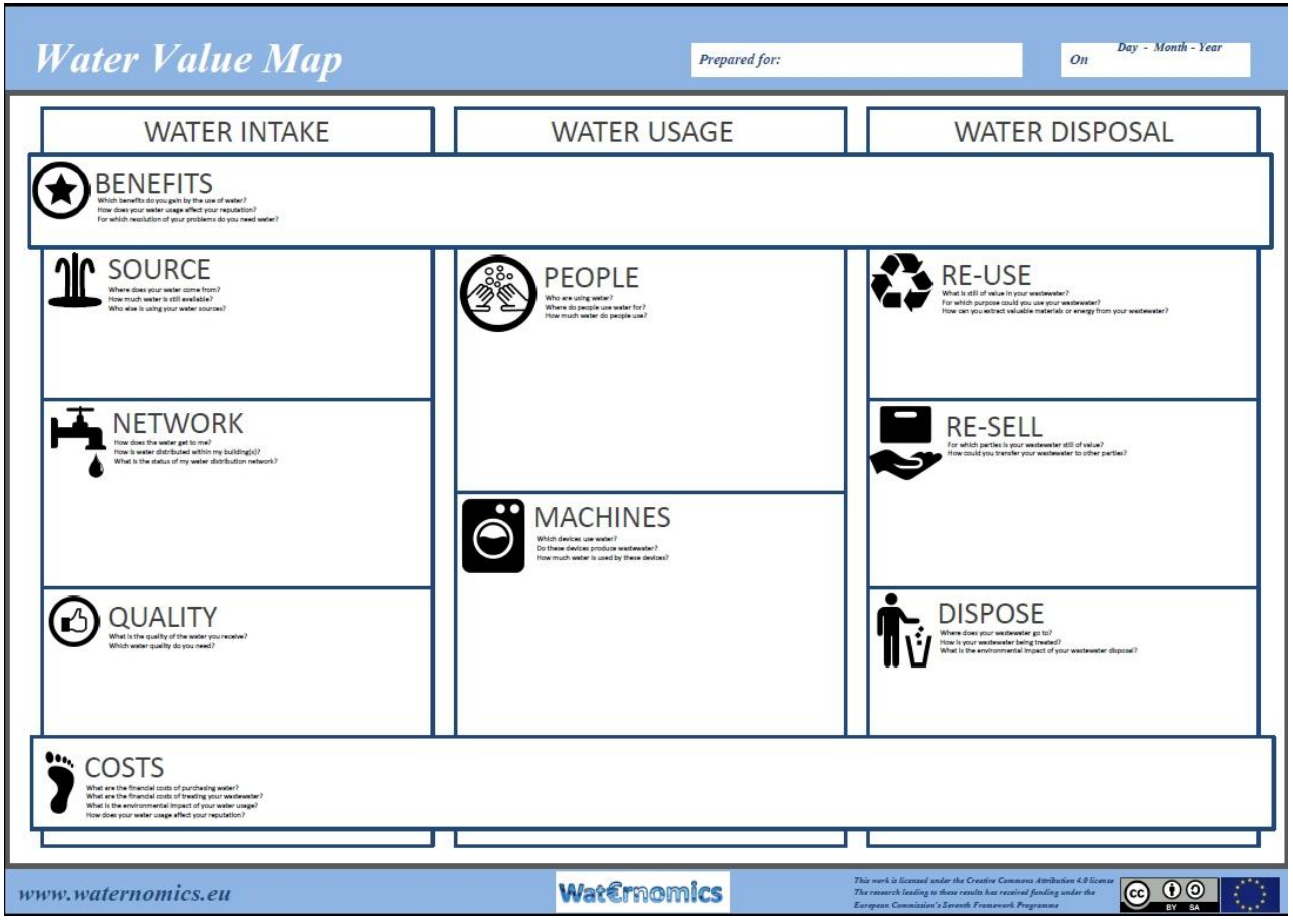
We've coded the methodology into a TRELLO board

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 Waternomics 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.

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



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

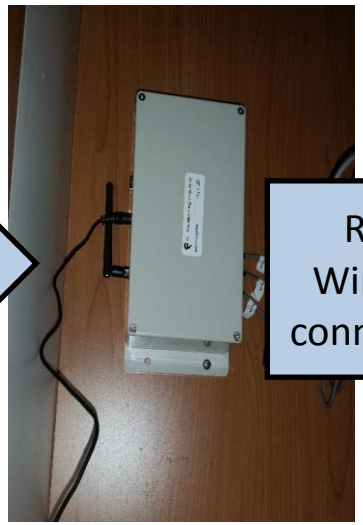
MWM

Transmitter box

Receiver box

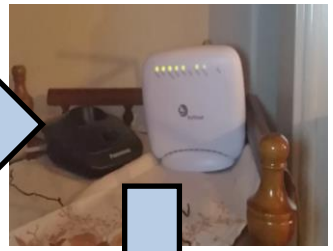
ADSL Modem/Router

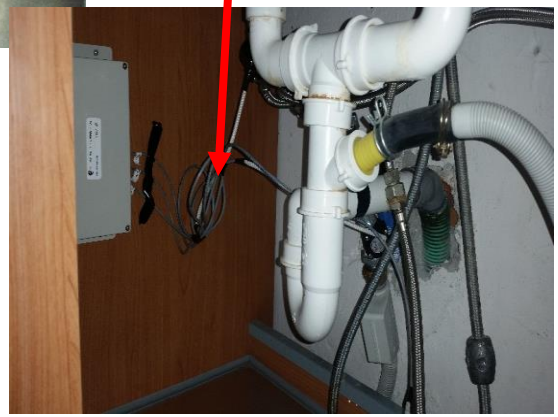
Cable



RS45
Wireless
connection

Ethernet





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

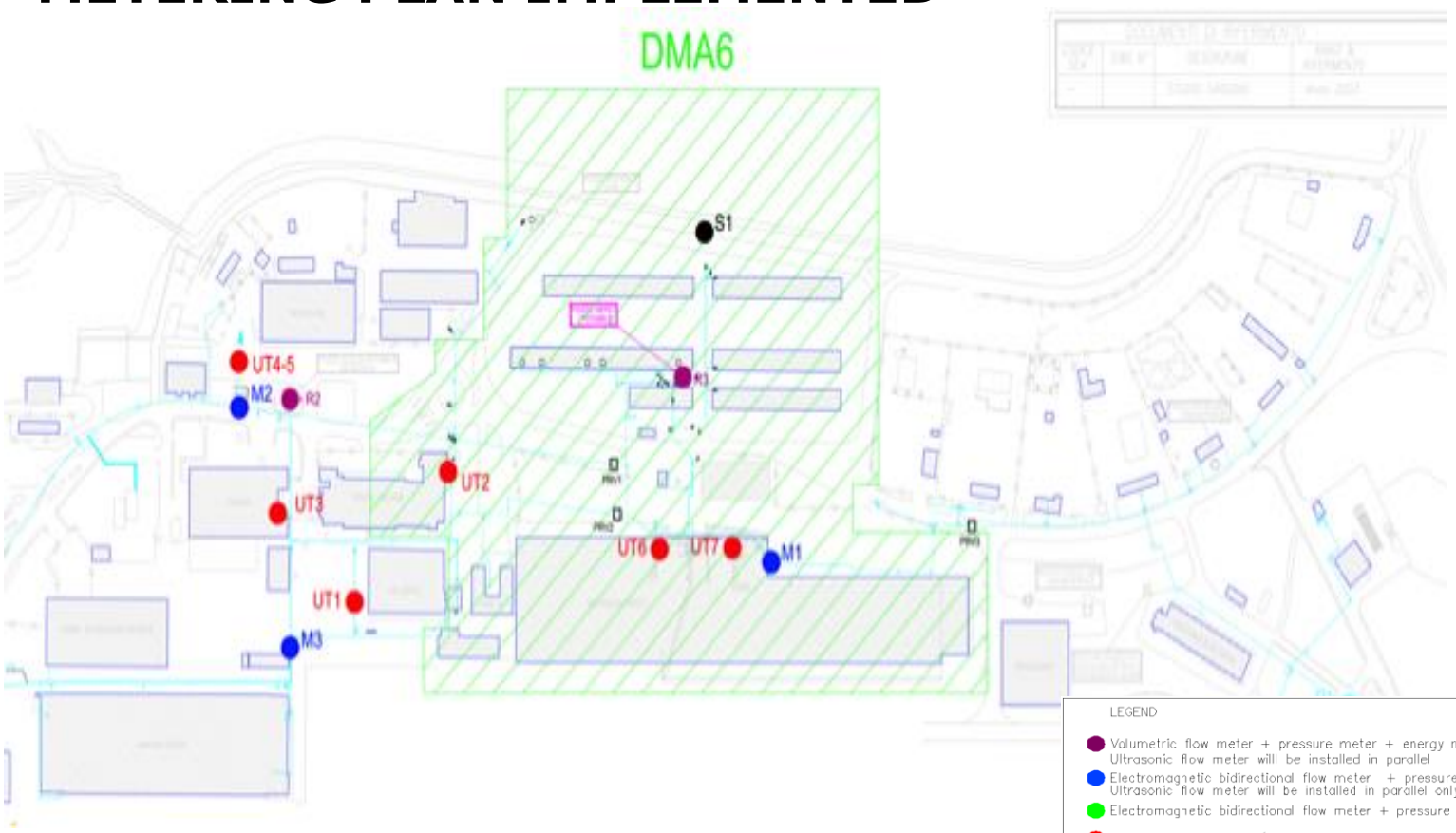
A District Meter Area has been chosen

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

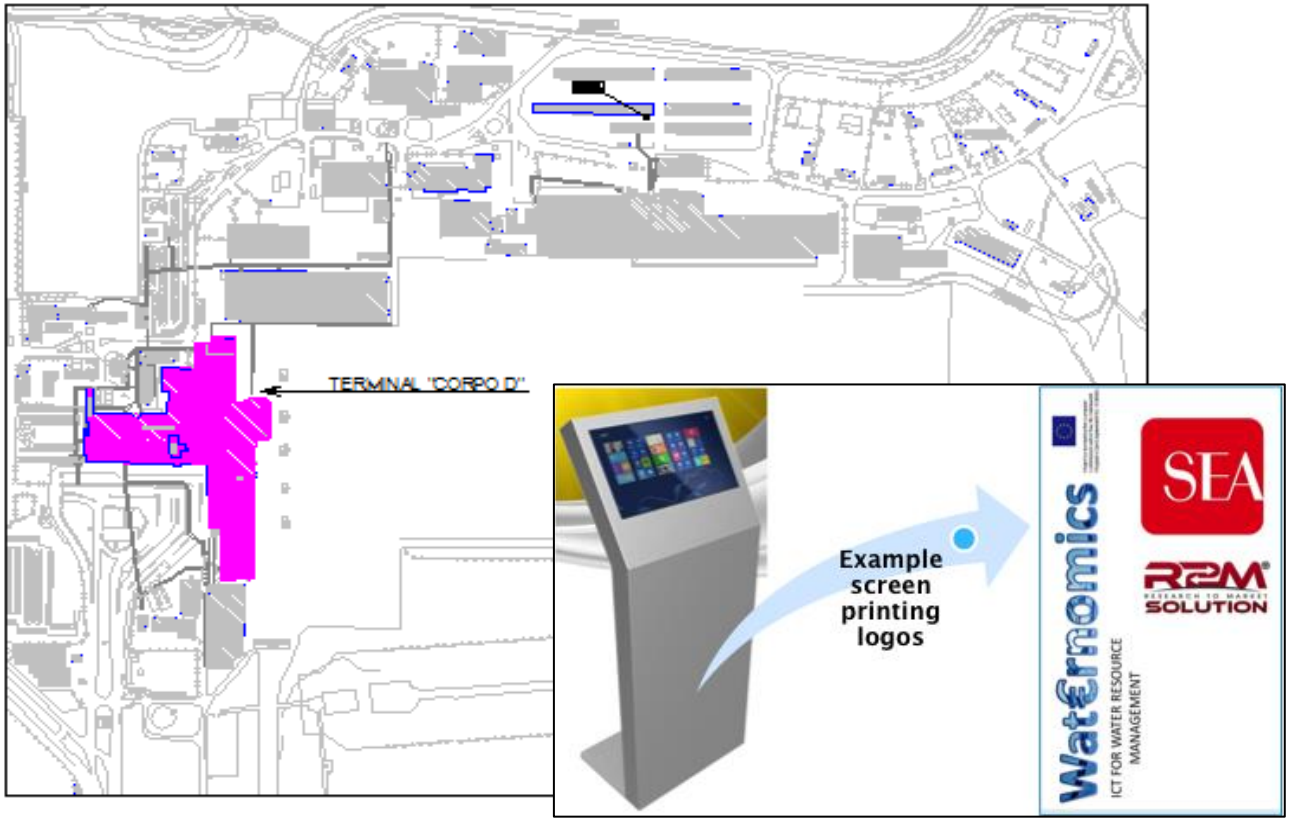
METERING PLAN IMPLEMENTED



LEGEND

- 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 monito 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
Manitenance 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.

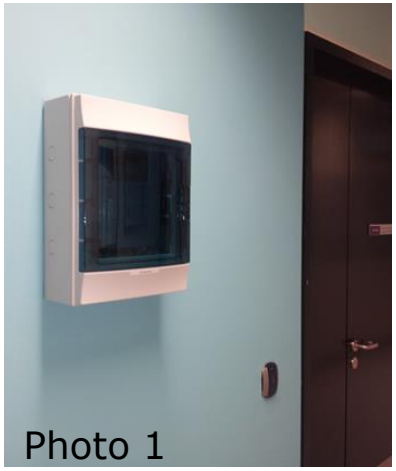


Photo 1


Photo 2

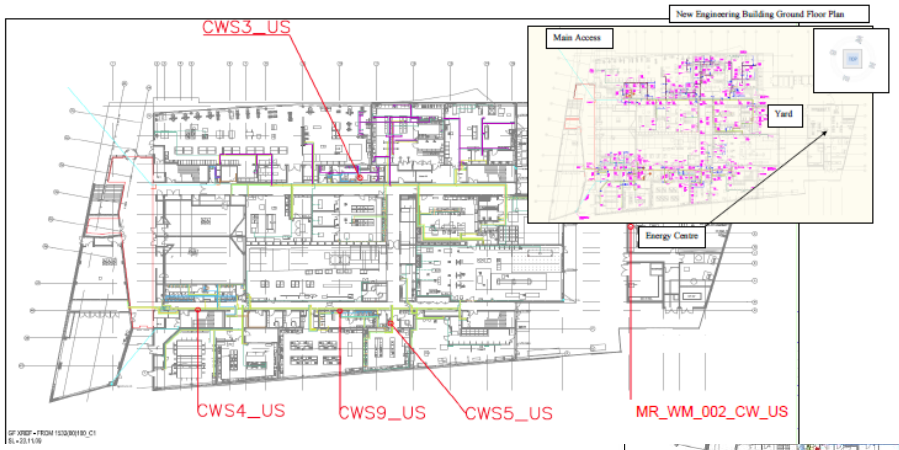
Photos 1, 3, 4 Installed Meters NUI Galway

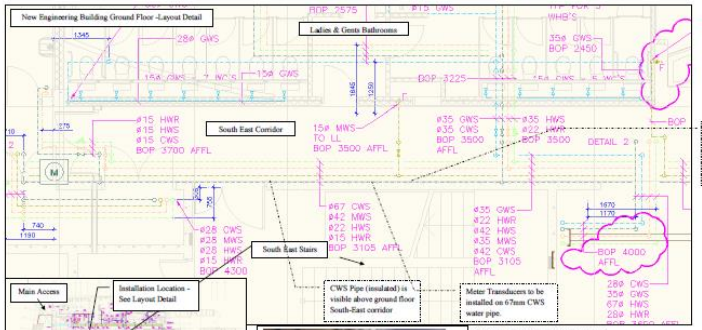

Photo 3

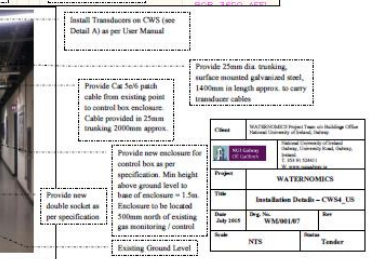

Photo 4

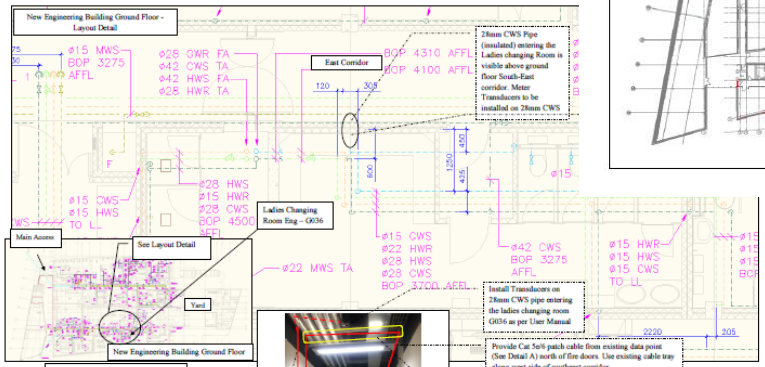
PILOT 3: ENGINEERING UNIVERSITY BUILDING - GALAWAY (IRELAND)

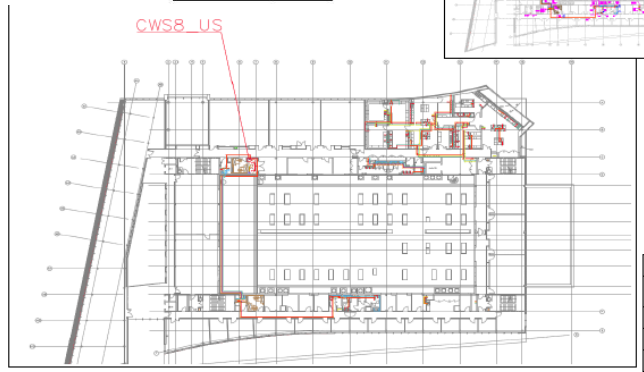
OÉ Gaillimh
NUI Galway

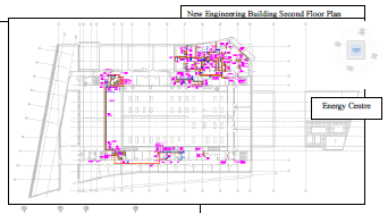


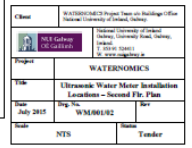












Coláiste na Coiribe secondary school under construction ~3km from Galway City (75,000 pop.); The 7,400 sqm school will be Ireland's largest Irish language second level school with 720 pupils (boys & girls aged 12-18);

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

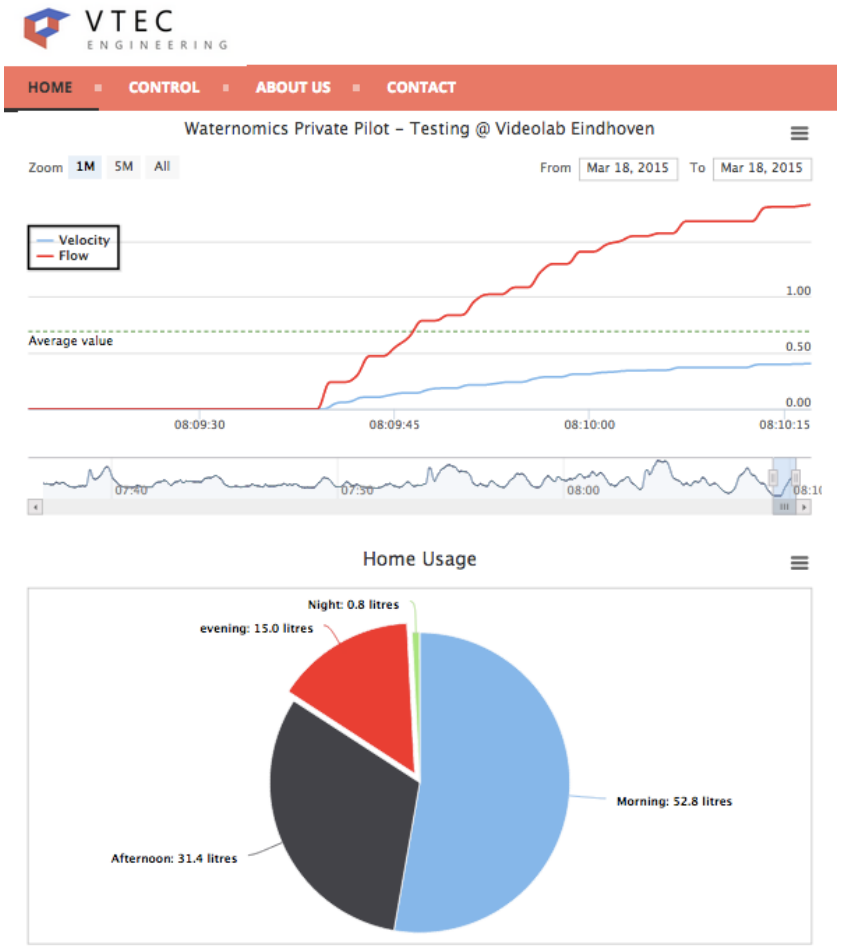
14 in-line water meters will be installed at the Pilot and a BMS Display

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.

NEXT STEPS

- 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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